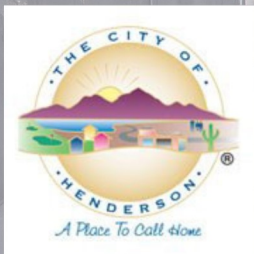
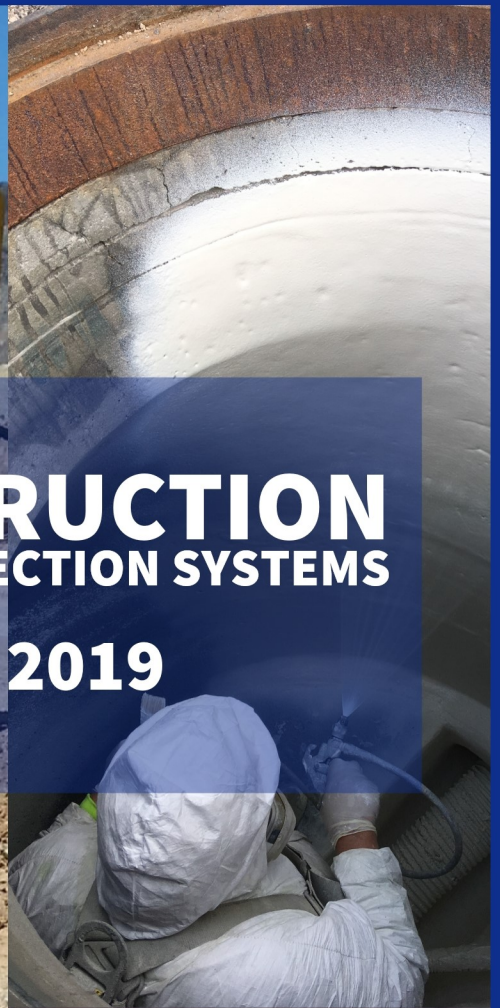


DESIGN AND CONSTRUCTION STANDARDS FOR WASTEWATER COLLECTION SYSTEMS

SOUTHERN NEVADA - 2019 4TH EDITION



CCWRD ADDENDUM #1 TO THE 2019 DCSWCS (4th EDITION)

This addendum only applies to the Clark County Water Reclamation District (CCWRD). Contact each Agency respectively for their individual addendum, if applicable.

Publication of the Addendum to the Design and Construction Standards for Wastewater Collection Systems, Southern Nevada – 2019 4th Edition shall supersede any former addenda. Any and all changes or modifications to the Design and Construction Standards for Wastewater Collection System are identified in ***italicized bold*** for additions and **struck out** and in **bold** for deletions.

A Specifications Committee has been organized to continually study and recommend changes to the standard specifications. Interested parties may address suggested changes and questions to the Specifications Committee for review.

The following participating agencies of the Clark County, Nevada area have adopted this Addendum by Resolution of their governing bodies as follows:

CLARK COUNTY WATER RECLAMATION DISTRICT
Adopted by Board of Trustees

SECTION 1 – GENERAL INFORMATION:

No changes.

SECTION 2 – DESIGN STANDARDS:

Revise as Follows:

2.1 GENERAL INFORMATION

No changes.

2.2 DEVELOPMENT REQUIREMENTS

No changes.

2.3 DESIGN CRITERIA FOR GRAVITY SEWERS

2.3.15 Manholes:

All public manholes shall have all-weather, 24/7 drivable access as required by the Agency capable of supporting an H2O vehicle loading and at least 20-feet wide for sewer maintenance purposes. All manholes shall have only one outlet pipe unless, no inlet piping is possible, such as a terminal manhole, or a specialized hydraulic structure is approved to mitigate Agency's concerns. All manholes shall be located to prevent the inflow of storm water runoff from adjacent surfaces. Manholes and manhole components shall conform to Agency's approved materials list.

Should the sanitary sewer system require multiple outlets, a specialized hydraulic structure shall be provided in lieu of a standard manhole. This structure shall be configured to optimize sewer flow hydraulics, minimize deposition of solids and facilitate maintenance.

A. Standard Manholes:

Standard manholes are manholes having a depth from top of rim to top of pipe between 4 feet and 20 feet. Standard manholes shall be designed in accordance with Standard Drawing No. SD-1. All standard manholes ~~over sewer pipes 8 to 12 inches in diameter shall have single manhole cover openings in accordance with Standard Drawing No. SD-3. All standard manholes over sewer pipes larger than 12 inches in diameter~~ shall have dual concentric manhole cover openings in accordance with Standard Drawing No. SD-2, or as required by Agency.

B. Shallow Manholes:

Shallow manholes are manholes having a depth from top of rim to top of pipe less than 4 feet. Shallow manholes shall only be used when permitted by the Agency only as a last resort when sewer depths and configurations cannot be modified to utilize standard manholes. Shallow manholes shall be designed in accordance with Standard Drawing SD-13.

C. Deep Manholes:

Deep manholes are manholes having a depth from top of rim to top of pipe greater

than twenty (20) feet. Deep manholes shall be a minimum of 72-inches internal diameter, regardless of the size, number, or flow paths of inlet and outlet pipes and have dual concentric manhole cover openings in accordance with Standard Drawing No. SD-2. For manholes greater than 25 feet deep, the Agency may require engineer to provide a structural detail for the base.

D. Drop Manholes:

Drop manholes are manholes where an external shaft drops sewage a depth, from invert of pipe to invert of shaft, a minimum of 2 feet at the manhole. Drop manholes are not permitted unless there is absolutely no other practical option for connecting sanitary sewers of differing elevations, including running parallel mains. In lieu of drop manholes, the grades of new sanitary sewers shall be adjusted such that the invert of the new sewer matches the crown of the existing sewer at the connecting manhole. Grades shall not cause the maximum sewer velocities in new sewer to exceed the requirements of Section 2.3.3 or cause erosion in the receiving manhole. The use of drop manholes will be reviewed by the Agency on a case by case basis.

The extra cost of additional sewer mains required to eliminate drop manholes shall not be considered as justification for allowing drop manholes. If allowed by the Agency, they shall be constructed per Standard Drawing SD-12. All drop manholes regardless of size, number, or flow paths of inlet and outlet pipes shall have corrosion protection per Agency requirements and conforming to Section 2.3.19.H.

E. Monitoring, Pretreatment Sampling, and Debris Screen Manholes:

The Agency at its sole discretion may require the installation of special on-site monitoring manholes per Standard Drawing SD-1, and/or pretreatment sampling manholes per Standard Drawing SD-31 for certain commercial, industrial and institutional customers to facilitate flow monitoring and wastewater sampling for its Pretreatment Program and to prevent the entry of detrimental materials into the public sanitary sewer system. The commercial/industrial/institutional customer served by such manholes shall own these manholes and shall provide regular maintenance such that the Agency may perform required monitoring and detrimental materials are prevented from entering the public sewer system.

The Engineer shall contact the Agency early in the Project design process for specific design criteria for monitoring, pretreatment sampling, and debris screen manholes. All such manholes shall also comply with the criteria set forth by the design and development standards of the Agency, the Uniform Plumbing Code, and the requirements of all other applicable building, plumbing and wastewater discharge codes and regulations. Any conflicts between the requirements of these Standards and the Uniform Plumbing Code shall be resolved in accordance with the provisions of Section 1.4.

2.3.19 Manholes and Manhole Appurtenances

A. Pre-Cast Manhole Sections:

Pre-cast manhole sections shall conform to Agency's approved materials list. Where manholes are placed in high groundwater areas and in other areas as designated by the Agency, the exteriors of the pre-cast sections, including bases, barrel sections and cones shall be waterproofed in accordance with Section 3.16.2 utilizing a coating material conforming to Agency's approved materials list.

B. Additional Requirements for Manhole Bases:

All manholes on new main sewers and new laterals shall have pre-cast manhole bases. Cast-in-place manhole bases may be utilized on new sewer mains per Agency requirements. For manholes deeper than 25-feet, structural plans for the manhole base are required. No internal platforms are allowed. The drop across the cast-in-place or pre-cast manhole invert shall be 0.2 ft minimum, except:

1. For manholes constructed as "through" manholes in accordance with SD-7, the drop across the manhole invert shall match the incoming and outgoing pipe slope. A "through" manhole is a manhole where there is no change in horizontal direction or vertical slope, and the pipe continues through the manhole at a constant slope and direction. All "through" manholes shall be designed such that bell and spigot are not present within the manhole base.
2. For manholes where the incoming pipe diameter is smaller than the outgoing pipe diameter, both pipes should have matching crown elevations at the manhole.
1. New manholes on existing sewers or existing laterals may have cast-in-place bases or pre-cast bases at the Contractor's option.
 - a. Pre-cast manhole bases shall conform to Agency's approved materials list, Standard Drawing SD-1 and other Standard Drawings as applicable.
 - b. Cast-in-place manhole bases shall conform to Section 3.16.1, Standard Drawing SD-7 and other Standard Drawings as applicable. Concrete shall conform to Agency's approved materials list and Section 4.7.2.
2. Efficient flow passage through manholes is essential to minimize the generation of odors, the release of corrosion-causing gases, and the deposition of solid materials in the manhole.
3. Flow channels shall be provided in pre-cast and cast-in-place manhole bases to smoothly direct flows from the incoming pipe(s) to the outgoing pipe without turbulence, deposition of solids or reduction in flow velocity passing through the manhole.
4. The width of the flow channels for the main sewer passing through the

manhole shall not exceed the internal diameter of the outgoing sewer. The width(s) of the flow channel(s) for incoming branch sewer(s) entering the manhole normal to the main sewer shall not exceed the internal diameter(s) of the branch sewer(s).

5. All flow channels within a manhole shall be the same height and shall extend to at least three-inches higher than the crown of the highest incoming sewer.
6. The tops of flow channels shall be sloped toward the main sewer not less than 1v:10h to facilitate sloughing off of debris.
7. Flow channels shall conform to Standard Drawing SD-9.
8. Flow channels in pre-cast bases shall be factory-installed. Flow channels in cast-in-place bases shall be field-installed.

C. Changes of Flow Direction Within Manholes:

For public sewer mains 12-inches nominal diameter and smaller, the maximum change in angle of the flow path through a manhole shall not exceed 90-degrees, unless otherwise approved by the Agency. For public sewer mains 15-inches nominal diameter and larger, the maximum change in angle of the flow path through a manhole shall not exceed 45-degrees, unless otherwise approved by the Agency. Where the total change of flow direction ranges from 46-degrees to 90-degrees, two manholes shall be used. Where the total change of flow direction ranges from 91-degrees to 120-degrees, three manholes shall be used. For changes of direction greater than 120-degrees, special hydraulic structures shall be provided. Engineer shall contact the Agency early in the Project design process to determine the requirements for special hydraulic structures. Where multiple manholes are used to accomplish changes of direction greater than 45-degrees, the change in direction accomplished in each manhole shall be approximately equal. Multiple manholes shall be spaced to facilitate sanitary sewer maintenance and avoid conflicts with other utilities. The spacing between multiple manholes shall generally range from a minimum of 1-foot to a maximum of 3-feet for each foot of depth to the invert of the sanitary sewer. The Engineer shall contact the Agency early in the Project design process to determine the spacing required for multiple manholes.

D. Additional Requirements for Pre-Cast Concrete Grade Rings:

Grade rings shall conform to Agency's approved materials list, and shall be installed in accordance with Standard Drawing SD-5. A minimum of one and a maximum of two grade rings shall be used for each manhole. The total distance from the top of the manhole cone to the top of the manhole frame after final paving shall not exceed 18-inches including grade rings, joints between the cone/grade rings/frame, and the height of the manhole frame.

E. Additional Requirements for Pre-Cast Concrete Section and Grade Ring Joints:

1. Manhole joints shall be sealed and grade rings shall be grouted in accordance with Sections 3.16.2.C and 3.16.6.

F. Frames and Covers:

Manhole frames and covers shall conform to Agency's approved materials list. The "Standard Concentric Dual Cover and Frame" shown in Standard Drawing SD-2 shall be used for all manholes ~~where the pipe diameter is greater than 12 inches. Where the pipe diameter is 12 inches or less, the "Standard Concentric Single Cover and Frame" shown in Standard Drawing SD-3 shall be used.~~ Locking manhole covers, as shown in Standard Drawing SD-6, shall be used as directed by the Agency.

G. Connections to Manholes:

New manholes shall be designed such that all flexible connectors required for new sewers are factory-installed and conform to Agency's approved materials list. A reinforcing bar as shown in Standard Drawing SD-9 shall be placed above each pipe connections in new pre-cast manholes to facilitate final grouting of the pipe connections into the manholes. The spaces between the protruding pipe ends entering the manholes shall be grouted in accordance Section 3.16.4 to form a smooth interior surface to prevent the accumulation of sewer solids and to fully support the upper projection of the sewer pipe into the manhole. Elevations of connections shall be designed in accordance with Section 2.3.8.

Connections of new sewers to existing manholes and existing sewers to new manholes shall be made using field-installed flexible connections conforming to elevation requirements of Section 2.3.8 and the installation requirements of Section 3.16.8. Field-coring of holes into new manholes for installing connections for new sewers is not permitted, except with the prior approval of the Agency.

H. Corrosion Protection:

Corrosion Protection meeting Agency requirements and conforming to Sections 3.16.8, and Agency's approved materials list, shall be provided in all locations where it may be reasonably anticipated that odors and/or corrosive gases may be released in the sewer as a result of turbulence or other factors. The Engineer shall contact the Agency as early as possible in the Project design process to identify any additional requirements for design and installation of corrosion protection. As a minimum corrosion protection shall be provided in the following locations:

1. All manholes for sewers 15-inches in diameter and larger;
2. All manholes where the pipe slope decrease between upstream and downstream sewers greater than 4-percent;
3. All manholes for sewers 10 inches and larger where there are changes in horizontal direction greater than 45 degrees or there are more than one inlet connection to the manholes;

4. All manholes receiving the discharge from a force main and one manhole upstream and one manhole downstream from the manhole receiving the discharge from a force main;
5. All siphon inlet and outlet structures and the next manhole downstream from the siphon outlet structure;
6. All drop manholes per Standard Drawing SD-12;
7. All pump station wet wells;
8. All manholes where the incoming pipe slope is greater than 4-percent, the change in horizontal direction is greater than 45-degrees, and where the d/D is 0.25 at peak flow after build out; and,
9. All other locations as directed by the Agency

I. Odor Control Equipment:

The Engineer shall contact the Agency early in the Project design process to determine the specific odor control equipment requirements, sizing, and equipment placement for each individual project. Odor control equipment shall be placed as follows:

1. upstream and downstream manholes of inverted siphons;
2. at pump station wet wells;
3. on the manholes downstream of ends of energy dissipating devices;
4. at manholes where incoming flow velocities exceed five (5) feet per second at peak dry weather flow;
5. at manholes receiving discharges from force mains and one manhole upstream and one manhole downstream from the discharge location;
6. at drop manholes and one manhole upstream and one manhole downstream from the drop manhole;
7. and, in other locations as directed by the Agency where there is potential for odors to escape from the sanitary sewer system.

Generally, for locations with limited potential for odor emissions, manhole odor-control insert units conforming to Section 4.6 shall be installed where designated by the Agency.

In addition to or in lieu of odor control inserts, the Agency reserves the right to also require that gas phase and/or liquid phase odor control equipment conforming to Section 4.6 shall be provided at sanitary sewer locations where the potential for odor generation is deemed significant by the Agency.

2.3.20 Manhole and Main Line Locations

All public manholes located in unpaved public right of ways or easements shall have all weather, 24/7, drivable access as required by the Agency capable of supporting an H20 vehicle loading and at least 20 feet wide for sewer maintenance purposes.

A. Main Line Locations:

Public interceptor sewers and public collector sewers shall not be placed beneath the following:

1. parallel sidewalks, parallel curbs/gutters, parallel roadway medians, parallel parkway areas, parallel walls
2. parking areas,
3. overhead power or communications wiring,
4. street light mast arms,
5. subdivision gated medians,
6. other areas where trees will be planted,
7. or in any location which is designed to collect water.

Where public interceptor sewers and public collector sewers must cross sidewalks, curbs/gutters, roadway medians, unpaved parkway areas, and walls, these crossings shall be perpendicular to the maximum extent practical.

B. Manhole Locations:

Sanitary sewer manholes shall be located as follows:

1. In the roadway pavement a minimum of 8-feet from back of curb **to outside edge of manhole** or a minimum of 6-feet from edge of pavement **to outside edge of manhole** for non-curbed streets wherever practical.
2. Terminal sanitary sewer manholes shall be located in the pavement a minimum of 8-feet from any curb in any direction.
3. Manholes shall not be placed in areas designed to collect storm water.
4. Outside the wheel path of motor vehicles and in areas where parked vehicles will not hinder access to the manhole.

Refer to RTC Standard 501 latest edition for typical locations for various utilities in a street cross-section.

2.4 DESIGN CRITERIA FOR PUMPING STATIONS

No changes.

2.5 DESIGN CRITERIA FOR FORCE MAINS

No changes.

2.6 CONSTRUCTION DOCUMENT REQUIREMENTS

No changes.

SECTION 3 – DESIGN STANDARDS:

Revise as Follows:

3.1 STANDARD SPECIFICATIONS

No changes.

3.2 CONTRACTOR'S LICENSE

No changes.

3.3 CONTRACTOR'S RESPONSIBILITY

No changes.

3.4 RIGHT-OF-WAY ENCROACHMENTS

No changes.

3.5 JOB START CHECK LIST

No changes.

3.6 CUT SHEETS

No changes.

3.7 CERTIFICATIONS OF INSTALLATION PROCEDURES

No changes.

3.8 GRADE LINES

No changes.

3.9 CONSTRUCTION STAKING

No changes.

3.10 RECORD DRAWINGS

No changes.

3.11 BYPASS PUMPING SYSTEM

No changes.

3.12 AGENCY PIPELINE ENCROACHMENT - BLASTING

No changes.

3.13 EARTHWORK

No changes.

3.14 PIPE INSTALLATION

No changes.

3.15 SOIL TESTING

No changes.

3.16 MANHOLE AND CAST-IN-PLACE STRUCTURE INSTALLATION3.16.1 Manhole Base Construction:

Manhole base construction shall be as follows unless otherwise required by the Agency:

1. All manholes on new public interceptor sewers, public collector sewers private collector sewers and new laterals shall have pre-cast manhole bases.
2. New manholes on existing sewers or existing laterals may have cast-in-place bases or pre-cast bases at the Contractor's option.
3. Pre-cast manholes shall conform to Agency's AML and Standard Drawing SD-1.
4. Cast-in-place bases shall conform to Standard Drawing SD-7.
5. Contractor shall use an impression ring when forming cast-in-place manhole bases. This impression ring shall match the manhole components.
6. Concrete for cast-in-place bases and flow channels within manholes shall conform to Section 4.7.2. At no time when placing concrete for cast-in-place manhole bases or other sanitary sewer structures shall the concrete be permitted to fall from a height greater than 6 feet (6') without the use of chutes, tremies or an elephant trunk. All structural concrete pours shall be performed in accordance with A.C.I. recommendations. The Contractor shall furnish the Agency's Representative with a copy of the concrete delivery ticket, which indicates the type of concrete and bonafide time stamp of when the truck was loaded, prior to any pouring operations. All concrete shall be poured from the truck within 90 minutes from the time on the concrete delivery ticket.
7. Changes in direction of flow, and size and grade of manhole flow channels shall be in accordance with Section 2.2.10.b. and Standard Drawing SD-9.
8. Where cast-in-place manhole bases are allowed, the invert channels in the manhole shall be formed in accordance with Standard Drawings SD-7.
9. Straight-through flow channels in cast-in-place manhole bases shall be created by using a full sewer pipe closely matching the internal diameter of the existing main sewer pipe upstream and downstream of the manhole as a form for the flow channel. After the manhole base has cured at least seven days **or when concrete break results reach 3375 PSI**, the pipe in the base of the manhole shall be carefully sawed out to form a smooth invert through the manhole.
10. Where branch sewers will enter cast-in-place manhole bases, at least 14-days prior to the manhole construction, Contractor shall submit a shop drawing of the

manhole base construction for Agency approval. Flow channels shall conform to Section 2.2.10.b, Section 2.2.17 and Standard Drawing SD-9.

11. The pipe(s) through the manhole base shall be connected to the existing upstream and downstream sewer pipes outside the new manhole using correctly sized flexible, water-tight couplings conforming to Agency's AML to match the existing sewer line in which the manhole is being installed.
12. Contractor shall provide the Agency's Representative all concrete mix tickets upon delivery to the site of the work.

3.16.5 Frame and Cover Installation:

1. Manhole and structure frames and covers shall conform to Agency's AML and as shown in Standard Drawings SD-2 ~~and SD-3~~.
2. All machined surfaces on the frame and cover shall be such that the cover will lie flat in any position in the frame and have a uniform bearing through its entire circumference.
3. Any frame and cover which creates any noise when passed over by automobiles shall be replaced.
4. Frames shall be set firmly in a bed of cement grout conforming to Agency's AML and shall be set true to finish grade as shown on the Construction Documents and as called for in these Standards. The grout shall extend across the full width of the base of the frame such that there are no voids under the frame. After the frame is placed and prior to the grout taking a "set", any excess grout that extruded into the manhole or structure shall be removed flush with the interior of the frame and top of the cone section.
5. Bolts shall be installed in the cover where required by Agency.

3.16.9 Debris Trap:

Following completion of the first manhole(s) upstream of the new connection(s) to the Agency's existing sanitary sewer system, a debris trap shall be installed in the manhole(s) per **3.14.5** and SD-27.

3.17 LATERAL SEWER CONNECTIONS

No changes.

3.18 ABANDONMENT OF EXISTING FACILITIES

No changes.

3.19 TESTING

No changes.

3.20 FINAL ACCEPTANCE

No changes.

3.21 CERTIFICATE OF OCCUPANCY
No changes.

3.22 BOND RELEASE:
No changes.

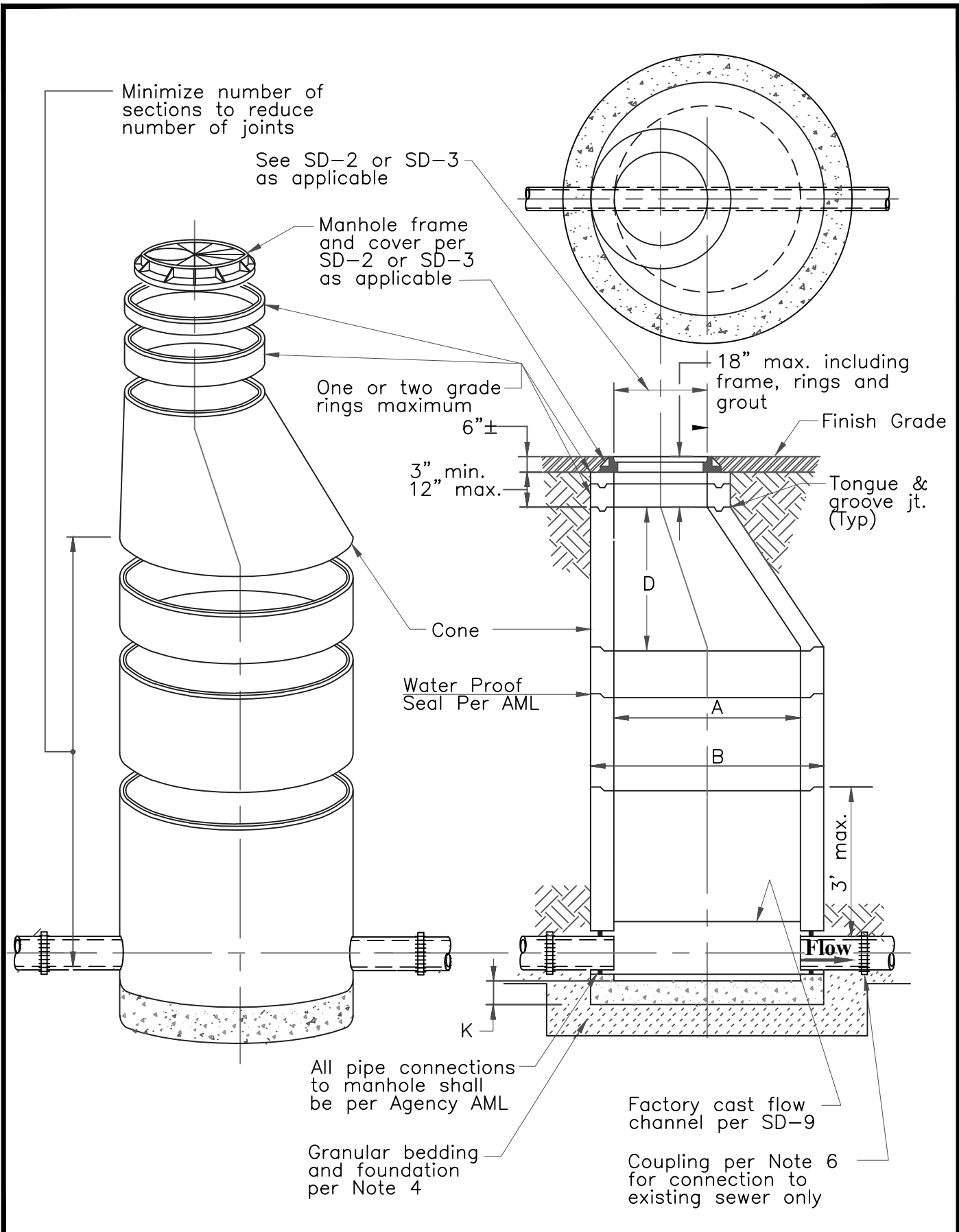
3.23 WARRANTY:
No changes.

SECTION 4 – CONTROL OF MATERIALS:
No changes.

SECTION 5 – STANDARD DRAWINGS:
Revise as Follows:

1. The following sheets are replaced by this addendum:
 - a. SD-1 and SD-1 CONT.
 - b. SD-7
 - c. SD-18
 - d. SD-19
 - e. SD-31

SECTION 6 – TABLES:
No changes.



STANDARD PRE-CAST MANHOLE

ISSUED:

NUMBER: SD-1

TABLE OF DIMENSIONS				
Size	A	B	D*	K
48	48	58	36	8
60	60	72	36	8
72	72	86	36	8

Table of Dimensions not applicable to polymer manholes. Polymer manhole thickness per manufacturer's recommendation.

*Varies per manufacturer

NOTES:

1. Pre-cast concrete manhole sections and adjusting rings shall conform to ASTM C-478 and approved Agency's Material List (AML).
2. Provide interior corrosion protection meeting Agency requirements and Section 2.3.19.H.
3. In high groundwater areas and where directed by the Agency, seal exterior of pre-cast manhole sections with bitumastic or equal waterproofing coating and provide double seals per AML between all pre-cast sections, including adjusting rings.
4. Where the trench bottom is undisturbed soil, 4-inches of granular bedding material meeting Agency requirements shall be placed under the pre-cast manhole base. Where the trench bottom has been disturbed and in fill areas, 12-inches of granular bedding meeting Agency requirements shall be placed under the pre-cast manhole base. Provide additional suitable foundation per Section 3.13 and as required by the Agency in areas of unstable trench bottom, wet conditions, over-excavation, rocky trench bottom and elsewhere as directed by the Agency.
5. Pre-cast manhole bases shall be used for construction of new sewer systems, whether publicly or privately owned. Pre-cast manhole bases or cast-in-place manhole bases per SD-7 may be used at the contractor's option for new manholes being installed along existing sanitary sewers.
6. ~~Flexible rubber couplings per AML shall be provided for connections to existing sewers where new manholes are installed.~~ For PVC pipes, couplings must match pipe material. For other pipe materials, couplings require District approval.
7. All manhole bases shall be 8" thick, minimum.

CCWRD only:

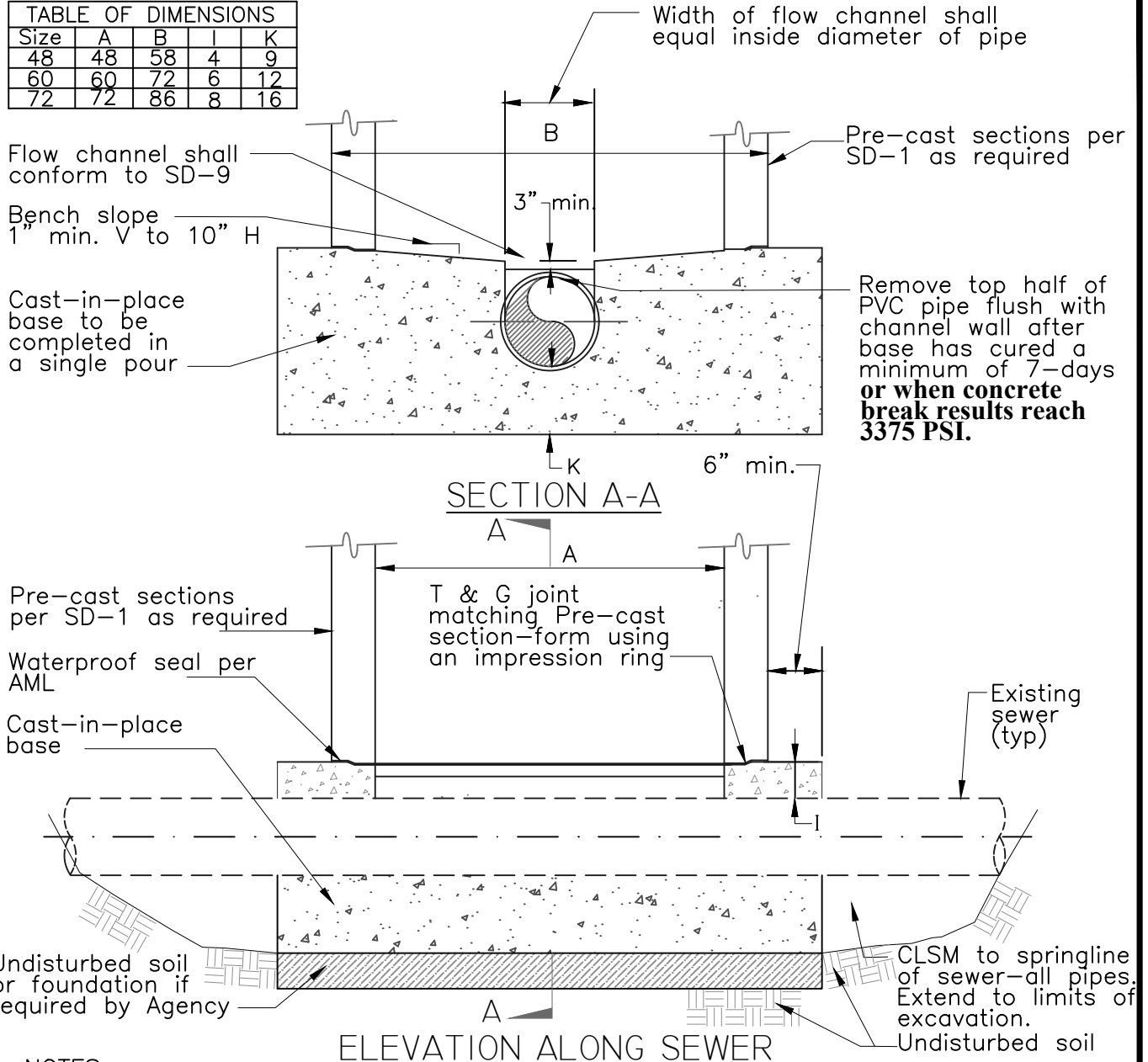
8. Orientation of cone entrance must be 180° from invert out.
9. Public manholes with stubs shall be pre-cast unless installed on existing pipe.

STANDARD PRECAST MANHOLE

ISSUED:

NUMBER: SD-1 CONT.

TABLE OF DIMENSIONS				
Size	A	B	I	K
48	48	58	4	9
60	60	72	6	12
72	72	86	8	16



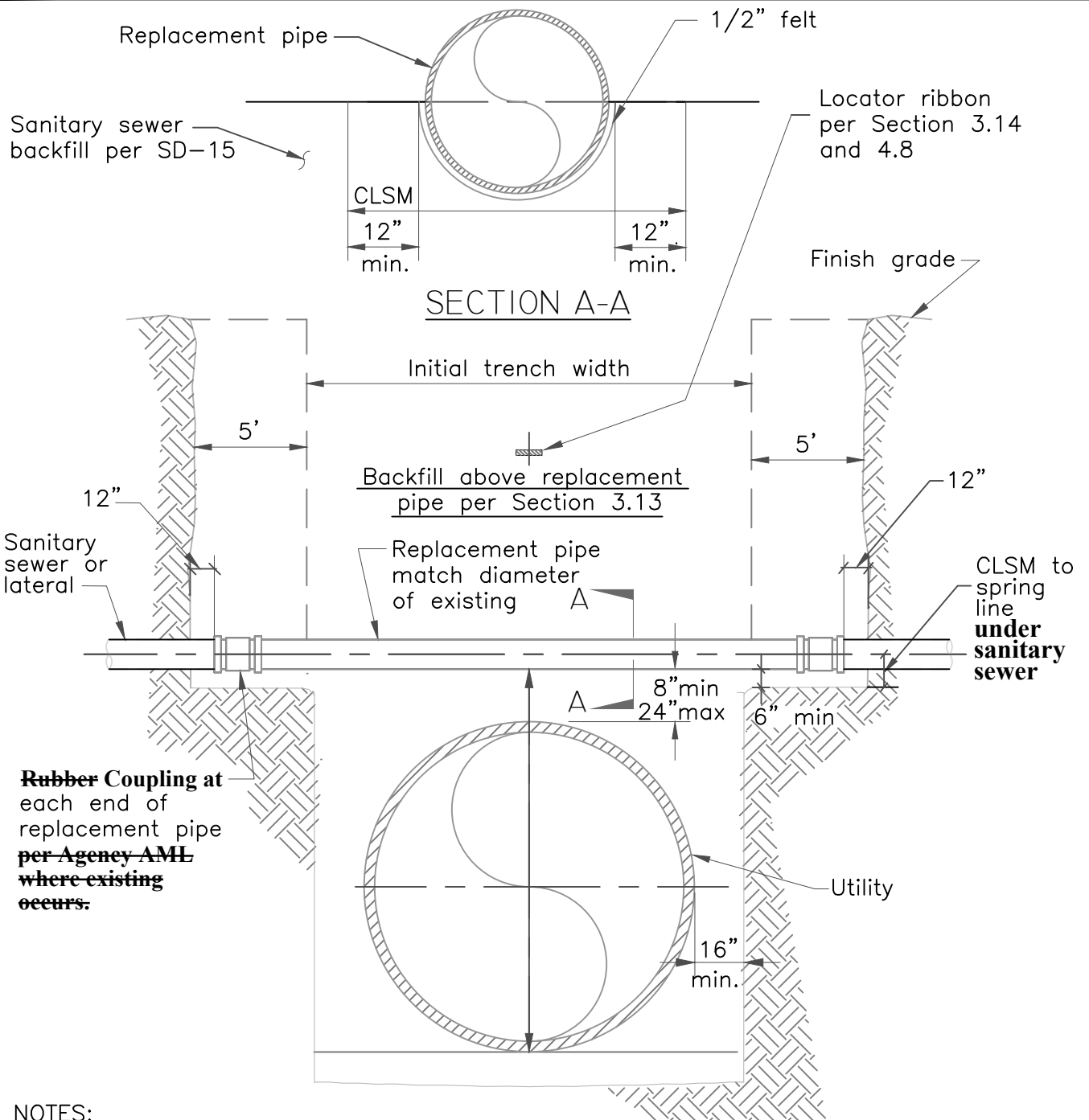
NOTES:

1. Along new or existing sewers, cast-in-place manhole base may be used in lieu of pre-cast base for new manholes.
2. A cast-in-place base may be used in lieu of a pre-cast base for new sewers only when the new manhole is a "through" manhole.
3. Concrete shall conform to Section 4.7.
4. Base may be round or square.
5. Provide suitable foundation per Section 3.13 and as required by the Agency in areas of unstable trench bottom, wet conditions, over-excavation, rocky trench bottom, and elsewhere as directed by the Agency.
6. If existing sewer pipe is damaged or if a pipe joint falls within the manhole base pour, the existing sewer pipe shall be replaced with PVC per Agency AML. The replacement PVC pipe shall be reconnected to the existing sewer using flexible couplings per Agency AML.
7. Provide corrosion protection per Section 3.16.8.
8. **Cast-in-place manhole base to set for 7 days before stacking components or when concrete break results reach 3375 PSI.**

CAST-IN-PLACE MANHOLE BASE INSTALLED IN EXISTING SEWER

ISSUED:

NUMBER: SD-7



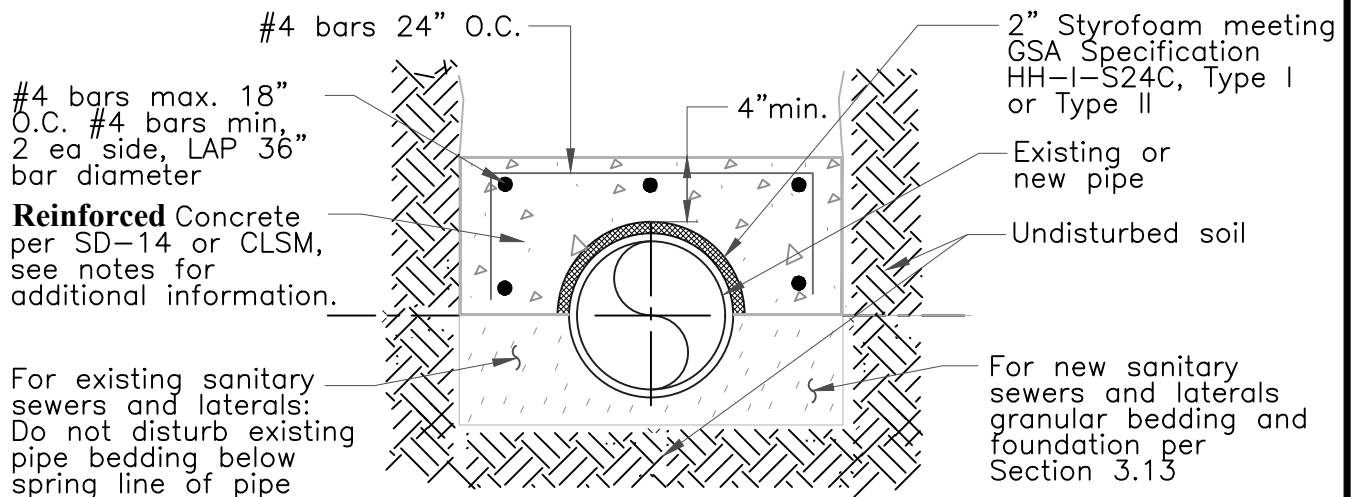
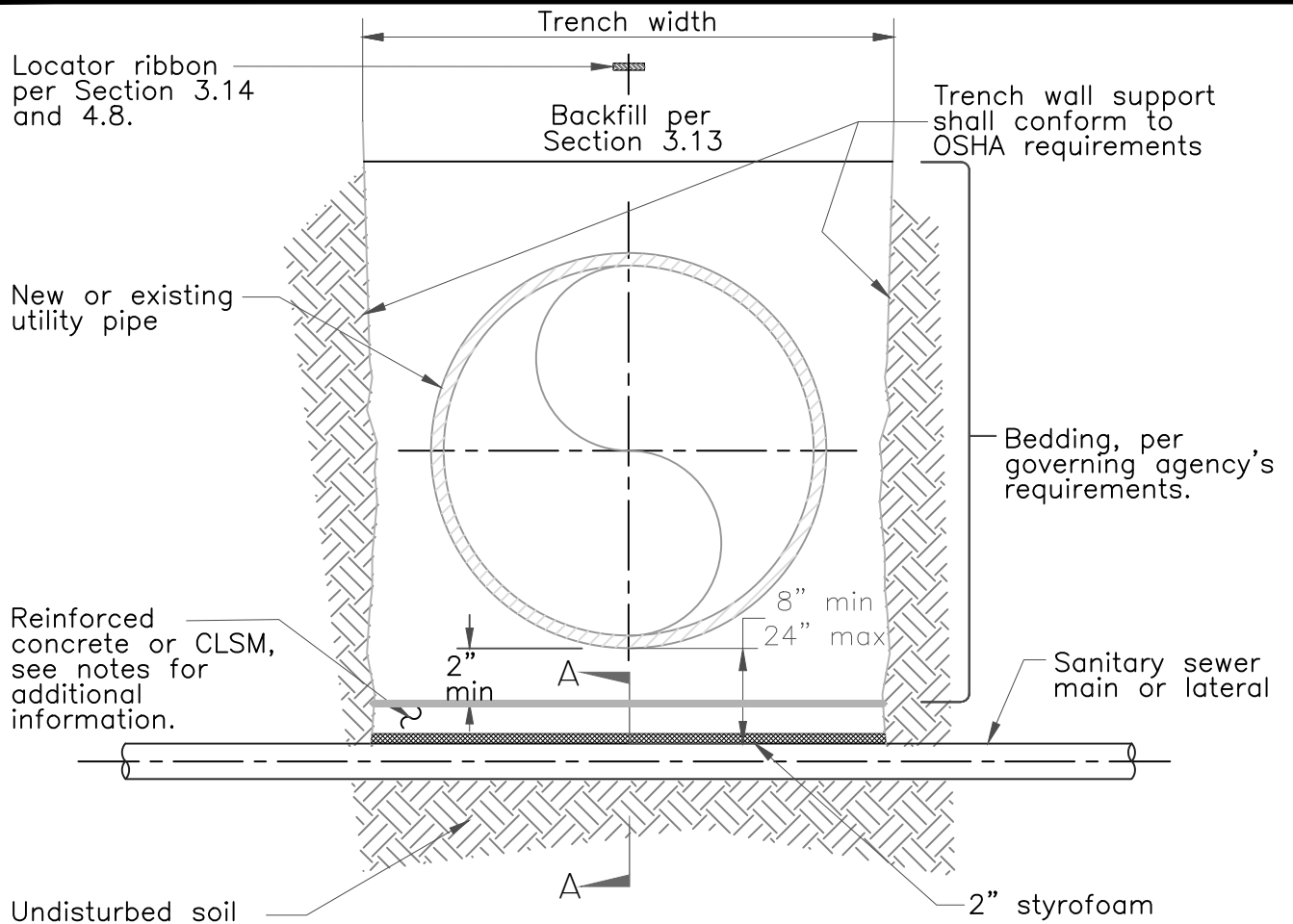
NOTES:

1. **Pipe replacement only required when repairing damaged pipe. All attempts must be made to protect pipe in place.** Replace all existing sanitary sewers and laterals with **C-900 PVC as applicable or as approved by the District.** Replace storm sewers as required by Agency.
2. Not for water mains or water services. See UDACS for replacement requirements.
3. Upper and lower trench wall support shall conform to OSHA requirements.
4. Use this detail where the vertical clearance from outside of new utility to outside of sewer/lateral is less than 24 inches.
5. If utility is existing, expose top of existing utility.
6. **For PVC pipes, couplings must match pipe material. For other pipe materials, couplings require District approval.**

**PROTECTION OF SANITARY SEWER
OR LATERAL OVER A UTILITY**

ISSUED:

NUMBER: **SD-18**



SECTION A-A

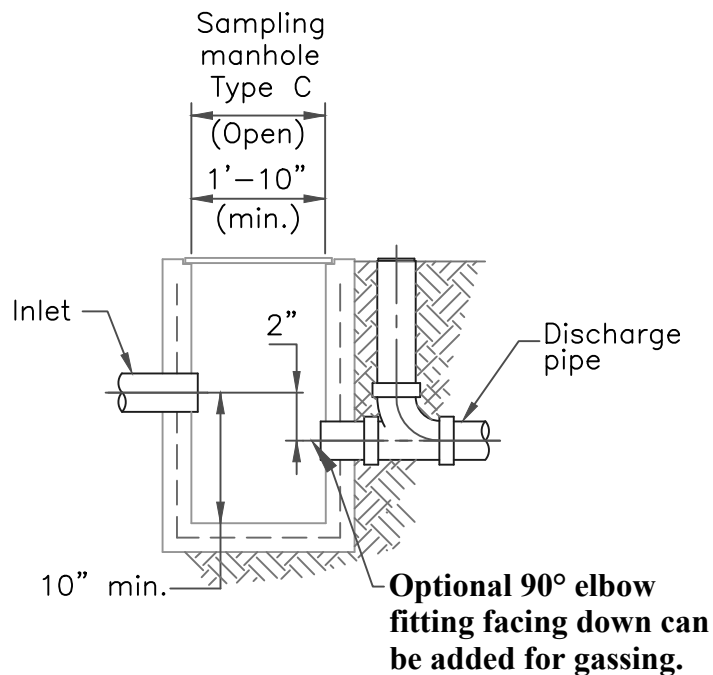
NOTE:

1. Use this detail where the vertical clearance from outside of utility pipe to outside of sewer/lateral is less than 24 inches and greater than 8".
2. Where vertical clearance from outside of utility pipe to outside of sewer/lateral is less than 8", contact governing agency for requirements.
3. For utility pipes greater than 24" in diameter with 24" or less cover, contractor shall use concrete.
4. For utility pipes 24" or less in diameter with 24" or less cover, contractor shall use CLSM.

PROTECTION OF SANITARY SEWER UNDER A UTILITY

ISSUED:

NUMBER: SD-19



NOTES:

1. Provide 2" free fall from centerline of outlet to centerline of discharge pipe.
2. Check with each governing Agency for allowable use of type **A, B or C** sampling manhole within their jurisdiction.
3. Type **A, B or C** manholes require a minimum of 10" at the bottom of the manhole for immersion of lab sampling bottle. **Type B manholes require 6" minimum tees since the sample bottle is lowered within the tee.**

PRETREATMENT SAMPLING MANHOLE

ISSUED:

NUMBER: SD-31

**DESIGN AND CONSTRUCTION STANDARDS
FOR WASTEWATER COLLECTION SYSTEMS**

2019

******Participating Agencies******

**CLARK COUNTY WATER RECLAMATION DISTRICT
5857 East Flamingo Road
Las Vegas, Nevada 89122
(702) 668-8160**

**CITY OF BOULDER CITY
401 California Avenue
Boulder City, Nevada 89005
(702) 293-9282**

**CITY OF HENDERSON
240 Water Street
Henderson, Nevada 89015
(702) 267-3670**

**CITY OF LAS VEGAS
495 S Main St
Las Vegas, Nevada 89101
(702) 229-6276**

**CITY OF NORTH LAS VEGAS
2829 Fort Sumter Drive
North Las Vegas, Nevada 89030
(702) 633-1275**

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FORWARD

Publication of these Design and Construction Standards for Wastewater Collection Systems is the fourth edition of this important document and shall supersede any former editions or any of the former individual editions published by the participating agencies.

Special provisions and drawings shall be provided, when necessary, to supplement or modify these standard specifications.

The Design and Construction Standards for Wastewater Collection Systems may be revised by issuance of a supplement to correct errors and omissions found in these specifications and to reflect advanced thinking and the changing technology of the construction industry. Each supplement shall supersede any previous supplement by inclusion of all pertinent portions.

To implement this end, a Specifications committee, including a representative of each of the participating agencies, has been organized to continually study and recommend changes to the standard specifications. Interested parties may address suggested changes and questions to the Committee for Design and Construction Standards for Wastewater Collection Systems, c/o any of the participating agencies listed on the cover of this publication.

The following participating agencies of the Clark County, Nevada area have adopted these specifications by Resolution of their governing bodies as follows:

CLARK COUNTY WATER RECLAMATION DISTRICT Adopted by Board of Trustees	May 7, 2019
CITY OF BOULDER CITY Adopted by Resolution	May 28, 2019
CITY OF HENDERSON Adopted by City Council	May 8, 2019
CITY OF LAS VEGAS Adopted by Resolution	
CITY OF NORTH LAS VEGAS Adopted by the Director of Utilities in accordance with the City of North Las Vegas Municipal Code 13.04.140	

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DESIGN AND CONSTRUCTION STANDARDS

TABLE OF CONTENTS

<u>SECTION</u>	<u>ITEM</u>
1	GENERAL INFORMATION
2	DESIGN STANDARDS
3	CONSTRUCTION STANDARDS
4	CONTROL OF MATERIALS
5	STANDARD DRAWINGS
6	TABLES
7	INDEX

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**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 1

GENERAL INFORMATION

TABLE OF CONTENTS

GENERAL INFORMATION

SECTION 1

<u>Section</u>	<u>Description</u>	<u>Page No.</u>
1.1	General Statement	1-1
1.2	Definitions	1-2
1.2.1	Additional Service Areas	1-2
1.2.2	Agency's Representative	1-2
1.2.3	Average Flow	1-2
1.2.4	Construction/Contract Document	1-2
1.2.5	Construction Drawings	1-2
1.2.6	Contractor	1-2
1.2.7	Design and Construction Standards	1-2
1.2.8	Developer	1-3
1.2.9	Director/General Manager	1-3
1.2.10	Engineer	1-3
1.2.11	Equivalent Residential Units (ERU)	1-3
1.2.12	Lateral	1-3
1.2.13	Participating Agency or Agencies	1-3
1.2.14	Peak Dry Weather Flow	1-4
1.2.15	Peak Wet Weather Flow	1-4
1.2.16	Private Collector Sewer	1-4
1.2.17	Project	1-4
1.2.18	Public Interceptor Sewer and Public Collector Sewer	1-4
1.2.19	Pump Station/Lift Station	1-5
1.3	Abbreviations	1-5
1.4	Reference to Standards and Publications	1-5
1.5	Locations of Existing Utilities and Site Objects	1-6
1.6	Working Hours	1-6
1.7	Inspection	1-6
1.7.1	Duties of Agency's Representative	1-6
1.7.2	Inspection of Work	1-7
1.7.3	Scheduling of Inspection	1-8
1.8	Indemnity	1-8
1.9	Guarantee	1-9
1.10	Violations	1-9
1.11	Time Limitation	1-9
1.12	Standard Drawings	1-9
1.13	Rules and Regulations	1-9

1.14	Approved Materials	1-10
1.15	Pretreatment Requirements	1-10

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SECTION 1

GENERAL INFORMATION

1.1 GENERAL STATEMENT

The Clark County Water Reclamation District and the Cities of Boulder City, Henderson, Las Vegas and North Las Vegas are governmental subdivisions of the State of Nevada that provide sanitary sewer service pursuant to the provisions of NRS 265, 266, 267, 318 and other applicable State requirements. The Design and Construction Standards for Wastewater Collection Systems presented herein have been adopted by the governing bodies of each of the Participating Agencies and represent the minimum design and construction criteria for sanitary sewer systems within the jurisdiction of each of the Participating Agencies. All Contractors working on wastewater collection systems shall be familiar with these specifications and shall have access to these specifications at all times during construction.

Except as expressly set forth in the Design and Construction Standards, the Developer or the Contractor shall select the means, methods and sequences for constructing facilities in accordance with these Standards. The Participating Agency will not participate in selection of the means, methods and sequences of construction. Where particular means, methods or sequences are expressly required by these Standards, such requirements are only for the purpose of obtaining the desired results. Contractor may suggest alternative means, methods and sequences of construction that Contractor believes will achieve the required results; however, the Participating Agency shall not be obligated to accept these alternative means, methods or sequences of construction.

Except as expressly set forth in a written agreement approved by the governing body for the Participating Agency, the Developer or the Contractor shall pay all costs of constructing facilities in accordance with these Design and Construction Standards. Except as expressly set forth in a written agreement approved by the Participating Agency's governing body, the Participating Agency assumes no liability for and does not agree to pay any costs of constructing facilities. No statements, actions or omissions of any officer, employee or agent of the Participating Agency may be construed as an assumption of liability for or an agreement to pay any costs of constructing facilities. The Participating Agency's governing body has not delegated any officer, employee or agent of the respective Agency nor to any other person any authority to assume liability for or agree to pay costs of constructing facilities.

These Design and Construction Standards shall apply to all sanitary sewer improvements constructed within public right-of-ways or public easements; and, shall also generally apply to private sewers and laterals constructed on private property as hereinafter specified. The Uniform Plumbing Code, latest edition, shall also apply to the construction of private sewers and laterals on private property. Any conflicts between the requirements of these Design and Construction Standards and the Uniform Plumbing Code shall be resolved in accordance with the provisions of Section 1.4.

1.2 DEFINITIONS

1.2.1 Additional Service Areas:

All communities and regions outside the Las Vegas Valley, including but not limited to, Laughlin, Overton, Moapa Valley, Searchlight, Blue Diamond, Coyote Springs, Indian Springs and other areas so designated by the Agency.

1.2.2 Agency's Representative:

The person designated by the Director/General Manager to represent the Agency and includes the inspection staff operating as an extension of the Agency's staff assigned to Developer's Project.

1.2.3 Average Flow:

The average flow per this standard shall be 250 gallons per day per ERU.

1.2.4 Construction / Contract Documents:

These Standards and the Construction Drawings, supplemental specifications, calculations, agreements and other documentation approved by the Agency depicting the entire construction work required to complete the Project. Contractor shall perform all construction in general conformance with the Construction Documents without material deviation. If the Contractor finds that changes are required in the Construction Documents to complete the Project in conformance with these Standards, Contractor shall bring these changes to the attention of the Engineer, Developer and Agency. Revised Construction Documents shall be prepared by the Engineer depicting the changes desired and these revised Construction Documents shall be submitted to the Agency for review and approval. The changes shall be in conformance with these Standards.

1.2.5 Construction Drawings:

The drawings included in the Construction Documents prepared by the Developer's Engineer that depict the sanitary sewer and other improvements to be constructed as part of the Project.

1.2.6 Contractor:

The construction company licensed by the Nevada State Contractors Board that has been engaged by the Developer to install the Developer's Project sanitary sewer improvements depicted in the Construction Documents prepared by the Engineer.

1.2.7 Design and Construction Standards:

The term "Design and Construction Standards" or "Standards" as used in this book shall refer to the Design and Construction Standards for Wastewater Collection Systems latest edition and any Participating Agency's current Addendum

1.2.8 Developer:

The individual, corporation, public Agency or partnership that requires sanitary sewer service, either by the installation of a lateral or by constructing a sewer main extension for a proposed or existing structure or structures. The term "Developer" shall also include individuals or groups transitioning from private septic systems to public sanitary sewer service if so designated by the Agency.

1.2.9 Director/General Manager:

The Director/General Manager of the Agency or his/her duly authorized Representative.

1.2.10 Engineer:

The professional engineer, registered in the State of Nevada, who has been engaged by a Developer, Agency or Contractor to prepare the Construction Documents for the Project.

1.2.11 Equivalent Residential Unit (ERU):

Equivalent Residential Unit (ERU) is the average amount of wastewater which a single-family residence discharges into the system. An ERU is equivalent to 90,000 gallons of wastewater discharged per year.

1.2.12 Lateral:

The term lateral shall refer to the privately owned service connection from an individual residential property, individual multi-family building or individual commercial/industrial building to a public collector sewer, a private collector sewer or manhole constructed along such sewers.

1.2.13 Participating Agency or Agencies:

The governmental entity having jurisdiction over the sanitary sewer service area in which the Project described in the Construction Documents is being constructed, which is one of the following:

The Clark County Water Reclamation District, located at
5857 East Flamingo Road
Las Vegas, Nevada 89122
(702) 668-8160.

The City of Boulder City, located at
401 California Avenue
Boulder City, Nevada 89005
(702) 293-9200.

The City of Henderson, located at
240 Water Street
Henderson, Nevada 89015
(702) 267-3670.

The City of Las Vegas, located at
400 East Stewart Avenue
Las Vegas, Nevada 89101
(702) 229-6276.

The City of North Las Vegas, located at
2250 N Las Vegas Blvd
North Las Vegas, Nevada 89030
(702) 633-1484.

1.2.14 Peak Dry Weather Flow (PDWF):

The average dry weather flow multiplied by the ASCE peaking curves factor in table T-3 or as calculated.

1.2.15 Peak Wet Weather Flow (PWWF):

The peak dry weather flow (PDWF) plus an additional flow allowance of no less than 25 percent.

1.2.16 Private Collector Sewer:

The term 'private collector main' (also called 'private main sewer') shall refer to those privately owned pipelines, including manholes and other appurtenances, located in private streets or on private property that are designed to receive tributary sanitary wastewater flows from one or more private collector mains and/or service laterals and convey said wastewater flows to public collector sewers and/or to public interceptor sewers.

1.2.17 Project:

The complete sanitary sewer system improvements including, but not limited to, public interceptor sewers, public collector sewers, private collector sewers, lateral sewers, manholes, pump stations, force mains, civil improvement set, and related appurtenances presented in the Contract Documents approved by the Agency, and in full conformance with applicable local, State and Federal requirements, that are intended to provide for the collection and conveyance of sanitary wastewater ultimately flowing to the existing main sewer system in the service area under the jurisdiction of the Agency.

1.2.18 Public Interceptor Sewer and Public Collector Sewer:

The terms 'public interceptor sewer' and 'public collector sewer' (also called 'public main sewer') shall refer to those pipelines, including manholes and other appurtenances, publicly owned and installed in dedicated easements or right-of-ways designed to receive and convey tributary sanitary wastewater flows from one or more private collector mains and/or service laterals. Public interceptor sewers are generally intended to serve large geographic areas and receive flows from multiple developments and both public and private collector sewers. Public collector sewers are intended to serve individual developments and receive flows from laterals and private collector sewers.

1.2.19 Pump Station / Lift Station

The terms “pump station” and “lift station” may be used interchangeably in these Standards and shall refer to a mechanical pumping station for the conveyance of sanitary wastewater through a dual force main system from a public collector sewer, private collector sewer, or lateral to a public sanitary interceptor or collector sewer at a higher elevation.

1.3 ABBREVIATIONS

ACI	American Concrete Institute
ANSI	American National Standard Institute
ASCE	American Society of Civil Engineers
ASTM	American Society of Testing and Materials International
AWS	American Welding Society
AWWA	American Water Works Association
CIP	Cast Iron Pipe
DIP	Ductile Iron Pipe
FRP	Fiberglass Reinforced Pipe
IQAC	Interagency Quality Assurance Committee
HDPE	High Density Polyethylene
NASSCO	National Association of Sewer Service Companies
NEMA	National Electric Manufacturers Association
NRCP	Non-Reinforced Concrete Pipe
RCP	Reinforced Concrete Pipe
PACP	Pipeline Assessment Certification Program
PVC	Polyvinyl Chloride Pipe
SSPC	Steel Structures Painting Council
UDACS	Uniform Design and Construction Standards for Potable Water Systems
UPC	Uniform Plumbing Code
VCP	Vitrified Clay Pipe

1.4 REFERENCE TO STANDARDS AND PUBLICATIONS

Any reference made in these Standards or in the approved Construction Documents to any specification, standard, method or publication of any scientific or technical society or other organization shall, in the absence of a specific designation to the contrary, be understood to refer to the specification, standard, method or publication in effect as of the date the construction drawings are signed by the agency. If the Engineer or Contractor discovers any conflict among these Standards, the Construction Documents, and/or the reference standards or other references, the conflict shall be brought to the attention of the Agency prior to proceeding with the Work that is affected by the conflict. The Engineer and/or Contractor, as appropriate to the nature of the conflict, shall submit to the Agency its proposed resolution to the conflict for Agency review. The resolution shall generally be in the manner that provides the greater overall quality, performance and/or service life of the sanitary sewer system improvements being constructed. The Agency shall advise the Engineer and/or Contractor as appropriate of its decisions for resolving the conflict in writing and that resolution shall be considered as a revision to the Construction Documents and shall apply to the subject Project only.

1.5 LOCATIONS OF EXISTING UTILITIES AND SITE OBJECTS

The horizontal and vertical locations of existing sewers, other Agency utilities and other utilities/site-objects, if any, shown in Agency records have been obtained from available records which may or may not be accurate. As such, the Agency makes no guarantee, expressed or implied, that the existing sewers, other utilities and/or site objects are in the locations shown in Agency records nor shall the Agency bear any costs whatsoever associated with redesign or relocation of Project facilities caused directly or indirectly by the differences between the actual locations of existing sanitary sewers, other utilities or site objects and the locations of those sewers/utilities/site-objects depicted in Agency records. Accordingly, the Developer, Engineer and/or Contractor as appropriate shall bear the full risk and responsibility to confirm the locations of the existing sewers or other utilities, if any, to which the Developer will connect its Project facilities or other existing utilities/site objects that may interfere with construction of those facilities.

The Agency shall not waive the requirements of these Standards, the reference standards cited in these Standards or the approved Construction Documents to accommodate the failure of the Developer, Engineer and/or Contractor to accurately locate existing utilities or other site objects prior to the start of construction.

1.6 WORKING HOURS

Should the Contractor desire to work outside of normal working hours (five days per week, eight hours per day, or as established by the Agency), they may do so if approved by the Agency's Representative in writing in accordance with the notification time requirements set forth in the Agency's standard policy, except in the case of an emergency as determined by the Agency. Where the Agency incurs employee/agent overtime costs as a result of working outside the Agency's normal work hours, the Contractor will be required to pay the overtime inspection fee as established by the Agency for each hour or each portion of each hour thereof including travel to and from Agency offices, with a minimum charge of three hours, for an Agency Representative to be present during the Contractor's operations. The Contractor will be required to sign a document which constitutes approval of an overtime inspection fee or an agency provided form. The format and wording of this document are presented in Table "B." The Contractor will also be required to pay holiday overtime charges for inspection services provided on Agency approved holidays.

1.7 INSPECTION

1.7.1 Duties of Agency's Representative:

The Contractor shall be solely responsible for the construction means and methods it employs to complete the Project. Neither the Agency nor the Agency Representative shall have authority to control the Contractor's means and methods. However, the Agency Representative shall have the right but not the duty to advise the Contractor if the Agency Representative observes Contractor means and methods being employed that will not likely lead to the Project being completed in accordance with the requirements of the approved Construction Documents.

The Contractor shall be solely responsible for job site safety, including support of partially completed construction; and, for the safe passage of vehicular traffic, pedestrian traffic and construction traffic. Neither the Agency nor the Agency's Representative shall have

the authority to enforce the Contractor's sheeting/shoring/bracing designs, job site safety plan or traffic control plan. However, the Agency Representative shall have the right but not the duty to report any conditions to the Contractor he/she observes at the Project site that he/she believes may potentially be unsafe to workers or the general public. Should the Contractor fail to implement corrective actions in a manner that is both appropriate and timely to the severity of the risk to workers/bystanders, the Agency and/or the Agency Representative shall have the right but not the duty to report such situations to other regulatory agencies as appropriate.

Representatives employed by the Agency will be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The Agency's Representative(s) is not authorized to alter or waive the provisions of the Construction Documents. The Agency's Representative(s) is not authorized to issue instructions contrary to the Construction Documents or to act as foreman for the Contractor. The authority to inspect shall not be deemed to impose a duty or responsibility on the part of the Agency to inspect.

The Agency's Representative(s) will, however, have the authority to reject work or materials until any questions at issue can be referred to and decided by the Agency.

Inspection of the work by an authorized Agency Representative shall not be considered as direct control of individual workers and their work. The direct control shall be solely the responsibility of the Contractor's foreman and superintendent.

Inspections are for the sole benefit of the Agency with the goal of attaining extensions and/or improvements to the sanitary system that are in general conformance with the Construction Documents approved by the Agency. Such inspections are not for the benefit of any others nor are they intended to confer rights and/or responsibilities beyond the Agency itself.

1.7.2 Inspection of Work:

The Contractor shall provide the Agency's Representative access to the work at all times that the Contractor, its subcontractors or its other representatives are at the work site for ascertaining whether the work is in accordance with the requirements and intention of these Standards and the Construction Documents.

All materials furnished, and all work done, under these standards shall be subject to inspection. Work completed without the prescribed inspection may be required to be taken out and replaced with the proper inspection, and the entire cost of removing and replacement, including the cost of all materials taken out, shall be borne by the Contractor, irrespective of whether the work is found to be defective or not.

Work buried without the authority of the Agency's Representative shall, upon order of the Agency's Representative, be uncovered to the extent required, and the Contractor shall bear the entire cost of performing all the work and furnishing all the materials necessary for the removal of the covering and its subsequent replacement as directed and approved by the Agency's Representative.

Failure to detect or reject any defective work or materials upon inspection shall not in any way prevent later rejection of that work or materials when such defect is discovered by the Agency nor obligate the Agency in any way to accept the defective work or materials as part of final acceptance of the entire Work.

1.7.3 Scheduling of Inspection:

The Agency requires advance written notice prior to major Project work tasks such as an inspection for start-up of work for a Project, trenching, pipe laying, pipe backfilling if different from laying, testing, CCTV, lateral taps, connections to existing sanitary sewers, raising covers to grade and other work tasks as directed by the Agency. The amount of time required for notice varies among the Agencies listed in Section 1.2.1. Contractor shall contact the individual Agency having jurisdiction over the Project to determine the specific advance notice time requirements and shall adhere to those requirements. Generally, Agencies require one or two days advance written notice for the major Project tasks listed above. A minimum of three working day's notice is required for all outlying service area inspections.

The Agency requires at least one working day notice for inspection cancellation. Failure to provide such notice shall result in a one working day delay from the originally scheduled inspection date(s) before another inspection can be scheduled. In addition, the Agency at its sole discretion may charge for up to one work day cost of providing an Agency Representative for cancellation of any inspection in less than the notice period required by the Agency and for failure to work on days when inspections have been scheduled. All notices for inspections and cancellations of inspections shall be submitted to the Agency in writing.

The Contractor shall submit a schedule to the Agency presenting their proposed overall construction operations before individual inspections can be scheduled. This schedule shall identify all major construction tasks including sewer system testing. Whenever the Contractor varies the period during which work is conducted, the Contractor shall give the Agency written notice as soon as the Contractor becomes aware of the schedule change so that proper inspection may be provided. The provisions of the first paragraph of this Section 1.8.3 shall apply regarding the minimum time requirements for giving the Agency notice of schedule changes. At such times as the Contractor's work force on the sewer becomes less than a full day's activity, it shall be the Contractor's responsibility to notify in writing the Agency's Representative, on a daily basis, of the work requiring inspection. All installations which are to be backfilled shall be inspected and approved by the Agency's Representative prior to backfilling and the Contractor shall give notice in advance of backfilling to the Agency's Representative so that proper inspection may be provided.

1.8 INDEMNITY

The Developer, the Engineer(s) and the Contractor(s) shall each indemnify and save harmless the Agency, its officers, agents, representatives and employees from all damages and costs to which they may be put by reason of injury or death to person(s) or damage to property resulting from the Engineer's and/or Contractor's means, methods, negligence or carelessness in the performance of the work or in guarding the same; or from any improper materials, implements, or appliances used in its construction; or by or on account of any other act or omission of the Engineer(s), the Contractor(s) or their agents.

1.9 GUARANTEE

The Developer guarantees that the entire work constructed by him/her fully meets all requirements of these standards. The Developer shall, at his/hers own expense, make any repairs or replacements made necessary by defects in materials or workmanship supplied by him/her that become evident to the Agency within one (1) year after the date of final acceptance and release of all bonds; and, restore to full compliance with the requirements of these standards, including the test requirements set forth herein for any part of the work constructed hereunder, which during said one-year period is found to be deficient with respect to any provisions of these standards. Any omission on the part of the Agency to discover defective work or materials at the time of construction shall not be deemed an acceptance, and the Developer will be required to correct defective work or materials discovered at any time before final acceptance and release of all bonds and within one year thereafter. The Developer shall hold the Agency harmless from claims of any kind arising from damage due to said defects. The Developer shall within 14 calendar days of receipt of written notice from the Agency, begin making all repairs and replacements to the satisfaction of the Agency. Such work shall include the repair or replacement of other work or materials damaged or affected by making the above repairs or corrective work, all at no cost to the Agency. If the Developer fails to make repairs and replacements promptly, the Agency may do the work and the Developer shall be liable to the Agency for all cost therefore.

1.10 VIOLATIONS

Non-compliance with any Section within these Standards constitutes violation of the Standards. The Agency retains the right, depending on the seriousness of the infraction, to refuse to accept the Project, until the violation is adequately resolved to the Agency's satisfaction.

1.11 TIME LIMITATION

Approval by the Agency of any public or private sanitary sewer extension shall be valid for a limited time, as will any related commitment of existing capacity in a particular public sanitary interceptor or collector sewer. In the event that construction of the new public or private sanitary sewer covered by the approved Construction Documents is not started within one (1) year from the date of approval, the Project shall be assumed to have been abandoned, and any subsequent proposal for reactivation shall be treated as a new Project.

1.12 STANDARD DRAWINGS

Included herein and made a part hereof are: Standard Drawings No. SD-1 through SD-34, which cover various design and construction subjects referenced in these Standards.

1.13 RULES AND REGULATIONS

The Agency's rules and regulations shall be adhered to at all times. Copies are available at the Agency's office.

1.14 APPROVED MATERIALS

Section 4 of these Standards contains materials and appurtenances which are generally approved for installation in the Agency's sanitary sewer system. The Engineer shall contact the Agency during the Project design process for additional materials and appurtenances that are approved for use in the Agency's sanitary sewer system.

Any individual, corporation, or other entity may submit to the Agency other materials for approval. Such submittals shall include documentation demonstrating to the Agency's satisfaction that the material meets the technical and performance requirements set forth in these and other applicable Standards. The submittals shall also demonstrate to the Agency's satisfaction that use of the proposed material is in conformance with the Agency's goal of developing a reliable, safe, and efficient collection system with minimal maintenance requirements and maximum life.

Approval of substitute materials by the Agency does not relieve the Contractor for the performance of those specific materials or for compliance with the performance requirements for the entire work. All materials incorporated into the Project shall be installed in accordance with manufacturer's recommendations. Contractor shall compare manufacturer's recommendations with the requirements of these Standards and the approved Construction Documents. Any conflicts among the manufacturer's recommendations, these standards and the approved Construction Documents shall be resolved in accordance with the requirements of Section 1.4 prior to the materials being incorporated into the work.

1.15 PRETREATMENT REQUIREMENTS

Each Agency listed in Section 1.2.1 has adopted an Industrial Waste Pretreatment Ordinance or Resolution that defines the types of wastes that may and may not be discharged to the Agency's sanitary sewer system. It shall be the Developer's responsibility to obtain a copy of the latest edition of the appropriate Ordinance and/or Regulation prior to commencing work. Particular attention shall be paid to the Local Limits established in each Ordinance or Regulation, so that the Developer can make appropriate pretreatment plans prior to construction. Developers are encouraged to contact those industrial users who will be discharging wastewater flows directly or indirectly into the facilities being constructed by the Developer to verify that all industrial pretreatment required are known and followed during construction of the Project. These requirements may be obtained from each individual Agency. Applications for Wastewater Discharge Permits and pretreatment plans must be filed with the appropriate Agency prior to construction. It is the Developer's sole responsibility to fully comply, and cause its Contractor to fully comply, with the terms of the approved Discharge Permits and pretreatment plans at all times while sanitary sewer improvements are being constructed, whether the Contractor is on site or not.

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**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 2

DESIGN STANDARDS

TABLE OF CONTENTS

DESIGN STANDARDS

SECTION 2

<u>Section</u>	<u>Description</u>	<u>Page No.</u>
2.1	General Information	2-1
2.2	Development Requirements	2-2
2.2.1	Point of Connection	2-2
2.2.2	Full Frontage Extension	2-2
2.2.3	Right-Of-Ways and Easements	2-2
	A. Right-Of-Ways	2-2
	B. Easements	2-2
2.3	Design Criteria for Gravity Sewers	2-4
2.3.1	Calculation of Peak Wastewater Flow	2-4
2.3.2	Pipe Size Requirements	2-4
	A. Public Interceptors, Public Collectors & Private Collector Sewers	2-4
	B. Laterals	2-5
	C. Private Collector Sewers & Laterals	2-5
	D. Public Force Mains	2-5
2.3.3	Pipe Slope Requirements	2-6
	A. Public Interceptors, Public Collectors & Private Collector Sewers	2-6
	B. Terminal Main Sewers in Cul-de-Sacs (less than 450 feet)	2-7
	C. Terminal Main Sewers (multiple segments totaling more than 450 feet)	2-7
	D. Laterals	2-7
2.3.4	Curved Sewers	2-8
2.3.5	Main Sewer Stub-Outs	2-8
2.3.6	Sewer Line Depths and Alignments	2-9
	A. General	2-9
	B. Sewer Main (Greater than 20 feet deep)	2-10
2.3.7	Shallow Mains and Laterals	2-11
2.3.8	Sewer Main Connections	2-11
2.3.9	Sewer Trenches	2-12
2.3.10	Lateral Connections into Collector Sewers and Manholes	2-12
	A. Lateral Connection General Requirements	2-12
	B. Lateral Connection to Main Greater than 21-inch Diameter	2-13
	C. Lateral Connection to Manholes	2-14
2.3.11	Water and Sewer Utility Crossings and Clearances	2-14
2.3.12	Other Utility Crossings and Separations	2-14
	A. Vertical Crossings	2-14
	B. Aerial Crossings of Sanitary Sewers and Air Jumper Pipes	2-15
	C. Parallel Installation of Sanitary Sewers and Other Utilities	2-15

2.3.13	Siphons	2-16
2.3.14	Boring or Jacking Sewer Pipe	2-18
2.3.15	Manholes	2-19
	A. Standard Manholes	2-19
	B. Shallow Manholes	2-19
	C. Deep Manholes	2-20
	D. Drop Manholes	2-20
	E. Monitoring, Pretreatment Sampling and Debris Screen Manholes	2-20
2.3.16	Conditions Requiring a Standard Manhole	2-21
2.3.17	Maximum Distance Between Manholes	2-21
2.3.18	Manhole Diameters	2-22
	A. General Requirements	2-22
	B. Manholes (Greater than 20-feet)	2-23
	C. Additional Requirements	2-23
2.3.19	Manholes and Manhole Appurtenances	2-23
	A. Pre-Cast Manhole Sections	2-23
	B. Additional Requirements for Manhole Bases	2-23
	C. Changes of Flow Direction Within Manholes	2-24
	D. Additional Requirements for Pre-Cast Concrete Grade Rings	2-25
	E. Additional Requirements for Pre-Cast Concrete Section and Grade Ring Joints	2-25
	F. Frames and Covers	2-25
	G. Connections to Manholes	2-25
	H. Corrosion Protection	2-26
	I. Odor Control Equipment	2-26
2.3.20	Manhole and Main Line Locations	2-27
	A. Main Line Locations	2-27
	B. Manhole Locations	2-28
2.3.21	Backwater Valves	2-28
2.4	Design Criteria for Pumping Stations	2-28
2.5	Design Criteria for Force Mains	2-29
	2.5.1 Flow Velocity Requirements	2-29
	2.5.2 Air Relief Valves	2-29
	2.5.3 Slope	2-29
	2.5.4 Depth	2-29
	2.5.5 Termination	2-29
	2.5.6 Discharge Pipe	2-30
	2.5.7 Design Pressure	2-30
	2.5.8 Aerial Crossings	2-30
	2.5.9 Hydraulic Losses	2-30
	2.5.10 Thrust Blocks	2-30
	2.5.11 Effluent Reuse Pipe Lines	2-31
2.6	Construction Document Requirements	2-31

2.6.1	Project Description Required	2-31
2.6.2	Sanitary Sewer Capacity Analysis	2-31
2.6.3	Complete Bound, Signed / Sealed Document Sets Required	2-32
2.6.4	Application Sheet Required	2-32
2.6.5	Full Civil Improvement Drawings Required	2-32
2.6.6	Final Document Submittal	2-32
2.6.7	Minimum Drawing Guidelines	2-32

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SECTION 2

DESIGN STANDARDS

2.1 GENERAL INFORMATION

The following subsections set forth the Agency's criteria for engineering design of sanitary wastewater collection systems. Factors, criteria and formulas are provided to guide and assist the Developer's Engineer in preparation of drawings and equipment and material specifications. Where criteria are not specified, the Engineer shall design using standards and procedures as set forth in the following reference standards:

1. The Clark County "Uniform Standard Specifications for Public Works' Construction Off-Site Improvements" with the most recent revisions and Agency addenda; and
2. The ASCE Manuals and Reports on Engineering Practice, specifically the ASCE Manual of Practice No. 60/WEF Manual of Practice No. FD-5 for "Gravity Sanitary Sewer Design and Construction" latest edition; and
3. The "Recommended Standards for Sewage Works" (10 State Standards), latest edition; and
4. The design of polyvinyl chloride pipe installations shall also conform to "The Handbook of PVC Pipe: Design and Installation" by the Uni-Bell PVC Pipe Association, latest edition; and
5. The design of private collector sewers and laterals shall also conform to the Uniform Plumbing Code, latest edition, and the Southern Nevada Building Officials amendments to the code, latest edition

Any conflicts between the requirements of these Design and Construction Standards and the reference standards cited above shall be resolved in accordance with the provisions of Section 1.4.

The horizontal and vertical locations of existing sewers, other Agency utilities and other utilities/site-objects, if any, shown in Agency records have been obtained from available records which may or may not be accurate. As such, the Agency makes no guarantee, expressed or implied, that the existing sewers, other utilities and/or site objects are in the locations shown in Agency records nor shall the Agency bear any costs whatsoever associated with redesign or relocation of Project facilities caused directly or indirectly by the differences between the actual locations of existing sanitary sewers, other utilities or site objects and the locations of those sewers/utilities/site-objects depicted in Agency records. Accordingly, the Developer, Engineer and/or Contractor as appropriate shall bear the full risk and responsibility to confirm the locations of the existing sewers or other utilities, if any, to which the Developer will connect its Project facilities or other existing utilities/site objects that may interfere with construction of those facilities.

The Agency shall not waive the requirements of these Standards, the reference standards cited in these Standards or the approved Construction Documents to accommodate the failure of the Developer, Engineer and/or Contractor to accurately locate existing utilities or other site objects prior to the start of construction.

2.2 DEVELOPMENT REQUIREMENTS

2.2.1 Point of Connection:

Point of Connection (POC) shall be approved by the Agency.

2.2.2 Full Frontage Extension:

Public sanitary sewers shall be installed along the full frontage of all sides of Project property adjacent to the public right-of-way, unless otherwise directed by the Agency. Sewers shall be sized in accordance with ultimate hydraulic requirements of the Project and upstream tributary lands reasonably expected to be tributary to said sewers. When the sewer will not be used by the Developer, the minimum size of public sanitary collector sewer required in the frontage street shall be 8 inches or as directed by the Agency.

2.2.3 Right-of-Ways and Easements:

A. Right-of-Ways

All public interceptor and collector sewers, manholes, force mains, and appurtenant structures shall be located within dedicated public right-of-ways to the maximum extent practical. Public interceptor sewer, public collector sewers and public force mains may be located in easements granted to the Agency only as a last resort.

Right-of-ways shall be sufficiently wide to facilitate maintenance of the interceptor sewer, collector sewer, and/or sanitary sewer system appurtenances located in those right-of-ways.

B. Easements

Public interceptor sewers, public collector sewers, public manholes, public force mains, and appurtenant structures may NOT be located in private streets or on private property where there is no easement granted to the Agency. New sanitary sewer mains, force mains and related appurtenances, except individual building laterals, shall be publicly owned, and located in dedicated easements to the Agency. The following additional requirements shall apply to easements:

1. Easements shall be on single parcels of property and shall be placed in common elements. Easements on separate documents must be recorded before Construction Documents can be approved by the Agency. The document numbers of all such easements shall be shown on the Construction Documents.
2. Easements done by final map shall be submitted concurrently and tracked with the Construction Documents.
3. Through easements having unobstructed access to the public right-of-way at each end are preferred by the Agency for public interceptor sewers and public collector sewers.

4. Terminal easements may be provided for public collector sewers only if there is no practical way to provide a through easement and only upon Agency approval. The width of terminal easements longer than 100-feet shall be sufficient to facilitate the turning around of large capacity truck-mounted sewer maintenance equipment having turning radii of not less than 50-feet, unless otherwise approved by the Agency.
5. Easements shall have driving surfaces capable of supporting an H20 vehicle loading under all weather conditions as required by the Agency.
6. Longitudinal slopes of easements are preferred by the Agency to be 3 percent or less, but shall not exceed 5-percent without the approval of the Agency.
7. Transverse slopes of easements shall not exceed 2-percent. Easements shall be graded to facilitate the passage of conventional sewer maintenance vehicles without "high-centering". The Engineer shall contact the Agency for specific entry slope requirements.
8. No overhead utilities or overhanging site objects shall be placed in/above public sewer or force main easements unless otherwise approved by the Agency. If the Engineer has no other option than to place overhead utilities and/or overhanging site objects in the sewer easement, including burying said utilities, the Engineer shall present its justification for placing overhead utilities and/or overhanging site objects in easements to the Agency for consideration. Cost alone shall not be considered as sufficient justification for placing overhead utilities and/or overhanging site objects in easements. The Agency shall review each such situation individually and is under no obligation to approve the placement of overhead utilities and/or overhanging site objects in a public sewer, force main or pump station easement.
9. Where overhead utilities and/or overhanging site objects are permitted by the Agency to be placed in easements, said overhead utilities and/or overhanging site objects shall have a minimum above-ground vertical clearance to the lowest point of the utility or site object everywhere within the easement at least equal to the depth of the deepest underground utility within the easement plus 5-feet, or an above-ground vertical clearance of 20-feet, whichever is greater.
10. No permanent landscaping having a mature height of greater than 3-feet shall be placed anywhere in any easement or in the vehicle ingress or egress pathways to easements.
11. No walls, signs, lights, parking area, buildings or other structures may be placed anywhere within any easement or in the vehicle ingress or egress pathways to easements.
12. Where directed by the Agency, and in lieu of the gates shown in Standard Drawing SD-26A (Note 3.), bollards conforming to Standard Drawing SD-34

shall be placed across the entrances to easements at the spacing designated by the Agency.

13. Easements shall be sufficiently wide to facilitate maintenance of the interceptor sewer, collector sewer, or sanitary sewer system appurtenances, and shall generally conform to Standard Drawings SD-26A and SD-26B.
14. The required width of a public sewer easement shall be at the discretion of the Agency. The Agency reserves the right to require the public sewer easement widths it deems necessary for maintenance of sewer lines, manholes and other sanitary sewer system appurtenances.
15. The minimum easement widths shall be per Table "A" unless otherwise approved by the Agency. Public sewer easements presented in Table "A" shall be increased in width where additional underground utilities are also placed in the easement or if the easement has a longitudinal slope greater than 3-percent.
16. Easement widths shall also be increased, as necessary, for each overhead utility placed in an easement to provide the required horizontal clearance indicated in Table "A".

2.3 DESIGN CRITERIA FOR GRAVITY SEWERS

2.3.1 Calculation of Peak Wastewater Flow:

The design of a sanitary sewer system shall be based on the Peak Dry Weather Flow (PDWF) or Peak Wet Weather Flow (PWWF) generated within the area to be served. For the purposes of these Standards, sanitary flow contribution rates for calculating design flows are expressed in terms of Equivalent Residential Units (ERU's).

Engineer shall contact the Agency regarding the following:

1. Wastewater flow calculation requirements.
2. ERU values for the Project, including all phases of development.
3. The applicability of the data in Table "C", peaking curves, and/or ASCE Peak Dry Weather Flow equation = $[(\text{Ave Flow in MGD})^{0.9044}] * 2.6186$.

2.3.2 Pipe Size Requirements:

A. Public Interceptors, Public Collector & Private Collector Sewers:

Shall be sized in accordance with the maximum depth-of-flow (d) to pipe-diameter (D) requirements (d/D) set by the Agency at the PDWF/PWWF rate determined in accordance with Section 2.3.1. At its sole discretion, the Agency may choose to increase the minimum diameters of public sanitary sewer mains to account for areas upstream of the Project that are likely to be tributary to Project facilities now or in the future. In such situations, the Agency shall advise the Developer and its

Engineer of the average flow generated in the area upstream of the Project that should be transported by Project facilities.

The minimum size for public interceptor sewers, public collector sewers, and private collector sewers for any Project shall be based upon the approved sewer analysis or master plan for the Project area and the requirements of these Standards. In all cases, the minimum acceptable nominal pipe diameter for a public interceptor sewer or public collector sewers shall be 8 inches.

B. Laterals:

The following sizes shall apply for laterals:

Single Family Residential:

1. The minimum nominal pipe diameter for a lateral sewer shall not be less than 4-inches.

Multi-Family Residential, Commercial, Industrial, or Institutional:

1. The Engineer shall determine the appropriate size for laterals serving these developments
2. The minimum nominal pipe diameter for a lateral sewer shall not be less than 6-inches.

The Agency reserves the right to require larger diameter laterals for specific circumstances such as lateral connections to sanitary sewers 15-inches in diameter and larger. The Engineer shall contact the Agency as early as possible in the Project design process to determine Agency-specific requirements for private collector sewers and laterals.

C. Private Collector Sewers & Laterals:

Private collector sewers and laterals shall generally meet the requirements for public sewers presented in these Standards and shall also meet the requirements of the Uniform Plumbing Code, latest edition. Private collector sewers, private force mains, and private pump stations may only be installed in multi-family, commercial, and industrial developments. All collector mains, pump force mains, and pump stations located in single family residential developments, with the exception of private sewer laterals, shall be publicly owned and shall be located in public easements conforming to Section 2.2.3.b. Any conflicts between the requirements for private collector sewers and laterals in the Uniform Plumbing Code and in these Standards shall be resolved in accordance with Section 1.4.

D. Public Force Mains:

The minimum size for publicly-owned force mains is 4-inches, unless otherwise approved by the Agency.

2.3.3 Pipe Slope Requirements:

Pipe slopes shall be designed according such that the following results or requirements are achieved.

A. Public Interceptors, Public Collector Sewer & Private Collector Sewer:

1. The Engineer shall submit to the Agency, with the Construction Documents submitted for approval, flow depth and velocity calculations in accordance with Sections 2.3.3.A.3 and 2.3.3.A.4, and actual number of contributing Equivalent Residential Units (ERUs) for all public interceptors, public collector sewers, and private collector sewers within the Project.
2. Flow depth (d) divided by pipe diameter (D) ratio requirements shall be per the Agency (design d/D ratio) when transporting the Peak Dry Weather Flow (PDWF) or Peak We Weather Flow for the Project and upstream tributary flows designated by the Agency, if any.
3. The Manning Equation shall be used to determine pipe flows as follows:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where: V = mean flow velocity in feet per second

n = roughness coefficient, but not less than 0.013

R = hydraulic radius in feet

S = pipe slope in feet per foot, but not less than the minimum slope listed in Table "D"

4. A roughness coefficient (n) of not less than 0.013 shall be used for all pipe materials. A coefficient which will yield higher friction losses shall be used where disturbing influences are known or anticipated, such as, disruption of flow by tributary inflows, offset joints, sewers having limited flow such that solids deposition may occur, or any other situation likely to impede sewer flows.
5. The minimum flow velocity shall not be less than 2 feet per second (FPS) when half-full at PDWF, and not more than 10 feet per second when 75-percent full at the Peak Wet Weather Flow (PWWF) as defined in Section 1.2.15 for the eventual final tributary area, unless otherwise approved by the Agency.
6. The minimum flow velocity of 2 feet per second or more shall be achieved at least once each day to limit solids deposition and sulfide production where upstream flow rates permit. It is also the intent to limit pipe wall erosion, limit manhole erosion and minimize odor generation that would occur at velocities greater than 10 feet per second.
7. Where sustained velocities greater than 10 feet per second will occur in the public interceptor sewers or public collector sewers, energy dissipation

and/or other measures approved by the Agency to prevent pipe and/or structure wall erosion shall be provided.

8. The minimum slopes in Table "D" have been calculated to achieve flow velocities of at least 2 feet per second in each nominal sewer pipe size presented when that pipe is half-full at PDWF where there is sufficient flow from the tributary area upstream.
9. The maximum slopes in Table "D" have been calculated to limit flow velocities in each nominal pipe size presented to not more than 10 feet per second when the pipe is 75-percent full at PWWF.
10. It is expected that where upstream flow quantities are sufficient to reach at least pipe half-full levels at PDWF, pipe slopes as designed for the Project will fall within the ranges presented in Table "D".
11. Hydraulic jumps shall be avoided whenever possible.

B. Terminal Main Sewers in Cul-de-Sacs and Other Locations (less than 450 feet):

Pipe slopes shall be designed according to the requirements and results indicated under 2.3.3.A with the following exceptions:

1. Where the terminal sewers will never be extended the minimum slope shall be not less than 0.010 ft/ft, unless approved otherwise by the Agency.
2. In individual locations where the elevations of the existing mainline sewers to which the new sanitary sewer network will be connected preclude the use of the preferred minimum slope of 0.010 ft/ft for terminal sewers, the minimum slope for terminal sewers that will never be extended may be reduced to not less than 0.006 ft/ft where approved by the Agency.

C. Terminal Main Sewers (multiple segments totaling more than 450 feet):

Pipe slopes shall be designed according to the requirements and results indicated under 2.3.3.A with the following exceptions:

1. The required minimum pipe slope shall be that slope which will generate a flow velocity of at least 3 feet per second at the PDWF rate from the tributary area at the downstream end of the terminal sewer when calculated in accordance with Sections 2.3.3.A.3 and 2.3.3.A.4.
2. In no case shall the slope of said terminal sewer be less than 0.006 ft/ft regardless of pipe diameter or flow velocity at the PDWF rate.

D. Laterals:

Unless otherwise approved by the Agency, pipe slopes for sanitary sewer laterals shall fall within the ranges presented in Table "D" regardless of flow velocities within the laterals.

2.3.4 Curved Sewers:

Curved public interceptors and public collector sewers, if allowed by the Agency, shall be constructed of C-900 per the Agency's Approved Materials List, as applicable, and shall be per the following minimum requirements:

1. The Contractor shall not exceed 1 degree deflection per joint of pipe or per manufacturer's recommendation, whichever is more stringent.
2. Bending of the pipe is not permitted.
3. Curved sewers are to be equidistant from the roadway or easement centerline at all points along the curvilinear portion of the sewer alignment.
4. Sewer service laterals with wyes may be constructed on the curvilinear sewer alignment in accordance with Section 3.17.
5. For 8 inch through 12 inch C-900 sewer utilizing 20 feet pipe lengths, and the 1 degree maximum deflection, the minimum curvature radius is 1,150 feet. A curvature radius of 575 feet may be allowed with a lay length of 10 feet, with Agency approval. A radius of less than 575 feet will not be allowed. No repair couplings are permitted; bell and spigot only.
6. Manholes shall be provided at both ends of curved sewers and shall comply with Section 2.3.17.
7. If the length of the curved sewer is greater than the allowable distance between manholes specified under Section 2.3.17, then additional manholes shall be provided along the curved sewer to meet the requirements of Section 2.3.17.
8. Marker balls in accordance with Sections 3.14 and the Agency's approved materials list shall be placed along curvilinear sewers spaced at uniform intervals not exceeding 25-feet.
9. Survey shots must be provided by the contractor at each lateral and joint deflection. Final location maps must be sealed and certified by a Nevada Professional Land Surveyor to have positional certainties of +/- 0.09 meters (+/- 0.3 feet) horizontally and vertically.
10. Detailed record drawings shall be provided for all curved sewer showing the precise location of the curved sewer in relation to other site surface objects such as curb lines or edges of pavement so that the curved sewer can be readily located for future excavation.

2.3.5 Main Sewer Stub-Outs:

Main sewer stub-outs shall be per the following minimum requirements:

1. Stub-outs provided for future extension of main sanitary sewers shall not extend out more than fifty (50) feet from an existing manhole or from a new manhole constructed as part of the Project unless otherwise permitted by the Agency.

2. Marker balls shall be per Section 3.14 and the Agency's approved materials list.
3. Marker balls shall also be placed at the upstream ends of the stub-outs and at uniform intervals of not less than 10-feet nor more than 25-feet along stub-outs greater than 25-feet in length.
4. Sealed caps per the Agency's approved materials list and thrust blocks containing at least one cubic foot of concrete conforming to Section 4.7 shall be placed at the ends of stub-outs to withstand air-testing and sewer cleaning operations without damage or displacement.
5. The horizontal and vertical locations of the ends of stub-outs shall be indicated on the record drawings provided to the Agency at the close-out of the Project.

2.3.6 Sewer Line Depths and Alignments:

The Agency shall not waive the requirements of these Standards, the reference standards cited in these Standards or the approved Construction Documents to accommodate the failure of the Developer, Engineer and/or Contractor to accurately locate existing utilities or other site objects prior to the start of construction.

Each sanitary sewer system design submitted to the Agency shall be given individual consideration by the Agency regarding depth and alignment requirements per the specific construction and site conditions.

Items of consideration will include: sewer sizes and slopes; sewer depth of cover; locations and configurations of connections to the existing sewer system; potential extensions of the Project facilities to serve upstream areas; and, other factors as determined by the Agency.

Should the actual locations of existing utilities and/or site objects be found during construction to interfere with the installation of sanitary sewers, laterals and/or other sanitary system appurtenances depicted in the approved Construction Documents, the Engineer shall prepare an alternative design conforming to these Standards to resolve the interference and submit that alternative design for Agency review prior to proceeding with the Project work affected. The Agency shall be under no obligation to approve the alternative design and may require the relocation of the existing utilities creating the interference such that the improvements shown in the approved Construction Documents can be completed as originally approved.

A. General:

1. All new sanitary sewers shall be kept on the same sides of the streets throughout the development whenever possible and shall be designed at such depths as required by the Agency on a case-by-case basis such that these sewers can receive flows by gravity from the Project area and additional upstream tributary areas as designated by the Agency, if any.

2. Where feasible, the following minimum depths shall be required, but these minimum depths shall not be viewed as acceptable depths unless confirmed by the Agency on a case-by-case basis:
 - a. Greater than 60' Right-of-Way:
 - i. Minimum 7-feet from finish grade to tops of the new mainline sanitary sewers.
 - b. 60' Right-of-Way or less that is part of a developed area of the Project such as a subdivision:
 - i. Minimum 6-feet from finish grade to the tops of new mainline sanitary sewers.
 - c. 60' Right-of-Way or less, that is not part of a planned subdivision or development:
 - i. Minimum of 6-feet from finish grade to top of the new mainline sanitary sewer.
 - d. Laterals:
 - i. Shall not have less than 4-feet of cover from the top of the lateral to finish grade anywhere within the public right-of-way or in dedicated sewer easements.

B. Sewer Mains (Greater than 20 feet):

Sewer mains greater than 20-feet deep shall only be considered by the Agency on a case-by-case basis. For all pipe installations greater than 20-feet the following shall apply:

1. Pipe materials suitable for the depth of cover, backfill materials, groundwater levels, and anticipated surface live and dead loads shall be used.
2. The trench shall have a minimum width of outside pipe diameter plus 16-inches and a maximum width as recommended by the Uni-Bell PVC Pipe Handbook (if applicable) and pipe manufacturer, but not greater than outside pipe diameter plus 36-inches.
3. The trench width, pipe bedding method, pipe haunch support, and pipe cover to 1-foot over the top of the pipe shall be designed by the Engineer. This design shall be sealed by the Engineer in accordance with State of Nevada law and shall be submitted to the Agency for approval with the Construction Documents for the Project.
4. The Engineer shall submit structural calculations demonstrating the suitability of the pipe materials and installation methodology proposed with the initial submittal of the Construction Documents for Agency review.

The horizontal and vertical locations of existing sewers, other Agency utilities and other utilities/site-objects, if any, shown in Agency records have been obtained from available records which may or may not be accurate. As such, the Agency makes no guarantee, expressed or implied, that the existing sewers, other utilities and/or site objects are in the locations shown in Agency records nor shall the Agency bear any costs whatsoever associated with redesign or relocation of Project facilities caused directly or indirectly by the differences between the actual locations of existing sanitary sewers, other utilities or site objects and the locations of those sewers/utilities/site-objects depicted in Agency records. Accordingly, the Developer, Engineer and/or Contractor as appropriate shall bear the full risk and responsibility to confirm the locations of the existing sewers or other utilities, if any, to which the Developer will connect its Project facilities or other existing utilities/site objects that may interfere with construction of those facilities.

2.3.7 Shallow Sewer Mains and Laterals:

Sanitary sewer mains and laterals that do not meet the minimum depth criteria specified in Section 2.3.6 shall adhere to the following:

1. Shallow sewer mains and laterals shall be avoided to the maximum extent practical.
2. The Engineer shall demonstrate that absolutely no other practical option exists for locating the sanitary sewer that would meet the minimum depth criteria set forth in Section 2.3.6.
3. Cost shall not be considered as an acceptable justification for violating the minimum depth requirement.
4. Acceptable justification factors for shallow sewer mains and laterals are as follows:
 - e. Unusually shallow existing mainline sewer; and,
 - b. Elimination of existing pump/lift stations.
5. Where depth of cover over the top of the pipe is less than 3 feet, the sanitary sewers and laterals shall be designed and constructed as required by the Agency. Construction of a berm or mounding of material to gain 3 feet of cover shall not be allowed.

2.3.8 Sewer Main Connections:

New sanitary sewers shall not be connected to smaller existing main sewers. The required invert elevations of new sanitary sewer connections to new or existing sanitary sewer manholes shall be in accordance with the following criteria:

A. Straight-through:

Match the slope of upstream and downstream sewers.

B. Change of Direction:

Where the incoming and outgoing pipes are the same size, the invert(s) of incoming pipe(s) shall be 0.2 feet higher than the invert of the outgoing pipe.

C. Incoming and Outgoing Pipes of different diameters:

The crowns on the incoming smaller pipes and outgoing larger pipes shall be at the same elevation.

D. New sewers to existing manholes:

The base of the manhole shall be core-drilled in accordance with Section 3.16.4 and an appropriate seal boot, per Agency's approved materials list, shall be used to positively seal against infiltration and exfiltration. Break-in connections shall not be permitted. The flow channels in the bases of existing manholes to which new sewers are connected shall be modified in accordance with Section 2.3.19.b to provide for efficient passage of wastewater flows. Manhole flow channel modifications shall generally conform to Standard Drawing SD-9.

Where the new sewers are larger than 15-inches in diameter, the connection requirements to existing manholes will be determined on a case-by-case basis. The Engineer shall contact the Agency as soon as possible in the Project design process to determine sewer connection requirements.

E. New sewer to new sewer manholes:

New sewer to new sewer manhole connections shall conform to Section 2.3.19.g

2.3.9 Sewer Trenches:

Sanitary sewers and sanitary sewer laterals shall be placed in individual trenches and no other parallel utilities shall be placed in these trenches. Multiple uses of sewer trenches shall not be allowed.

2.3.10 Lateral Connections Into Collector Sewers and Manholes:

Lateral connections shall be constructed in accordance with the following requirements:

A. Lateral Connections General Requirements:

1. Laterals shall be connected directly to collector sewers.
2. Lateral connections shall be constructed in accordance with Section 3.17 and Standard Drawings SD-20 through SD-25 as applicable for connections to new and existing sewers.
3. Lateral connections into new collector sewers shall be by use of appropriately sized wye fittings conforming Agency's approved materials list.

4. Lateral connections into existing sewer shall be by use of appropriately sized wye fittings or tapping saddles conforming to Agency's approved materials list, as permitted/required by the Agency.
5. Sanitary sewer laterals shall be installed perpendicular to the main sanitary sewer and shall be straight, without curves or horizontal bends unless otherwise approved by the Agency.
6. Laterals shall not be located under residential driveways unless otherwise approved by the Agency.
7. New laterals shall not be connected to public collector sewers with a diameter smaller than the diameter of the lateral unless specifically approved by the Agency.
8. For new collector sewers 12-inches in diameter and smaller, laterals shall be connected to these new sewers as shown in Standard Drawings SD-20 or SD-21 as applicable.
9. Deep lateral connections such as the typical example shown in Standard Drawing SD-25 may only be used upon the specific approval of the Agency. The Engineer shall demonstrate to the Agency that there are no other options in lieu of providing deep lateral connections including parallel sewers as shown in Standard Drawing SD-22. If permitted, the Engineer shall include specific designs for deep laterals in the Construction Drawings.
10. Laterals serving single family buildings may not be connected to other laterals under any circumstances.
11. Residential buildings having four units or less shall have individual laterals for each unit and said laterals shall be connected to public collector sewers.
12. Laterals for buildings having more than four units, large multi-family, commercial, and industrial establishments shall be designed in accordance with Section 2.3.2.
13. Laterals may not be connected directly to public interceptor sewers unless specifically approved by the Agency.
14. Laterals, 4-inch and 6-inch, may be connected to new collector sewers or interceptor sewers up to 21-inches in diameter where the depth/diameter (d/D) is less than 0.75 as shown in Standard Drawings SD-20 and SD-21 as applicable.

B. Lateral Connection to Main Greater than 21-inch Diameter:

1. Laterals may connect to new collector sewers or interceptor sewers larger than 21-inch with a d/D greater than 0.75 at a new manhole as shown in Standard Drawing SD-22.

2. More than three lateral connections per 500-feet of collector/interceptor sewer, may be connected using one of the following methods:
 - a. A separate collector sewer shall be installed to receive the lateral connections as shown in Standard Drawing SD-22; or
 - b. Laterals may be connected to the collector or interceptor sewer via individual manholes as shown in Standard Drawing SD-22.

C. Lateral Connection to Manholes:

1. Where permitted/required by the Agency, laterals may be connected to public manholes provided said manholes have outlet pipes at least 8-inches in diameter.
2. Lateral connections to manholes, where permitted/required by the Agency, shall be constructed in accordance with Sections 2.3.8, 2.3.19.J, 3.16.4 and 3.17.
3. The lateral shall be connected such that the minimum drop across the manhole invert meets 2.3.19.B, unless otherwise directed by the Agency.
4. The exiting flow channel in the manhole shall be modified as required in Section 2.3.19.B to direct flows from the lateral to the main sewer without causing ponding, turbulence or solids deposition in either the lateral flow path or mainline sewer flow path.
5. Break-in connections into pipes or manholes shall not be permitted under any circumstances.

2.3.11 Water and Sewer Utility Crossings and Clearances:

Crossings of potable water lines and sanitary sewers shall be constructed in accordance with the requirements of Section 2.3.12 and all other applicable provisions of the Uniform Design and Construction Standards for Potable Water Systems (UDACS), latest edition. Crossings of reuse water lines and sanitary sewers shall be constructed to the same requirements as potable water line crossings, unless otherwise approved by the Agency. Encasement of the Sewer main or sewer lateral shall only be considered on a case-by-case basis and must be approved by the agency.

2.3.12 Other Utility Crossings and Separations:

A. Vertical Crossings:

1. The vertical separation between sanitary mains or laterals shall be a minimum of 2 feet. If the vertical separation does not meet the minimum clearance then SD-18 and SD-19 shall apply. Where SD-18 and SD-19 apply, identify the protection on the civil plans in profile.
2. Care shall be taken in placing the new utility above the sewer/lateral to avoid impacts or point loads on the sewer/lateral.

3. Following the placement and backfilling of the new utility, the main sanitary sewer shall be televised in accordance with Section 3.19.1.E; and, if access is available, the sanitary lateral shall also be televised in accordance with Section 3.19.1.E.

If utility crossings of sanitary sewers cannot meet the heretofore specified vertical and/or horizontal clearance requirements, the Engineer shall submit drawings depicting the proposed alternative crossing designs to the Agency for approval not less than 30 days prior to the start of construction of the subject crossing.

B. Aerial Crossings of Sanitary Sewers and Air Jumper Pipes:

1. Adequate support shall be provided for all joints in the pipe utilized for the crossings. The supports shall be designed to prevent frost heave, overturning and settlement.
2. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion joints shall be provided between above ground and below ground sewers and at intervals along the overhead pipeline to allow for soil movement and thermal expansion/contraction.
3. For aerial crossings over waterways and drainage channels, the impact of flood waters and debris shall be considered.
4. Sanitary sewers and siphon air jumper pipes shall be placed not less than 10-feet above predicted 100-year flood elevations.

Supporting structures within or less than 20 feet from the waterway path shall be designed to resist impacts from floating debris during maximum flood elevations. Where possible, the bases of supporting structures shall be located at least 10 feet horizontally or 5 feet vertically from predicted 100-year flood elevations, whichever yield the greatest separation from the waterway.

C. Parallel Installation of Sanitary Sewers and Other Utilities (other than water):

Clearances between public interceptor sewers or public collector sewers and other utilities shall be in accordance with Regional Transportation Commission (RTC) Uniform Standard Drawing 501.

1. Where other utilities are present, where the clearances shown in the RTC Uniform Standard Drawing 501 cannot reasonably be achieved or where depth to sanitary facility inverts exceeds 10-feet, the Engineer shall consult with the Agency early in the Project design process to establish clearance requirements between public sanitary facilities and other utilities and site objects.
2. Sanitary sewer facilities shall be placed in independent trenches as required under Section 2.3.9 such that construction of said trenches does not undermine the adjacent utilities.

3. Where the parallel utilities are at relatively the same elevation as the sanitary sewer facilities, there shall be at least 6 feet of clearance between the outside of the utility conduit and/or encasement and the outside of the manhole structures along sanitary sewer pipe.
4. If the parallel utilities are at a different elevation than the sanitary facilities, then the clearance between the other utilities and the sanitary sewer shall be increased by at least 1-foot for each foot of elevation difference from outside to outside of pipe (higher or lower) between the other utilities and the sanitary facilities. The sanitary sewer shall be located such that the higher utility shall be outside of one-to-one angle-of-repose lines projected upward from the outsides of the pipe walls of the lower utility to permit excavation of the lower utility for repairs without undermining the upper utility.

The Agency is under no obligation to accept the alternative designs and may require relocation of sanitary sewer improvements to achieve the minimum horizontal and vertical clearances heretofore specified.

2.3.13 Siphons:

Siphons (also known as inverted siphons or depressed sewers) will be approved by the Agency on a case-by-case basis and only will be considered when absolutely no other practical methods for avoiding obstructions are available. Cost alone shall not be considered by the Agency as justification for constructing siphons in lieu of alternative obstruction avoidance methods. A typical siphon design is shown in Standard Drawings SD-32A and SD-32B for general guidance. The Engineer shall contact the Agency early in the project design process to document the need for a siphon and to determine specific Agency requirements. In general, siphons shall meet the following requirements as a minimum:

1. Siphons shall have at least two barrels for transporting wastewater and shall be sized such that the siphon can transport the peak dry-weather wastewater design flow at full build-out of the development with one barrel out of service and can transport the full hydraulic capacity of the incoming sewer with all barrels in service, all without causing surcharging of the incoming sanitary sewer.
2. Siphon barrels shall generally be equal in diameter and sized such that the flow velocity through one barrel shall not be less than 3 feet per second at the average daily wastewater flow rate at full build-out of the completed development or 2 feet per second at the peak daily flow rate at the full build-out of the current phase of the development, whichever yields the smaller siphon barrel size. Upon approval of the Agency, three (or more) barrel siphons or siphons with differing barrel sizes may be utilized where small initial phases of large developments are being constructed in order to achieve minimum flow velocity requirements during early development phases.
3. Structures shall be placed at the inlet and outlet ends of all siphons such as those depicted in Standard Drawings SD-32A and SD-32B. Structures shall be centered over the siphon barrels. The structures shall be sufficiently large to facilitate maintenance of the siphon barrels including cleaning from either end.

Siphon structures shall be protected against internal corrosion from the effects of H₂S as required by the Agency.

Siphon inlet flow channels and barrels shall generally be configured to direct all flows up to the peak daily wastewater design flow rate to a single barrel during initial Project phase and up to the average daily design wastewater flow rate at full build-out of the development. The additional siphon barrel(s) shall be configured to receive ultimate flows above the average daily design flow rate.

Provisions for independently isolating flow to each of the barrels of multiple-barrel siphons shall be provided at each end of the siphon. These provisions shall be configured to facilitate maintenance of the siphon barrel being blocked. Handwheel-operated fiberglass, aluminum or 316 stainless steel slide gates are required for each siphon barrel where the incoming sewer is greater than 12-inches in diameter and are preferred for all siphons. Drop-in fiberglass, aluminum or stainless-steel plates may be used for siphon barrels where the incoming sewer 12-inches in diameter or less, where approved by the Agency. If drop-in plates are selected, the appropriate gate boards shall be provided, and the access structures shall be equipped with a suitable tie-down lugs per Agency's AML at the top of the structures for pulling the plates using a cable come-along or similar equipment.

4. Siphon structures shall be leak-proof and adequately protected from flooding. The exteriors of siphon structures near waterways of drainage channels shall be waterproofed with a coating system per Agency's AML and additional Agency requirements. Siphon structures shall be located a minimum of 25-feet outside 100-year floodways, unless otherwise approved by the Agency. Tops of siphon structures shall be placed at least 2-feet above predicted 100-year flood elevations.
5. All siphons crossing streams, washes and drainage channels shall be buried not less than 5-feet below their current bottom elevation. The area over the siphon up to 2-feet above the 100-year flood elevation shall be covered with rip rap material ranging in particle size from 50 pounds to 150 pounds or a 12-inch thick reinforced concrete lining as directed by the Agency. The protection over the siphon shall extend not less than 20-feet each way of the siphon crossing to prevent exposure by a 100-year flood. Siphon barrels shall be encased in reinforced concrete as shown in Standard Drawing SD -14.
6. Siphon inlet and outlet structures shall be interconnected with a separate overhead air jumper pipe to facilitate the movement of air through the sewer system, unless otherwise approved by the Agency. The air jumper pipe size shall be determined by the Engineer, but its cross-sectional area shall be not less than 50-percent of the combined cross-sectional area of the siphon pipes, unless otherwise approved by the Agency. The air jumper pipe shall be located where it will be self-draining under all operating conditions and where it will be protected from damage in accordance with the requirements of Section 2.3.12.B. Siphons shall be equipped with odor control devices as directed by the Agency. Generally, small two-barrel siphons equipped with air jumpers in accordance with Section 2.3.13.B shall be provided with odor control inserts as specified in Section 2.3.19.I in the inlet and outlet structures. Where required by the Agency,

larger siphons and small siphons where air jumpers cannot be provided shall be equipped with multi-phase odor control suitable for preventing both liquid-phase and gas-phase odor emissions as described in Section 2.3.19.1. The Engineer shall submit to the Agency, the proposed odor control system for the siphon structures as early in the design phase as practical to allow Agency input into the design.

7. The Engineer shall furnish hydraulic calculations showing the operation of siphons through the various phases of the development from build-out of the first phase of the Project to full build-out of the ultimate area that will be tributary to the siphon to demonstrate that required siphon velocities will be achieved and that the incoming sewer to the siphon will not be surcharged to levels greater than the d/D values allowed by the Agency under any flow conditions. The calculations shall also demonstrate that the siphon can transport the peak dry weather flow of the ultimate tributary area with one siphon barrel out of service and without surcharging above the crown elevation of the incoming sewer. As a minimum safety factor, the elevation difference between the inlet and outlet chambers of siphons shall be at least 1-foot greater than the calculated hydraulic loss across the siphon at full development. The Agency, at its sole discretion, may require the elevation difference between the inlet and outlet structures to be increased depending upon the unique design and operating characteristics of the subject siphon and potential variations in incoming flow rates.

2.3.14 Boring or Jacking Sewer Pipe:

Where open cut trenches are not possible and boring or jacking is required the following criteria shall be included in design:

1. The sewer pipe casing shall conform to the Uniform Design and Construction Standards for Potable Water Systems, latest edition, UDACS Plate No. 23.
2. Casing details shall be provided for all sanitary mains and services. All details shall be approved by the Agency prior to construction.
3. Crossings of NDOT and UPRR right-of-ways shall be in accordance with NDOT and/or UPRR requirements.
4. Locations of the existing sanitary sewers in the vicinity of boring/jacking operations shall be determined in accordance with Section 2.3.6.
5. Jacking and receiving pit locations and dimensions shall be shown on the plans.
6. Plans shall indicate relocation requirements for existing utilities in the vicinity of the jacking and receiving pits.

The horizontal and vertical locations of existing sewers, other Agency utilities, and other utilities/site-objects shown in Agency record drawings may or may not be accurate. As such, the Agency makes no guarantee, that the existing sewers, other utilities, and/or site objects are in the locations shown in Agency record drawings. The Agency shall not bear any costs associated with redesign or relocation of Project facilities caused directly or indirectly by the differences between the actual locations

of existing sanitary sewers, other utilities or site objects and the locations of those sewers/utilities/site-objects depicted in Agency record drawings.

Accordingly, the Developer, Engineer and/or Contractor shall bear the full risk and responsibility to confirm the locations of the existing sewers or other utilities, to which the Developer will connect its Project facilities or other existing utilities/site objects that may interfere with construction of those facilities.

Should the actual locations of existing utilities and/or site objects be found during construction to interfere with the boring/jacking operation as depicted in the approved Construction Documents, the Engineer shall prepare an alternative design conforming to these Standards to resolve the interference and submit that alternative design for Agency review. The Agency shall be under no obligation to approve the alternative design and may require the relocation of the existing utilities creating the interference such that the boring/jacking operation can be completed as originally approved.

2.3.15 Manholes:

All public manholes shall have all-weather, 24/7 drivable access as required by the Agency capable of supporting an H20 vehicle loading and at least 20-feet wide for sewer maintenance purposes. All manholes shall have only one outlet pipe unless, no inlet piping is possible, such as a terminal manhole, or a specialized hydraulic structure is approved to mitigate Agency's concerns. All manholes shall be located to prevent the inflow of storm water runoff from adjacent surfaces. Manholes and manhole components shall conform to Agency's approved materials list.

Should the sanitary sewer system require multiple outlets, a specialized hydraulic structure shall be provided in lieu of a standard manhole. This structure shall be configured to optimize sewer flow hydraulics, minimize deposition of solids and facilitate maintenance.

A. Standard Manholes:

Standard manholes are manholes having a depth from top of rim to top of pipe between 4 feet and 20 feet. Standard manholes shall be designed in accordance with Standard Drawing No. SD-1. All standard manholes over sewer pipes 8 to 12 inches in diameter shall have single manhole cover openings in accordance with Standard Drawing No. SD-3. All standard manholes over sewer pipes larger than 12 inches in diameter shall have dual concentric manhole cover openings in accordance with Standard Drawing No. SD-2, or as required by Agency.

B. Shallow Manholes:

Shallow manholes are manholes having a depth from top of rim to top of pipe less than 4 feet. Shallow manholes shall only be used when permitted by the Agency only as a last resort when sewer depths and configurations cannot be modified to utilize standard manholes. Shallow manholes shall be designed in accordance with Standard Drawing SD-13.

C. Deep Manholes:

Deep manholes are manholes having a depth from top of rim to top of pipe greater than twenty (20) feet. Deep manholes shall be a minimum of 72-inches internal diameter, regardless of the size, number, or flow paths of inlet and outlet pipes and have dual concentric manhole cover openings in accordance with Standard Drawing No. SD-2. For manholes greater than 25 feet deep, the Agency may require engineer to provide a structural detail for the base.

D. Drop Manholes:

Drop manholes are manholes where an external shaft drops sewage a depth, from invert of pipe to invert of shaft, a minimum of 2 feet at the manhole. Drop manholes are not permitted unless there is absolutely no other practical option for connecting sanitary sewers of differing elevations, including running parallel mains. In lieu of drop manholes, the grades of new sanitary sewers shall be adjusted such that the invert of the new sewer matches the crown of the existing sewer at the connecting manhole. Grades shall not cause the maximum sewer velocities in new sewer to exceed the requirements of Section 2.3.3 or cause erosion in the receiving manhole. The use of drop manholes will be reviewed by the Agency on a case by case basis.

The extra cost of additional sewer mains required to eliminate drop manholes shall not be considered as justification for allowing drop manholes. If allowed by the Agency, they shall be constructed per Standard Drawing SD-12. All drop manholes regardless of size, number, or flow paths of inlet and outlet pipes shall have corrosion protection per Agency requirements and conforming to Section 2.3.19.H.

E. Monitoring, Pretreatment Sampling, and Debris Screen Manholes:

The Agency at its sole discretion may require the installation of special on-site monitoring manholes per Standard Drawing SD-1, and/or pretreatment sampling manholes per Standard Drawing SD-31 for certain commercial, industrial and institutional customers to facilitate flow monitoring and wastewater sampling for its Pretreatment Program and to prevent the entry of detrimental materials into the public sanitary sewer system. The commercial/industrial/institutional customer served by such manholes shall own these manholes and shall provide regular maintenance such that the Agency may perform required monitoring and detrimental materials are prevented from entering the public sewer system.

The Engineer shall contact the Agency early in the Project design process for specific design criteria for monitoring, pretreatment sampling, and debris screen manholes. All such manholes shall also comply with the criteria set forth by the design and development standards of the Agency, the Uniform Plumbing Code, and the requirements of all other applicable building, plumbing and wastewater discharge codes and regulations. Any conflicts between the requirements of these Standards and the Uniform Plumbing Code shall be resolved in accordance with the provisions of Section 1.4.

2.3.16 Conditions Requiring a Standard Manhole:

Manholes shall be located as follows:

1. At the terminal end of each sewer line;
2. At each change in sewer line direction;
3. At each change in sewer line grade;
4. At each change in sewer line pipe size;
5. At each lateral connection to the sewer main 21-inches in diameter or larger, when so required by the Agency;
6. At the ends of curvilinear main sewer segments, where curvilinear sewers are allowed by the Agency;
7. At end of stub-outs longer than 50-feet, unless otherwise required by Agency;
8. Where a force main or dual force main set enters a gravity line – only one connection of a force main or dual force main set from a single pump station permitted per manhole; and,
9. At the connection of private laterals, 8-inches in diameter and larger, to a sewer main.

2.3.17 Maximum Distance Between Manholes:

Except as otherwise required by the Agency, pipe size shall govern maximum distance between manholes as follows:

Pipe Size	Maximum Distance*
8 inches to 18 inches	450 feet
21 inches to 30 inches	500 feet
33 inches and larger	per Agency

* If the sanitary sewer slope exceeds 5%, the distance between manholes shall not exceed 250-feet unless otherwise approved by the Agency

1. If curvilinear sewers are allowed by the Agency, manholes shall be installed at the point of curvature and the point of tangency of the curved sewer.
2. A manhole shall be installed at the end of stub outs longer than 50 linear feet, unless otherwise approved by the Agency.

2.3.18 Manhole Diameters:

A. General Requirements:

Unless otherwise required by the Agency, pipe size, number of connections, changes in flow path and manhole depth shall govern the internal diameter of manholes as indicated below. Manhole internal diameters required for other combinations of inlets and flow paths shall be as specified by the Agency. The Agency, at its sole discretion, may require larger manholes than indicated below based upon the actual number of connections, elevations of connections or any other factors deemed pertinent by the Agency:

Pipe Size	Connection/Flow Path	Manhole Minimum Internal Diameter
8 inches	Maximum of three inlet pipes and single outlet pipe – elevation of outlet pipe invert is less than one-foot lower than all incoming pipe inverts.	48 inches
10 to 12 inches	Straight-through flow path with single inlet and outlet pipes	48 inches
8 to 12 inches	All manholes with drop connections	60 inches
8 to 12 inches	More than three inlet pipes or elevation of outlet pipe invert is one-foot to two-feet lower than any incoming pipe invert.	60 inches or as required by Agency
10 to 12 inches	With flow path bend in manhole or more than one inlet pipe.	60 inches
15 to 24 inches	Straight-through flow path with single inlet and outlet pipes	60 inches
15 to 24 inches	All manholes with drop connections	72 inches or as required by Agency
15 to 24 inches	With flow path bend in manhole or more than one inlet pipe	72 inches or as required by Agency
27 inches or larger	All flow path combinations	72 inches or as required by Agency
Force mains	All public manholes receiving discharges from force mains	60 inches or as required by Agency

B. Manholes (Greater than 20-feet):

Manholes greater than 20-feet in depth shall be a minimum of 72-inches in internal diameter, regardless of the size, number, or flow paths of inlet and outlet pipes.

C. Additional Requirements:

The Engineer shall contact the Agency as soon as possible in the Project design process to determine any additional requirements for manholes with the following conditions:

1. Sewers 27 inches and larger;
2. Manholes having differences of inlet pipe and outlet pipe elevations one-foot or more;
3. Manholes with drop connections; for manholes receiving discharges from force mains;
4. Manholes having more than three inlet connections.

2.3.19 Manholes and Manhole Appurtenances

A. Pre-Cast Manhole Sections:

Pre-cast manhole sections shall conform to Agency's approved materials list. Where manholes are placed in high groundwater areas and in other areas as designated by the Agency, the exteriors of the pre-cast sections, including bases, barrel sections and cones shall be waterproofed in accordance with Section 3.16.2 utilizing a coating material conforming to Agency's approved materials list.

B. Additional Requirements for Manhole Bases:

All manholes on new main sewers and new laterals shall have pre-cast manhole bases. Cast-in-place manhole bases may be utilized on new sewer mains per Agency requirements. For manholes deeper than 25-feet, structural plans for the manhole base are required. No internal platforms are allowed. The drop across the cast-in-place or pre-cast manhole invert shall be 0.2 ft minimum, except:

1. For manholes constructed as "through" manholes in accordance with SD-7, the drop across the manhole invert shall match the incoming and outgoing pipe slope. A "through" manhole is a manhole where there is no change in horizontal direction or vertical slope, and the pipe continues through the manhole at a constant slope and direction. All "through" manholes shall be designed such that bell and spigot are not present within the manhole base.
2. For manholes where the incoming pipe diameter is smaller than the outgoing pipe diameter, both pipes should have matching crown elevations at the manhole.
3. New manholes on existing sewers or existing laterals may have cast-in-

place bases or pre-cast bases at the Contractor's option.

- a. Pre-cast manhole bases shall conform to Agency's approved materials list, Standard Drawing SD-1 and other Standard Drawings as applicable.
 - b. Cast-in-place manhole bases shall conform to Section 3.16.1, Standard Drawing SD-7 and other Standard Drawings as applicable. Concrete shall conform to Agency's approved materials list and Section 4.7.2.
4. Efficient flow passage through manholes is essential to minimize the generation of odors, the release of corrosion-causing gases, and the deposition of solid materials in the manhole.
 5. Flow channels shall be provided in pre-cast and cast-in-place manhole bases to smoothly direct flows from the incoming pipe(s) to the outgoing pipe without turbulence, deposition of solids or reduction in flow velocity passing through the manhole.
 6. The width of the flow channels for the main sewer passing through the manhole shall not exceed the internal diameter of the outgoing sewer. The width(s) of the flow channel(s) for incoming branch sewer(s) entering the manhole normal to the main sewer shall not exceed the internal diameter(s) of the branch sewer(s).
 7. All flow channels within a manhole shall be the same height and shall extend to at least three-inches higher than the crown of the highest incoming sewer.
 8. The tops of flow channels shall be sloped toward the main sewer not less than 1v:10h to facilitate sloughing off of debris.
 9. Flow channels shall conform to Standard Drawing SD-9.
 10. Flow channels in pre-cast bases shall be factory-installed. Flow channels in cast-in-place bases shall be field-installed.

C. Changes of Flow Direction Within Manholes:

For public sewer mains 12-inches nominal diameter and smaller, the maximum change in angle of the flow path through a manhole shall not exceed 90-degrees, unless otherwise approved by the Agency. For public sewer mains 15-inches nominal diameter and larger, the maximum change in angle of the flow path through a manhole shall not exceed 45-degrees, unless otherwise approved by the Agency. Where the total change of flow direction ranges from 46-degrees to 90-degrees, two manholes shall be used. Where the total change of flow direction ranges from 91-degrees to 120-degrees, three manholes shall be used. For changes of direction greater than 120-degrees, special hydraulic structures shall be provided. Engineer shall contact the Agency early in the Project design process to determine the requirements for special hydraulic structures. Where

multiple manholes are used to accomplish changes of direction greater than 45-degrees, the change in direction accomplished in each manhole shall be approximately equal. Multiple manholes shall be spaced to facilitate sanitary sewer maintenance and avoid conflicts with other utilities. The spacing between multiple manholes shall generally range from a minimum of 1-foot to a maximum of 3-feet for each foot of depth to the invert of the sanitary sewer. The Engineer shall contact the Agency early in the Project design process to determine the spacing required for multiple manholes.

D. Additional Requirements for Pre-Cast Concrete Grade Rings:

Grade rings shall conform to Agency's approved materials list, and shall be installed in accordance with Standard Drawing SD-5. A minimum of one and a maximum of two grade rings shall be used for each manhole. The total distance from the top of the manhole cone to the top of the manhole frame after final paving shall not exceed 18-inches including grade rings, joints between the cone/grade rings/frame, and the height of the manhole frame.

E. Additional Requirements for Pre-Cast Concrete Section and Grade Ring Joints:

1. Manhole joints shall be sealed and grade rings shall be grouted in accordance with Section 3.16.6.

F. Frames and Covers:

Manhole frames and covers shall conform to Agency's approved materials list. The "Standard Concentric Dual Cover and Frame" shown in Standard Drawing SD-2 shall be used for all manholes where the pipe diameter is greater than 12-inches. Where the pipe diameter is 12-inches or less, the "Standard Concentric Single Cover and Frame" shown in Standard Drawing SD-3 shall be used. Locking manhole covers, as shown in Standard Drawing SD-6, shall be used as directed by the Agency.

G. Connections to Manholes:

New manholes shall be designed such that all flexible connectors required for new sewers are factory-installed and conform to Agency's approved materials list. A reinforcing bar as shown in Standard Drawing SD-9 shall be placed above each pipe connections in new pre-cast manholes to facilitate final grouting of the pipe connections into the manholes. The spaces between the protruding pipe ends entering the manholes shall be grouted in accordance Section 3.16.4 to form a smooth interior surface to prevent the accumulation of sewer solids and to fully support the upper projection of the sewer pipe into the manhole. Elevations of connections shall be designed in accordance with Section 2.3.8.

Connections of new sewers to existing manholes and existing sewers to new manholes shall be made using field-installed flexible connections conforming to elevation requirements of Section 2.3.8 and the installation requirements of Section 3.16.8. Field-coring of holes into new manholes for installing connections for new sewers is not permitted, except with the prior approval of the Agency.

H. Corrosion Protection:

Corrosion Protection meeting Agency requirements and conforming to Sections 3.16.8, and Agency's approved materials list, shall be provided in all locations where it may be reasonably anticipated that odors and/or corrosive gases may be released in the sewer as a result of turbulence or other factors. The Engineer shall contact the Agency as early as possible in the Project design process to identify any additional requirements for design and installation of corrosion protection. As a minimum corrosion protection shall be provided in the following locations:

1. All manholes for sewers 15-inches in diameter and larger;
2. All manholes where the pipe slope decrease between upstream and downstream sewers greater than 4-percent;
3. All manholes for sewers 10 inches and larger where there are changes in horizontal direction greater than 45 degrees or there are more than one inlet connection to the manholes;
4. All manholes receiving the discharge from a force main and one manhole upstream and one manhole downstream from the manhole receiving the discharge from a force main;
5. All siphon inlet and outlet structures and the next manhole downstream from the siphon outlet structure;
6. All drop manholes per Standard Drawing SD-12;
7. All pump station wet wells;
8. All manholes where the incoming pipe slope is greater than 4-percent, the change in horizontal direction is greater than 45-degrees, and where the d/D is 0.25 at peak flow after build out; and,
9. All other locations as directed by the Agency

I. Odor Control Equipment:

The Engineer shall contact the Agency early in the Project design process to determine the specific odor control equipment requirements, sizing, and equipment placement for each individual project. Odor control equipment shall be placed as follows:

1. upstream and downstream manholes of inverted siphons;
2. at pump station wet wells;
3. on the manholes downstream of ends of energy dissipating devices;
4. at manholes where incoming flow velocities exceed five (5) feet per second at peak dry weather flow;

5. at manholes receiving discharges from force mains and one manhole upstream and one manhole downstream from the discharge location;
6. at drop manholes and one manhole upstream and one manhole downstream from the drop manhole;
7. and, in other locations as directed by the Agency where there is potential for odors to escape from the sanitary sewer system.

Generally, for locations with limited potential for odor emissions, manhole odor-control insert units conforming to Section 4.6 shall be installed where designated by the Agency.

In addition to or in lieu of odor control inserts, the Agency reserves the right to also require that gas phase and/or liquid phase odor control equipment conforming to Section 4.6 shall be provided at sanitary sewer locations where the potential for odor generation is deemed significant by the Agency.

2.3.20 Manhole and Main Line Locations:

All public manholes located in unpaved public right of ways or easements shall have all weather, 24/7, drivable access as required by the Agency capable of supporting an H2O vehicle loading and at least 20 feet wide for sewer maintenance purposes.

A. Main Line Locations:

Public interceptor sewers and public collector sewers shall not be placed beneath the following:

1. parallel sidewalks, parallel curbs/gutters, parallel roadway medians, parallel parkway areas, parallel walls
2. parking areas,
3. overhead power or communications wiring,
4. street light mast arms,
5. subdivision gated medians,
6. other areas where trees will be planted,
7. or in any location which is designed to collect water.

Where public interceptor sewers and public collector sewers must cross sidewalks, curbs/gutters, roadway medians, unpaved parkway areas, and walls, these crossings shall be perpendicular to the maximum extent practical.

B. Manhole Locations:

Sanitary sewer manholes shall be located as follows:

1. In the roadway pavement a minimum of 8-feet from back of curb or a minimum of 6-feet from edge of pavement for non-curbed streets wherever practical.
2. Terminal sanitary sewer manholes shall be located in the pavement a minimum of 8-feet from any curb in any direction.
3. Manholes shall not be placed in areas designed to collect storm water.
4. Outside the wheel path of motor vehicles and in areas where parked vehicles will not hinder access to the manhole.

Refer to RTC Standard 501 latest edition for typical locations for various utilities in a street cross-section.

2.3.21 Backwater Valves:

Drainage piping serving fixtures which have flood level rims located below the elevation of the next upstream manhole cover of the public or private sewer serving such drainage piping shall be protected from backflow of sewage by installing an approved type backwater valve. All fixtures located within the dwelling unit may discharge through a single backwater valve provided that approved type cleanouts are located immediately upstream and downstream of the backwater valve. Backwater valves shall be located where they will be accessible for inspection and repair at all times. The access sleeve shall not extend more than 24 inches from the top of the valve cover to the top of the sleeve cap. All backwater valves located 24 inches or less will not require an access box. The backwater valve may be installed a maximum of 36 inches below grade provided an access box with minimum dimensions of 14 inches in width by 23 inches in length measured from inside edge to inside edge is used and the minimum depth of the box is 12 inches. All backwater valves located deeper than 26 inches shall be made accessible by use of a yard box or vault sized large enough to permit a person to enter the box for the purpose of accessing the backwater valve.

2.4 DESIGN CRITERIA FOR PUMPING STATIONS

Pump stations and force mains may only be used in lieu of gravity sewers only as a last option when gravity sewers are impractical. For pump stations, the Engineer shall contact the Agency early in the Project design process for the specific facility and design requirements for pump stations and ancillary facilities. As a minimum, pump stations and discharge force mains shall be designed to meet 1.36 times the ultimate peak dry weather flows from the anticipated tributary area to the pump station or 1.25 times the full pipe hydraulic capacity of the gravity sewer entering the pump station wet well, whichever is greater, with all pumps running. Capacity calculations used for sizing the pump station and downstream force main shall be provided to the Agency with the Pumping Station Data Sheet.

2.5 DESIGN CRITERIA FOR FORCE MAINS

The following subsections define design criteria and standards for raw wastewater and effluent reuse force mains. Dual force mains shall be provided for each pump station, each having 100-percent of the design hydraulic capacity required. Valving shall be provided to facilitate isolation of each force main for testing, maintenance or other purposes. Following are the general design criteria for design of force mains. The Engineer shall contact the Agency as early as practical in the Project design process to establish the specific design criteria for the Project.

2.5.1 Flow Velocity Requirements:

A velocity of no less than 3 feet per second shall be achieved in each force main when operating independently (with one pump on stand-by) at the PWWF calculated in accordance with Section 2.3.1. Calculation of force main velocity, design pressure and hydraulic losses shall be submitted to the Agency with Table "F". The minimum diameter for publicly owned force mains shall be four-inches, regardless of velocity at peak design flow, unless otherwise approved by the Agency.

2.5.2 Air Relief Valves:

Where approved by Agency, an automatic air relief valve with approved backflush attachments specifically designed for raw sewage applications shall be placed in the force main to prevent air locking. The air relief valve shall be placed above-ground or below-ground as required by the Agency. The air relief valve configuration shall be in accordance with Standard Drawing SD-28 or SD-29 as applicable. The air relief valve system shall be equipped with odor control system conforming to Agency requirements as presented in Section 2.3.19.I.

2.5.3 Slope:

Force mains shall maintain a positive uphill slope from the pump output to the manhole receiving the force main discharge. Slopes of force mains shall not exceed 0.5-percent, unless otherwise approved by the Agency. Changes in force main slope and direction should be minimized. To limit accumulations of gases, no segment of a force main shall have a zero slope. Low points which are subject to solids accumulation shall be avoided.

2.5.4 Depth:

The raw wastewater and effluent reuse force mains shall be designed with a minimum depth of 3.5 feet of cover over the top of the pipe, unless otherwise approved by the Agency. A 4-inch thick by 2-foot wide non-reinforced concrete cap shall be provided above the force main if the minimum depth of cover required cannot be maintained.

2.5.5 Termination:

Force mains shall be extended only as far as the closest gravity sewer. Force mains shall discharge to private manholes as shown in Standard Drawing SD-10 where

feasible. The private manholes shall then discharge to private gravity sewers which in turn shall discharge to new public manholes along the sanitary sewer main. Where site conditions do not permit the installation of private manholes and private gravity sewers and where approved by the Agency, force mains may discharge directly to public sanitary sewer mains at new manholes as shown in Standard Drawing SD-11. Only one set of dual force mains shall be connected to a manhole. This manhole shall be configured to reduce turbulence, minimize odor release and control erosion from the incoming force main flow. Manholes receiving discharges from force mains shall be provided with corrosion protection in accordance with Section 3.16.8.

2.5.6 Discharge Pipe:

Discharge piping shall be per the following:

1. Station discharge piping shall be a minimum of 2 feet higher than the pump discharge.
2. The discharge pipe shall conform to Agency's approved materials list.
3. If required by Agency, pressurized cleanouts as shown in Standard Drawing SD-33A shall be provided every 400 feet along force mains.

2.5.7 Design Pressure:

The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure, pressure surges (water hammer), and total (active and passive) earth loads.

2.5.8 Aerial Crossings:

Force mains used for aerial crossings shall meet applicable requirements of Section 2.3.12.b.

2.5.9 Hydraulic Losses:

Friction losses through force mains shall be based on the Hazen-Williams formula. For the Hazen-Williams formula, "C" equaling 150 shall be used for new PVC or HDPE force main pipe and "C" equaling 120 for older pipe. Turbulent ("minor") losses at fittings, bends and valves shall be determined in a similar manner. The Engineer shall submit hydraulic calculations for force mains at "C" = 150 and "C" = 120 to demonstrate the performance of force mains at start-up and after extended service.

2.5.10 Thrust Blocks:

Where required by the Agency, thrust blocks shall be included as necessary to secure the force main from movement. Generally, such locations are those where fittings are provided to change the direction of the force main, either horizontally or vertically. Thrust blocks shall be in accordance with the Uniform Design and Construction Standards for Potable Water Systems, latest edition, UDACS Plate No. 31. Concrete for thrust blocks shall conform to Agency's approved materials list. The Engineer shall contact the Agency as soon as is practical in the design process to review the

Agency's requirements for pipe thrust restraint. The Engineer shall submit to the Agency for review alternative pipe restraint designs for those locations where the Engineer believes that thrust blocks will not perform satisfactorily and for those locations where the Agency does not permit the use of thrust blocks.

2.5.11 Effluent Reuse Pipe Lines:

All pipe that is used for effluent reuse shall be purple in color if PVC pipe, or extruded with purple stripes at 120-degree points along the pipe, and shall conform to the AWWA reuse standards.

2.6 CONSTRUCTION DOCUMENT REQUIREMENTS

ALL OF THE FOLLOWING REQUIREMENTS LISTED MUST BE MET BEFORE THE PROJECT WILL BE APPROVED FOR CONSTRUCTION. DUE TO THE UNIQUE NATURE OF INDIVIDUAL PROJECTS, THE AGENCY, AT ITS SOLE DISCRETION, MAY ALSO ADD ADDITIONAL REQUIREMENTS THAT MUST ALSO BE MET BEFORE THE PROJECT IS APPROVED.

2.6.1 Project Description Required:

As part of the Construction Document package prepared for each Project, and where required by the Agency, the Engineer shall provide an overall Project description which shall include the following:

1. Built-out Wet Weather peak wastewater flows at each connection to the public interceptor and/or collector sewer, including future Project phases, to assist the Agency in assessing potential impacts of the Project on the existing sanitary sewer system.
2. List any possible industrial wastes that may be discharged to Agency sewers from development within the Project.
3. Any upstream area that may ultimately be tributary to Project facilities. The Engineer shall contact the Agency early in the Project design process to identify these potential tributary areas.
4. Finally, the Project description shall also include a Final Map and/or Parcel Map as appropriate to depict the overall extent of the Project. For multi-phased Projects, the description and maps should address both the Project currently proposed for construction and the remainder of the development that has already been constructed or will ultimately be tributary to the Project sewer system and thence to the Agency's sanitary sewer system, whether discharged directly through the Project sanitary sewer system or indirectly through other connections to the Agency's sanitary sewers.

2.6.2 Sanitary Sewer Capacity Analysis:

When requested by the Agency, the Engineer shall submit a capacity analysis of the proposed sewers and at least the next 1-mile of existing downstream sewers receiving wastewater flows from the proposed development. This capacity analysis shall

address the current phase of the development and all future phases that will route wastewater flows through the new sewers being constructed as part of the Project and/or to the same downstream existing sewers.

2.6.3 Complete, Bound, Signed/Sealed Document Sets Required:

All construction drawings, specifications, calculations, and other supporting documents submitted to the Agency shall be complete and bound as appropriate for review; and, must be signed and stamped by a civil engineer who is registered in the State of Nevada.

Any drawing sets or other submittals appearing or subsequently discovered to be incomplete, unchecked, or disordered will be returned to the submitter without review or comment. The Agency will not provide partial comments on such returned sets except to note the reason for return.

The Engineer shall perform all required QA/QC reviews and checking prior to submitting the Construction Documents and supporting information for review by the Agency.

2.6.4 Application Sheet Required:

All Construction Documents submitted to the Agency for review must be accompanied by an Application Sheet. Please contact the respective Agency for a copy of the appropriate Application Sheet.

2.6.5 Full Civil Improvement Drawings Required:

The Construction Document submittal shall include the full civil improvement package for the Project phase being constructed including paving, grading and drainage plans. The submittal shall also include the general civil design for the remainder of the Project, if any, depicting the overall intent of the paving, grading and drainage for other previously-constructed or future phases of the Project.

2.6.6 Final Document Submittals:

The Developer's Engineer shall submit final construction drawings in a format required by approving Agency.

If required by approving Agency, mylar drawings shall be original plots of high quality and shall be fully legible. Photo-copied mylars, mylars of poor overall quality, and mylars displaying excessive shading/hatching will not be accepted.

2.6.7 Minimum Drawing Guidelines:

All drawings shall be prepared in a neat and legible manner. Include an application form, per Agency requirements. All drawings shall also be submitted to the Approval Agency on sheets measuring 24-inches by 36-inches. These guidelines represent the minimum required before the sewer design will be evaluated by the Approving Agency. Contact the Approving Agency for additional requirements.

A. Title Block:

1. Project Name.
2. Developer's Name, Business Address, Business Phone Number, 24/7 Emergency Contact Phone Number and Name.
3. Engineer's Company Name, Business Address, Business Phone Number, 24/7 Emergency Contact Phone Number and Name.
4. Engineer's Stamp.
5. Drawing Scale (Vertical & Horizontal), both numerical and bar graph form.
6. Revision Block
7. Provide Vicinity Map

B. Cover Sheet:

1. Agency Signature Block.
2. Vicinity Map (Major Cross Streets)
3. APN Number
4. Benchmarks & basis of bearing

C. Notes Sheets:

1. General Notes per Approving Agency.
2. Agency Signature Block.
3. Deviation from Design Standards Signature Block.
4. Sewer Quantity List.

D. Master Utility Sheets:

Master Utility Plan Sheets shall be provided for all projects having two or more utility sheets and for all subdivisions, unless otherwise required by Agency.

1. Agency Signature Block.
2. Include "North" arrow
3. Plan View
 - a. Manhole Numbers.
 - b. Street Names (if "private" label as such).
 - c. Lot Numbers and Block Numbers.
 - d. Label Sewer Point of Connection as "POC".
 - e. Show all existing and proposed utilities (indicate type and size)
 - f. Show any easements including Patent Easements
 - g. Indicate Peak Dry Weather Sanitary Wastewater flow (in MGD)
 - h. Indicate if project is single-family, multi-family, commercial, industrial, mixed-use or other type.
 - i. Indicate number of units by type.
4. Public Manhole Table (Include)
 - a. Manhole Numbers

- b. Northing and Easting
- c. Station/Offset (Centerline of street/easement unless otherwise noted by Approving Agency)
- d. RIM Elevations
- e. Invert In – all invert in directions
- f. Invert Out
- g. Depth
- h. Diameter
- i. Indicated if Corrosion Protected or Not

E. Utility Plan Sheets:

1. Include “North” arrow
2. Street Names (if “private” label as such)
3. Show sewer mains (Label as “private” or “public”)
4. Lot Numbers and Block Numbers
5. Indicate the number of lots to be served by the Project and if the Project is a phase of a larger development indicate the total number of lots for full build-out (if known)
6. Finish Floor Elevations
7. Station/Offset (Centerline of street/easement unless otherwise noted by Approving Agency)
8. Lateral Locations
9. Driveway Locations
10. Typical Lateral Layout Details
11. Agency Signature Block
12. Manhole Number
13. Manhole Rim Elevation
14. Show all utilities, include size and type
15. All horizontal dimensions including clearances with other utilities
16. Construction Notes are to include lateral and backwater valve (BWV) information per Southern Nevada Building Official’s Amendments and Current UPC

F. Plan & Profile Sheets:

1. Include “North” arrow
2. Plan View
 - a. Provide azimuths or bearing angles (upstream to downstream) for new sanitary sewers.
 - b. Street Names (if “private” label as such)
 - c. Show flow arrows on all sewer lines.
 - d. Show all Right of Way widths for all utilities
 - e. Street Stationing/Offset (Centerline of street/easement unless otherwise noted by Approving Agency)
 - f. Show all Sewer and Patent Easement boundaries (overhead and underground) in accordance with SD-26A and SD-26B, include record document number.
 - g. Show all utilities, include type and size, vertical and horizontal location

- h. Show distance between horizontal utilities, dimension from outside to outside of pipe.
 - i. Label Point of Connection as “POC”
 - j. Show all Sewer Mains (label “private” or “public”)
 - k. Show launching/receiving shafts (where required) for pipe jacking
 - l. Show all laterals, existing and new
 - m. Show the “drivable access” in accordance with Section 2.3.20 provided for facility maintenance. Provide a structural roadway section of materials and design for the “drivable access”.
 - n. Identify upstream and downstream termini
3. Profile View
- a. Indicate Manhole Numbers
 - b. Indicate Manhole stations
 - c. Indicate Manhole Offset
 - d. Indicate Manhole size, type and depth
 - e. Indicate Manhole Northing and Easting
 - f. Indicate Manhole Rim Elevation
 - g. Indicate Manhole Invert in – all invert in directions
 - h. Indicate Manhole Invert out
 - i. Indicate Street Stationing
 - j. Indicate Pipe Length (manhole to manhole)
 - k. Indicate Pipe Diameter
 - l. Indicate Pipe Slope
 - m. Indicate Pipe Material
 - n. Show grade elevations
 - o. Show all utility crossings (dimension from outside to outside), include any specifics required if clearances do not meet minimum requirements
4. Construction Notes – include all items necessary to construct sewer shown on sheet. Keep notes consistent from sheet to sheet. Call out appropriate DCSWCS Standard Drawings for all sewer appurtenances.

**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 3

CONSTRUCTION STANDARDS

TABLE OF CONTENTS
CONSTRUCTION STANDARDS

SECTION 3

<u>Section</u>	<u>Description</u>	<u>Page No.</u>
3.1	Standard Specifications	3-1
3.2	Contractor's License	3-1
3.3	Contractor's Responsibility	3-1
3.4	Right-of-Way Encroachments	3-2
3.5	Job Start Check List	3-3
3.6	Cut Sheets	3-3
3.7	Certifications of Installation Procedures	3-4
3.8	Grade Lines	3-4
3.9	Construction Staking	3-4
3.10	Record Drawings	3-5
3.11	Bypass Pumping System	3-5
3.11.1	Bypass Pumping Plan	3-5
3.11.2	Bypass Pumping System	3-6
	A. Bypass Pumping Capacity	3-6
	B. Pumping Equipment	3-6
	C. Odor Control Requirements	3-7
3.11.3	Prohibition Against Sanitary Systems Overflows	3-7
3.11.4	Use of New Sanitary Systems	3-7
3.11.5	Noise Attenuation	3-7
3.11.6	Bypass System Power Source	3-8
3.11.7	Bypass System Traffic Protection	3-8
3.11.8	Bypass System Maintenance and Operation	3-8
3.11.9	Agency Notice of Operation	3-9
3.12	Agency Pipeline Encroachment - Blasting	3-9
3.12.1	Contractor Responsibility for Blasting	3-9
3.12.2	Blasting Plan	3-9
3.12.3	Existing Facility Inspection	3-10
3.12.4	Blaster Qualifications	3-10
3.12.5	Agency Representation	3-10
3.12.6	Blasting Monitoring	3-10
3.12.7	Independent Blasting Consultant	3-10
3.12.8	Blasting Plan Modifications	3-10

3.13	Earthwork	3-11
3.13.1	Excavation	3-11
3.13.2	Dewatering	3-13
3.13.3	Pipe Bedding	3-14
	A. Pipe Bedding (Rigid Pipe)	3-14
	B. Pipe Bedding (Flexible Pipe)	3-14
	C. All Other Provision	3-15
3.13.4	Pipe Zone Backfill	3-15
	A. Pipe Zone Backfill (Rigid Pipe)	3-15
	B. Pipe Zone Backfill Operations (Flexible Pipe)	3-16
3.13.5	Trench Backfill	3-17
	A. Granular Backfill	3-17
	B. Selected Backfill Material	3-18
	C. Unpaved Areas (See Standard Drawing No. SD-16)	3-18
	D. Paved Areas (See Standard Drawings No. SD-17)	3-18
	E. Nevada State Right-of-Ways	3-19
3.14	Pipe Installation	3-19
3.14.1	General	3-19
3.14.2	Curvilinear Sewers	3-21
3.14.3	Ductile Iron Pipe	3-21
3.14.4	Groundwater	3-21
3.14.5	Debris Traps	3-22
3.14.6	Pipe Locator Ribbon	3-22
3.14.7	Marker Balls	3-22
3.14.8	Plugs	3-23
3.15	Soil Testing	3-23
3.16	Manhole and Cast-in-Place Structure Installation	3-24
3.16.1	Manhole Base Construction	3-24
3.16.2	Assembling Pre-Cast Concrete Manhole Components	3-25
	A. Pre-Cast Manhole Sections	3-25
	B. Grade Ring Joints	3-26
	C. Final Manhole / Structure Adjustment	3-26
3.16.3	Cast-in-Place Concrete Structures	3-26
3.16.4	Pipe Connection Installation	3-27
3.16.5	Frame and Cover Installation	3-28
3.16.6	Exterior Waterproofing	3-28
3.16.7	Excavation and Backfilling	3-29
3.16.8	Corrosion Protection (as required by Agency)	3-29
	A. Manhole Corrosion Protection – Factory-Installed Coatings	3-29
	B. Manhole and Cast-in-Place Structure Corrosion Protection - Field Applied Coatings	3-29
	C. Manhole Corrosion Protection – Polymer Manholes	3-30

3.16.9	Debris Trap	3-30
3.16.10	Odor Control Equipment	3-30
3.17	Lateral Sewer Connections	3-31
3.17.1	Lateral Connections to New Sewers	3-31
3.17.2	Lateral Connections to Existing Sewers	3-31
3.17.3	Damage to Existing Sewers During Lateral Connection Installation	3-32
3.17.4	Tapping Requirements	3-32
A.	VCP	3-33
B.	NRCP & ACP	3-33
C.	RCP	3-33
D.	CIP & DIP	3-33
E.	PVC, FRP & HDPE	3-33
3.18	Abandonment of Existing Facilities	3-33
3.18.1	Main Lines and Laterals	3-34
A.	Method a (Crush in Place)	3-34
B.	Method b (Excavate and Remove Line)	3-34
C.	Method c (Pressure Grout Line)	3-35
D.	Method d (Cured In Place Sectional Liner)	3-36
3.18.2	Manholes	3-36
A.	Method a (Existing Sewer to be Abandoned)	3-36
B.	Method b (Existing Sewer to be Abandoned case by case)	3-36
C.	Method c (Existing Sewer to Remain)	3-36
D.	Method d (Existing Sewer to Remain case by case)	3-37
3.19	Testing	3-37
3.19.1	Sanitary System Construction – Initial Acceptance	3-37
3.19.2	Gravity Sewers & Appurtenances – Initial Acceptance	3-38
A.	Low Pressure Air Test	3-38
B.	Manhole Visual Inspection & Corrosion Protection – Holiday Testing	3-39
C.	Sewer Cleaning	3-39
D.	Deflection Testing	3-40
E.	Sewer Televising	3-41
3.20	Final Acceptance	3-41
3.21	Certificate of Occupancy	3-42
3.22	Bond Release	3-43
3.23	Warranty	3-43

SECTION 3

CONSTRUCTION STANDARDS

3.1 STANDARD SPECIFICATIONS

1. Wherever the words "Standard Specifications" appear on the plans or in these Standards, they shall refer to the most current Standard Drawings and Specifications for Public Works Construction Off-site Improvements, Clark County, Nevada, as amended.
2. Unless otherwise specified herein, the "Standard Specifications" shall apply. In addition, specifications from other national agencies have been referenced where applicable.
3. Should the Engineer or Contractor discover any conflict among The Construction Documents, these Standards, or the reference standards cited, that conflict shall be resolved in accordance with Section 1.4.

3.2 CONTRACTOR'S LICENSE

The Agency requires that all Contractors installing public interceptor sewers, public collector sewers, private collector sewers, sanitary laterals, pump stations, force mains, and appurtenant above ground and underground structures have the proper "Class A" license, per the Nevada State Contractor's Board, to do this type of construction.

3.3 CONTRACTOR'S RESPONSIBILITY

1. All Contractors working on wastewater collection systems shall be familiar with these specifications and shall have access to these specifications at all times during construction.
2. The Contractor shall have access to at least one copy of the approved Construction Documents available at all times at the project site for use by the Contractor's work forces and the Agency Representative.
3. The Contractor shall have access to these Standards available at all times at the project site for use by Contractor's work forces and Agency Representative.
4. The Contractor shall perform all construction work in conformance with the approved Construction Documents and these Standards and shall not perform any work that does not conform.
5. The Contractor shall notify and obtain approval from the Agency prior to construction of the Project for:
 - a. Deviations from the existing conditions depicted in the Construction Documents that the Contractor finds during field activities as soon as those deviations are discovered.
6. All changes in the Project design necessitated by the deviations identified shall be made by the Engineer and approved by the Agency prior to construction of the affected Project elements.

7. As the work progresses, the Engineer or Contractor, as appropriate, shall advise the Agency in writing of any additions, deletions or changes to the Work described in the approved Construction Documents or these Standards that it desires to make prior to performing these additions, deletions or changes.
 - a. Such additions, deletions or changes shall be made by the Engineer and so noted in revised Construction Documents.
 - b. Revised documents shall be submitted to the Agency for review and approval.
 - c. The Agency is under no obligation to approve the desired additions, deletions or changes.
 - d. The Agency will conduct its reviews in the normal course of its reviews of other Projects and is under no obligation to expedite its reviews to meet desired Project construction schedules.
 - e. The Agency is not responsible for any costs of delay to the construction for reviewing the desired additions, deletions or changes.
 - f. Any additional costs of construction due to reviews, acceptance, modification or rejection of the desired additions, deletions or changes shall be borne by the Developer.

The horizontal and vertical locations of existing sewers, other Agency utilities and other utilities/site-objects, if any, shown in Agency records have been obtained from available records which may or may not be accurate. As such, the Agency makes no guarantee, expressed or implied, that the existing sewers, other utilities and/or site objects are in the locations shown in Agency records nor shall the Agency bear any costs whatsoever associated with redesign or relocation of Project facilities caused directly or indirectly by the differences between the actual locations of existing sanitary sewers, other utilities or site objects and the locations of those sewers/utilities/site-objects depicted in Agency records. Accordingly, the Developer, Engineer and/or Contractor as appropriate shall bear the full risk and responsibility to confirm the locations of the existing sewers or other utilities, if any, to which the Developer will connect its Project facilities or other existing utilities/site objects that may interfere with construction of those facilities.

The Agency shall not waive the requirements of these Standards, the reference standards cited in these Standards or the approved Construction Documents to accommodate the failure of the Developer, Engineer and/or Contractor to accurately locate existing utilities or other site objects prior to the start of construction.

3.4 RIGHT-OF-WAY ENCROACHMENTS

Contractor is required to comply with any restrictions imposed by encroachment permit from State, County or City, if that situation arises in the context to which these Standards apply.

3.5 JOB START CHECK LIST

The following shall be completed prior to the commencement of construction:

1. Approved Construction Documents - including all drawings required per Section 2.6.3 and other Sections of these Standards
2. Construction Schedule
3. Shop drawings (if any) submitted and approved
4. Bypass pumping plan submitted and approved
5. Blasting plan submitted and approved
6. Site Storm Water Management Plan with Best Management Practices to be implemented.
7. Cut Sheets
8. Soils Report
9. Select Backfill Materials Analysis
10. Offsite Permit-with a copy submitted to the Agency
11. Barricade Permit-with a copy submitted to the Agency
12. Encroachment Permit-with a copy submitted to the Agency
13. Project Completion Bonds
14. All easements granted to the Agency and recorded
15. All materials certifications required in these Standards
16. Other information requested by the Agency
17. Verification of POC elevation

3.6 CUT SHEETS

No work shall commence on any Project components requiring a profile until cut sheets are submitted to and approved by the Agency's Representative. The cut sheets shall be prepared under the supervision of a Nevada Professional Land Surveyor (NPLS). All cut sheets shall be signed and stamped by the NPLS. Cut sheets shall match the approved drawings and other Construction Documents and shall show at a minimum the following:

1. Stationing
2. Hub elevations
3. Invert elevations
4. Cuts
5. Direction and distance of offset
6. Street names
7. Job title
8. Date of preparation
9. Bench mark data
10. Names of surveyors
11. Manholes with stations
12. Top of manhole elevations

3.7 CERTIFICATIONS OF INSTALLATION PROCEDURES

For all HDPE and FRP pipe, and all other pipe materials 48-inch diameter or larger, the Contractor shall furnish to the Agency its certification and a certification from the pipe manufacturer (or their designee) each verifying that the Contractor's superintendent, on-site foreman and lead pipe layer engaged in the work have been trained by the pipe manufacturer in the manufacturer's recommended installation methods prior to the start of work. Certifications verifying that the above designated personnel have received the necessary training for previous Projects is acceptable, provided that training was completed within one year previous to the start of the subject Project.

For the first day of pipe installation/backfilling and for one additional day for each 2000 feet (or increment thereof) of installation of HDPE or FRP pipe of all diameters and all other pipe materials 48-inch diameter or larger, the Contractor shall engage the services of a qualified representative of the pipe manufacturer to observe pipe installation and backfill procedures. The pipe manufacturer's representative shall provide additional certification that the installation/backfilling procedures he/she observed were in general conformance with the pipe manufacturer's recommendations.

The Contractor shall notify the Agency in writing at least two working days prior to the days on which the pipe manufacturer's representative shall be present at the work site to observe pipe installation.

3.8 GRADE LINES

Prior to laying any pipe, the grade lines shall be established in the trench bottom at the designated grades and thickness of pipe bedding required. Pipe bedding shall be carefully graded such that the pipe, when installed, shall be true to line and grade within 0.10 feet. If the grade is determined to be outside of tolerance, the Agency may require re-laying of the pipe or at a minimum require the Engineer to submit a plan revision.

For straight runs of sewer, hubs/batter boards shall be provided at manholes and changes in vertical and/or horizontal alignment as a minimum. A laser or other method approved by Agency shall be used to establish the grade lines between the manhole and alignment change hubs/batter boards on straight sewer segments. Additional hubs/batter boards spaced as specified in Section 3.9 shall be used to establish grade lines on curvilinear sewer segments.

3.9 CONSTRUCTION STAKING

At its option, Contractor may use a station/offset system or a coordinate system for locating improvements for construction. This locating system shall be shown on the Construction Drawings approved by the Agency. The offset, station and cut or X/Y/Z coordinates matching the approved Construction Drawings shall be printed at each hub.

Hub spacing shall not exceed 20 feet on curved sewers, as determined by the Agency depending on the radius of the curve and on all sewer mains with slope less than 1-percent; and 10-foot intervals in intersections with heavy traffic conditions, unless unusual field conditions require additional staking to assure accurate placement of the new sewer in accordance with the approved Construction Documents and the tolerances specified in Section 3.8.

All hubs shall remain undamaged and in place at least until the sewer segments in the vicinities of the hubs are installed, backfilled, inspected, and successfully tested.

3.10 RECORD DRAWINGS

Record drawings showing the horizontal and vertical locations of mainline sanitary sewers, sanitary sewer laterals and other sewer system appurtenances as they were actually installed shall be submitted to the Agency prior to and as a condition of the Agency's initial acceptance of the new sanitary sewer system and before sanitary wastewater is introduced to the new sanitary sewers. Horizontal and vertical locations shall be referenced to permanent benchmarks in the Project area. Record drawings shall be submitted within two weeks of completion of the work including final testing.

Record drawings shall include as a minimum:

1. distances between manholes, lateral locations (by station from the downstream manhole and offset from the centerline of the sewer) at the connection to the mainline sewer and at the property line
2. any horizontal or vertical alignment changes from the approved Construction Documents with updated stations and elevations
3. all utilities crossing the new sewer or Project installed utilities lying parallel within 20-feet of the new sanitary sewer
4. Protection methods for water mains crossing or adjacent within 10-feet to the new sewer
5. Any areas of concrete encasement
6. Direction of flow by arrows on mains or directional wyes on laterals at the main
7. Invert elevations and stations of all mainline stubouts
8. Sewer main offset from street centerline
9. Diameter(s) and type(s) of pipe and manhole materials

Record drawings shall be in a reproducible format required by Agency and of good quality such that all information is clearly readable, without dark spots, loss of information, or blurring.

In addition to these record drawings, the Agency may require the submittal of separate documents identifying the final location of the Project which must be stamped by a NPLS, or require the contractor to coordinate with Agency staff to collect this data during construction. Refer to each Agency for their specific requirements prior to construction.

3.11 BYPASS PUMPING

Contractor shall provide a detailed written plan, drawings and other documentation as necessary presenting any proposed bypass pumping operations for review and approval to the Agency at least 30 calendar days prior to the commencement of bypass pumping operations.

3.11.1 Bypass Pumping Plan

The bypass pumping plan shall meet the following requirements as a minimum:

1. Location of pumps,

2. Pump sizes,
3. Suction and discharge pipe sizes,
4. Suction/discharge pipe locations,
5. Manhole locations where flows are intercepted and discharged,
6. Odor control provisions,
7. Pumping system site protection provisions,
8. Noise control provisions,
9. General operating provisions,
10. Emergency operating provisions and operating schedule.
11. Calculations demonstrating that the bypass system (pumps, redundant pumps, and pipes) have the required capacity, considering static head, dynamic head, friction losses, and minor hydraulic losses.
12. Bypass pumping plan, drawings, calculations and documentation shall be prepared, stamped and signed by a Nevada Licensed Professional Engineer.
13. Indicate the peak hydraulic capacity of the existing sewer flowing full. The first upstream manhole from the suction manhole shall not be surcharged.
14. List the primary individual in charge of operations and additional lead personnel who shall be on site when the primary individual is away not present, together with 24/7 emergency telephone numbers for the on-site operators, Contractor's site superintendent, developer and other individuals who may need to be contacted in case of bypass pumping system operational issues

3.11.2 Bypass Pumping System

The bypass pumping system shall meet the following requirements as a minimum:

A. Bypass System Capacity:

1. Shall be capable of transporting 1.5 times the maximum wet-weather flow expected within the existing sewer;
2. Or 125-percent of the full pipe capacity of the existing incoming sewer, whichever is greater.
3. Shall include 100-percent redundant pump capacity
4. all necessary appurtenances required to put the redundant pumps into operation sufficiently quickly to prevent building flooding or surface overflows from the tributary sanitary sewer system, should there be a failure in the primary bypass pumping system.
5. Piping shall be pressure-tested with water in the presence of the Agency Representative at least two work days prior to the commencement of pumping operations.
6. Test pressure shall be twice the maximum operating pressure of the bypass pumping system or 50 psi, whichever is greater.
7. Piping shall maintain at least 90-percent of the test pressure for a minimum of two hours after initial pressurization and there shall be no visible leaks from the system during the test or at any other time.

B. Pumping Equipment:

Shall include pumps, conduits, motors/engines, and all related equipment necessary to divert the flow or sewage around section in which work is to be

performed. The Contractor shall promptly repair or replace the failed equipment to the satisfaction of the Agency's Representative.

C. Odor Control Requirements:

1. Equip with both gas-phase and liquid-phase odor control systems as necessary to prevent nuisance odors from escaping the pumping or sewer construction operations.
2. Place at both the pump suction and force main discharge locations. Details of these odor control systems shall be included in the bypass pumping plan and supporting documentation submitted to the Agency.

The Contractor is cautioned that hydrogen sulfide, methane, and other potentially hazardous and/or explosive gasses or other materials may be present in existing or new sanitary sewers. There also may not be sufficient oxygen in the sanitary sewer system to support life. Therefore, the Contractor is advised to take suitable precautions to protect its work forces and the general public from exposure and shall provide odor control and other systems as necessary for such conditions.

3.11.3 Prohibition Against Sanitary System Overflows:

Contractor shall provide all materials and labor as necessary to maintain flows in the existing sewer and tributary main sewers and laterals at all times and under all weather conditions. Interruption of flows is not permitted. Overflows from bypass operations shall not be permitted to directly or indirectly enter any streams or bodies of water.

The Contractor shall be solely responsible for any damage to public or private property, and any legal actions taken by the state regulatory agencies and/or others if such overflows, stoppages, or backups that occur during construction. Contractor shall immediately contact the Agency, state regulatory agencies and others as appropriate should a sanitary sewer overflow occur, regardless of the flow rate or flow volume discharged.

3.11.4 Use of New Sanitary Sewers:

The new sewer line may be used by the Contractor to carry the sanitary flow after the new pipe has passed inspection and testing. Any "temporary" connections to the new sewer line and "restoration" of the new sewer line to the configuration required in the Construction Documents following completion of bypass pumping operations shall be approved by the Agency's Representative.

3.11.5 Noise Attenuation:

Engine driven equipment for bypass pumping equipment, power generation or air compression shall have sound attenuating "critical grade mufflers" to limit noise from these combined noise sources when they are in normal operation to a maximum of 50 decibels at a distance of 100-feet from the individual unit producing the greatest amount of noise.

If equipment is operated between the hours of 8:00 PM and 6:00 AM, this equipment shall also be provided with sound attenuation enclosure consisting of a three-sided enclosure with roof constructed of 2 by 4 frame with ½-inch plywood sheathing and 2-inch Styrofoam panels attached to the inside of the entire enclosure. The enclosure shall be portable in order to allow the enclosure to be moved when bypass pumping equipment is moved.

3.11.6 Bypass System Power Source:

The bypass pumps may be directly engine driven or may be electrically powered, either by drops from local public utility system or by a dedicated generator system. Pumps placed in the sanitary sewers shall be of explosion-proof configuration.

In the case of direct engine driven pumps, the redundant pumps shall also be direct engine driven by their own independent power units.

In the case of electrically driven pumps, whether powered from the public utility or dedicated generators, a second independent generator system of equal power output capacity shall be provided in case of power failure and the bypass pumping system shall be equipped for quick switch-over to the back-up generator. Electrical power systems shall be explosion-proof and waterproof.

3.11.7 Bypass System Traffic Protection:

The bypass pumping system shall be protected from damage by construction equipment, passing vehicular traffic and vandalism. Pumping system and piping protection methods to be utilized shall be presented in the bypass pumping plan. Vehicular traffic access and pedestrian access must be maintained in accordance with the MUTCD and ADA requirements. Suitable traffic warning and directional control devices shall be placed where required to keep both construction and non-construction traffic away from the bypass pumping system and its appurtenances. Bypass system piping that may be exposed to vehicular traffic shall be capable of withstanding a directly-applied HD-20 loading with an impact factor of 2.0.

3.11.8 Bypass System Maintenance and Operation:

The bypass pumping system shall be maintained by qualified operating personnel, of which at least one individual shall be present on site at all times that the system is in operation.

The operating personnel shall be capable of operating, maintaining, repairing, refueling or otherwise keeping the bypass pumping system in full operation at all times. The operating personnel shall inspect the system, including piping, at least once per hour while the bypass pumping system is in operation and shall maintain a log of said inspections, documenting system functions, malfunctions, general maintenance performed, and emergency maintenance performed. This log shall be kept up-to-date for each daily work shift and shall be readily available to the Agency for review.

3.11.9 Agency Notice of Operation:

The Contractor shall notify the Agency of its intention to begin bypass pumping not less than two work days prior the start of pumping operations. Further, the operation of the bypass pumping system shall not be initiated until work is ready to commence on the construction of the sanitary sewer improvements for which bypass pumping is required. In addition, operations shall not commence on a Friday unless week-end construction work is planned, nor shall pumping system operations commence on the days prior to holidays or other traditional non-work days.

3.12 AGENCY PIPELINE ENCROACHMENT - BLASTING

Prior to actual blasting, all non-explosive means of excavation must be explored and shall be utilized if found feasible. The blasting requirements presented in this section represent the minimum requirements for conducting blasting operations. When blasting within 200 feet of any Agency sewer main or other facilities, the following are required:

3.12.1 Contractor Responsibility for Blasting:

The Contractor is solely responsible for any damage to existing facilities, the new Work, the contractor's work force and the general public caused by its blasting operations, including temporary or permanent loss of use. These requirements and any other measures deemed necessary to fully protect all existing facilities, new Work, contractor work force, equipment, and the general public from blasting shall be employed by the contractor. The contractor and subcontractors associated with the blasting, shall comply with all applicable federal, state, and local regulations.

3.12.2 Blasting Plan:

The Contractor shall submit a written blasting plan to the Agency's Representative, for review and approval, at least thirty days before blasting commences. The Agency's review, review comments, or lack of comments on the blasting plan shall not relieve the Contractor of its sole responsibility to fully protect all existing facilities, the new Work, the contractor's work force, the Contractor's equipment and the general public from harm from the Contractor's blasting operations.

The blasting plan shall include the following minimum information:

1. Explosive type
2. Delay types and intervals
3. Delay pattern
4. Maximum shot hole depth, diameter, and spacing
5. Drilling Pattern – Show plan view and profile in relation to Agency facilities. The drilling pattern and initiation procedure shall provide the greatest relief possible in a direction away from any Agency pipeline and must minimize vibration and ground movement. The use of stress relieving trenches may be required by the Agency.
6. Maximum charge per hole
7. Maximum Charge Per Delay - No more than one charge shall be fired during each delay period.
8. Type of protective blasting mat used, and method of placement (if any)

3.12.3 Existing Facility Inspection:

Existing sanitary and storm sewers within 200 feet of the proposed blasting zone shall be televised prior to blasting to determine the current condition of those sewers. Within fourteen calendar days following completion of blasting operations, these existing sanitary and storm sewers shall be re-televised to determine if they have been damaged by blasting operations.

All televising shall be done in accordance with the requirements of Section 3.19.1.e. Any damage to the sanitary and/or storm sewers discovered through comparison on the pre- and post-blasting televising shall be repaired by the Contractor to the sewer owner's satisfaction at no cost to the Agency.

3.12.4 Blaster Qualifications:

All blasting shall be conducted by experienced, trained, and licensed personnel each of whom shall be in good standing with the licensing entities, including the State of Nevada. Documentation of licensed blasters shall be provided to the Agency's Representative prior to blasting.

3.12.5 Agency Representation:

Blasting shall be done only with the Agency's Representative present.

3.12.6 Blasting Monitoring:

The Contractor shall supply a seismograph and qualified operator, jointly acceptable to both the Contractor and Agency's Representative, at Contractor's expense. Seismograph readings shall be taken over the Agency's affected pipelines and facilities and shall be recorded for each blast.

Results shall be provided to the Agency's Representative after each blast. A peak particle velocity of 2 inches per second shall not be exceeded at any Agency facility. Peak particle velocities shall be recorded in the longitudinal, transverse, and vertical directions.

3.12.7 Independent Blasting Consultant:

Prior to, or post construction, the Agency reserves the right to require an independent blasting consultant to review the Contractor's blasting plan and procedures. The expense for this consultant shall be borne by Contractor.

3.12.8 Blasting Plan Modifications:

Any deviation from the blasting plan shall require additional review by the Agency. In the event the plan's peak particle velocities are exceeded, the Contractor shall be liable to pay the full cost of inspecting the Agency's facilities outside the 200-foot limit and the cost of any repairs and/or facility replacements resulting from such occurrence, as well as any other costs directly resulting from such occurrence.

Compliance with the preceding requirements does not express or imply that the Contractor, its subcontractors, blasters, consultants or any other associated party is relieved of any responsibility or liability in the event any of the Agency's facilities or other property in the Project area are damaged in any way before, during, or after blasting operations. The Agency will hold all parties responsible for costs incurred for any breach of integrity of Agency pipelines, other Agency facilities, or other utilities/site-objects in the vicinity of blasting operations.

3.13 EARTHWORK

The Contractor shall perform all earthwork required for construction of all facilities, pipelines, and appurtenances as specified or shown on the drawings, including clean-up as required. Excavation for appurtenant structures, such as manholes, inlets, transition structures, junction structures, vaults, valve boxes, catch boxes, catch basins, pump stations, lift stations and other facilities, shall be deemed to be in the category of excavation. Density values specified in the following subparagraphs shall be Modified Proctor densities per ASTM D 1557.

During any construction activity, such as, but not limited to: grading, excavating, construction of new facilities, adjustment of grade rings for new pavement, or any other construction activity that exposes an operational sanitary sewer system, the Contractor shall adhere to the following:

1. The contractor shall install exterior/marine grade plywood bulkheads in the upstream and downstream sanitary sewer to prevent debris from entering the piping systems during construction activities. Plywood shall remain in place until the final adjustments to street grade and concrete collars have been installed.
2. Any debris that accumulates in the sewer shall be removed and the bulkheads shall be removed at the end of each day's construction such that the sanitary systems are returned to normal operational condition.
3. Additional protection shall be placed around any open excavations adjacent to exposed operational sanitary sewers to prevent debris from falling into the sanitary sewer, including storm water runoff. This protection shall remain in place until the excavation is backfilled.

3.13.1 Excavation:

A The excavation support is an integral part of the Contractor's means and methods of construction. Excavations including the manner of supporting excavations and provisions for access to trenches:

1. Shall conform to applicable State Industrial Safety requirements and Federal Occupational Safety and Health Act (OSHA) requirements.
2. The Contractor shall submit to the Agency a certification that the excavation support has been designed by a Nevada Licensed Professional Engineer.
3. The above referenced engineer shall inspect the initial phase of excavation support installation and inspect thereafter, no less than one day per each month. The referenced engineer shall also provide a certification to the

Agency after each inspection which confirms the excavation support has been installed and is being utilized in general conformance with his/her design.

B. Excavation shall include:

1. The removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with proper execution and completion of the work.
2. The Contractor shall furnish all equipment, materials and manual labor that may be required for the excavation, including but not limited to, all pumping, ditching, or other measures for the removal or exclusion of water, including storm and wastewater reaching the worksite, from any source so as to prevent damage to the work or adjoining property.

C. Excavation for pipeline:

1. Shall be open-cut trenches with vertical sides having a 1-foot minimum above the top of the pipe as shown in Standard Drawing SD-15, unless otherwise shown in the Construction Documents or provided herein.
2. Excavation from 1-foot above the top of the pipe to the ground surface shall be in accordance with Standard Drawings SD-16, and SD-17 and the Contractor's method of trench wall support which shall conform to State Industrial Safety and OSHA requirements.
3. The bottom of the trench shall have a minimum width of pipe outside diameter plus 16-inches and a maximum width as recommended by the Uni-Bell PVC Pipe Handbook (if applicable) and pipe manufacturer but not greater than pipe outside diameter plus 36-inches. In addition, the compaction of foundation, bedding, haunching and initial backfill shall extend to the trench wall.

D. Whenever the excavation is made below the grade shown on the drawings, the trench shall be backfilled to the required grade with Agency approved material and said material shall be brought to optimum moisture content and compacted by mechanical means. Layers shall not exceed 8 inches in loose thickness before compaction and shall be compacted to a minimum of 90 percent of maximum density

E. Excess material and excavated material determined unsuitable for backfill by the Agency's Representative shall be removed from the site of the work by the Contractor at its own expense.

F. The Contractor shall provide a uniform, stable base to the grade shown on the plans or to the minimum depth required.

G. Where an unstable or running soil condition is encountered in the trench wall, such as may be found by excavation below groundwater, this condition shall be stabilized by an agency approved material before laying the pipe.

H. For manholes, valves, and other appurtenances:

1. The Contractor may excavate to place the concrete structure directly against the excavated surface, provided that the faces of the excavation are firm and unyielding and are at all points outside the structure lines shown on the plans.
2. If the native material is such that it will not stand without sloughing or if pre-cast structures are used, the Contractor shall over-excavate to place structure and this over-excavation shall be backfilled as required for the adjoining pipeline and compacted to a minimum of 90-percent of maximum density.

3.13.2 Dewatering:

Under no conditions shall groundwater be allowed to enter into the existing sanitary sewer system. All dewatering costs shall be borne by the Contractor. To stabilize the excavation when groundwater is encountered, the Contractor shall adhere to the following:

1. Lower and maintain groundwater levels distance of at least 2-feet below the bottom of the excavation at its lowest point at all times the excavation is open, including non-work periods.
2. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the following provisions.
3. Dewatering shall be conducted such that no concrete footings or floors or pipelines are placed in water nor shall water be allowed to rise over them until the concrete or mortar has set at least 24 hours.
4. Water shall not be allowed to rise unequally against the walls until design strength is achieved or for a period of 28 days nor shall water be allowed to rise in pipeline trenches or drained excavations until pipelines or facilities are backfilled or restrained to prevent flotation.
5. Where groundwater is found to be present above the bottom of the trench:
 - a. Dams shall be constructed in the backfill material in accordance with Section 3.14 to limit the movement of groundwater through the bedding. Dams shall be constructed of CLSM per Agency's approved materials list only.
 - b. The foundation noted in SD-15 shall be 1" minus crushed rock. The crushed rock shall be wrapped with a fabric wrap per the governing Agency's approved material list.

3.13.3 Pipe Bedding:

The gradation and classification of backfill materials are provided in Table "G".

A. Pipe Bedding (Rigid Pipe):

1. Bedding, in accordance with this section and Standard Drawing SD-15, shall be required where conditions of unstable trench bottom, over-excavation, or rocky foundation are encountered. Bedding is also required to provide support necessary to develop the design supporting strength of the pipe.
2. Bedding material, Type II or other Agency-approved material, shall provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints.
3. All loose material in excess of two inches in diameter shall be removed from the bottom of the trench and fill material beneath the pipe compacted to a minimum 90 percent of maximum density.
4. If approved native material is not used for bedding, the Contractor shall provide a copy of the material delivery ticket from an Agency-approved source for the imported bedding material utilized.
5. Where rocky or unyielding foundation material is encountered, subgrades shall be excavated to remove protruding rocks. Type II bedding shall be provided in layers not exceeding 8 inches in loose thickness before compaction. Layers shall be compacted to a minimum of 90 percent of maximum density.
6. Concrete Cradles, Arches, Encasement:
 - a. Pipe that is to be bedded in a concrete cradle or encased in concrete shall be placed in proper position on temporary supports consisting of concrete block or bricks. When necessary, the pipe shall be rigidly anchored or weighted to prevent flotation when the concrete is placed.
 - b. Concrete for cradles, arches or encasement shall be placed uniformly on each side of the pipe. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.
7. During backfill, sufficient bedding material shall be placed around the pipe and compacted to hold the pipe to the designed alignment during subsequent pipe jointing and backfilling operations.

B. Pipe Bedding (Flexible Pipe):

1. The pipe shall be bedded to line and grade with uniform and continuous support for a firm base. Blocking shall not be used to bring the pipe to grade.
2. Installed pipe with elastomeric seal joints:

- a. Bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint.
 - b. Care shall be taken that the bell hole is no larger than necessary to accomplish proper joint assembly.
 - c. When the joint has been made, the bell hole shall be carefully filled with bedding or haunching material to provide for adequate support of the pipe throughout its entire length.
- C. All other provisions for bedding of rigid pipe as set forth in Section 3.13.3.a shall also apply.

3.13.4 Pipe Zone Backfill:

The compaction of pipe backfill materials within the pipe zone shall be by mechanical means only, **jetting or flooding shall not be allowed**. The pipe zone of the trench is defined as the full width of the trench excavation from the top of the compacted pipe foundation to the elevation 12 inches minimum above the outside top of the pipe bell. See Standard Drawings SD-16, and SD-17.

A. Pipe Zone Backfill (Rigid Pipe):

1. Unless otherwise specified, after the pipe is laid, the pipe zone shall be backfilled with Type II material, crushed rock, or sand where permitted by agency (refer to Table "G") and compacted as follow:
 - a. Below the springline of the pipe, the backfill material shall be placed in such a manner that it is uniformly compacted around the pipe.
 - b. Minimum 12 inches to a maximum of 24 inches above the top of pipe. Each lift shall not exceed a maximum of 12 inches loose.
2. The backfilled trench shall be compacted as follow:
 - a. Not less than 90 percent of maximum density in the pipe zone.
 - b. Adequate sumps and pumping shall be provided, as determined by the Agency's Representative, for removing excess water from the trench.
 - c. Any water in a partially backfilled trench shall be allowed to completely drain away before the remaining backfill is placed.
3. The selection and use of mechanical compaction equipment shall be as follow:
 - a. Utilize with care so that the pipe will not be disturbed or damaged.
 - b. In no case shall compaction equipment make direct contact with the pipe.

- c. A minimum of 12 inches of cover is required above the pipe when handheld compaction equipment is utilized.
- d. A minimum of 36 inches of cover is required above the concrete and vitrified clay pipes when heavy compaction equipment is utilized.

B. Pipe Zone Backfill Operations (Flexible Pipe):

1. This section is derived from NSI/ASTM Standard D2321. Where more restrictive standards are recommended by the pipe manufacturer, those shall be used.
2. Wet Conditions - In any area where the pipe will be installed below historic groundwater levels or where the trench could be subject to inundation, the following is required:
 - a. Crushed rock material shall be placed to the top of the pipe zone.
 - b. In the initial stage of placing this type of material, sufficient crushed rock material shall be worked under the haunch of the pipe to provide adequate side support.
 - c. Precautions must be taken to prevent movement of the pipe during placing of the material under the pipe haunch.
 - d. Protection of the pipe from large particles of backfill material is required.
 - e. Where unstable trench walls exist because of migratory materials such as water-bearing silts or fine sand, the loss of side support through the migratory action shall be prevented.
3. Dry Conditions - In any area where groundwater will not be experienced at any time above the level of the foundation material or where the trench will not be subject to inundation, the following is required:
 - a. Type II material (refer to Table "G") or CLSM shall be placed in the pipe zone.
 - b. Type II material (refer to Table "G") shall be placed within the pipe zone and compacted by hand or mechanical tamping in lifts not exceeding 12 inches loose.
 - c. In the initial stage of placing Type II (refer to Table "G") or CLSM, the material shall be worked under the haunch of the pipe to provide adequate side support. Movement of the pipe shall be prevented during placement of Type II material or CLSM under the pipe haunch.
 - d. The initial Type II backfill material shall be placed in the following stages:
 1. From pipe bedding to springline of the pipe.
 2. From springline to the top of pipe.

3. From top of pipe to a minimum of 12 inches and a maximum of 24 inches over the top of pipe.
 - e. Each stage of haunching and initial backfill shall be compacted by handheld compaction equipment to a minimum of 90 percent maximum density.
4. To avoid contact between the pipe and compaction equipment, and elude damaging effect to the pipe, compaction, haunching, and initial backfill shall adhere to the following:
 - a. Minimum of 12 inches of cover is required above the pipe when handheld compaction equipment is utilized.
 - b. Minimum 24 inches of cover is required above the pipe when heavy compaction equipment is utilized.
 - c. Minimum 36 inches of cover is required above the pipe before the trench is wheel loaded.
 - d. Minimum 48 inches of cover is required above the pipe before utilization of hydrohammer.
5. If sheeting or other trench protection is removed, do not disturb previously constructed foundation bedding, haunching, and initial backfill. If it has been necessary to place or drive sheeting or other trench protection below the top of the pipe, this portion shall be left in place since its removal could jeopardize the side support necessary for "flexible conduits."

3.13.5 Trench Backfill:

Backfill in the pipe trench above the pipe zone shall be as follows unless otherwise required by the governing authority for the installation. Compaction of backfill material by flooding or jetting is not permitted.

A. Granular Backfill (Refer to Table G):

Material used for granular backfill shall be as follows:

1. Shall consist of natural sand or a mixture of sand with gravel, crushed gravel or crushed stone.
2. Granular Backfill shall be free of pea gravel.
3. Material shall be free of sod, frozen earth, organic materials, rubbish, or debris.
4. Material placed adjacent to structures shall have a water-soluble sulfate content of less than 0.3 percent by dry soil weight.

B. Selected Backfill Material (Refer to Table G):

Material used for selected backfill shall be as follow:

1. Shall be a quality acceptable to the Agency and may consist of suitable material from excavation.
2. Shall be free of broken concrete, bituminous material, sod, frozen earth, organic materials, rubbish, or debris.
3. Shall have a sufficient amount of fine material to fill the voids between the coarse aggregate.

C. Unpaved Areas (See Standard Drawing No. SD-16.):

1. In unpaved areas, backfill above the pipe zone shall be "Selected Backfill" or "Granular Backfill" as specified in Sections 3.13.5.a and 3.13.5.b and Table "G" of these Standards.
2. This backfill shall be placed in lifts not to exceed 18 inches loose in thickness and shall be compacted to a minimum of 90 percent of maximum density.

D. Paved Areas (See Standard Drawings SD-17):

1. In paved areas with right-of-ways of 60 feet or less, backfill above the pipe zone to a level 24 inches below the bottom of the pavement shall be:
 - a. In paved areas, backfill above the pipe zone shall be "Selected Backfill" or "Granular Backfill" as specified in Sections 3.13.5.a and 3.13.5.b and Table "G" of these Standards.
 - b. This backfill shall be placed in lifts not to exceed 18 inches loose in thickness and shall be compacted to a minimum of 90 percent of maximum density.
 - c. Compaction shall be by mechanical means.
 - d. Backfill material in the 24-inch depth beneath the pavement shall be Type II base aggregate (refer to the Standard Specifications) compacted to not less than 95 percent of maximum density by mechanical means.
2. In paved areas with right-of-ways greater than 60 feet, backfill above the pipe zone to a level two (2) feet below the bottom of the pavement may be:
 - a. "Selected Backfill" or "Granular Backfill" compacted to 90 percent of maximum density by mechanical means or "CLSM" as specified in subsection 208.02.06 of the "Uniform Standard Specifications For Public Works' Construction Offsite Improvements, Clark County Area, Nevada."

- b. Backfill material in the top two (2) feet of the trench immediately below the bottom of the pavement shall be "CLSM" as specified in Section 4.7.1 and Subsection 208.02.07 of the "Uniform Standard Specifications or Public Works' Construction Offsite Improvements, Clark County Area, Nevada."

E. Nevada State Right-of-Ways:

Unless otherwise shown on the drawings or specified, compaction of backfill within Nevada State Department of Transportation (NDOT) right-of-ways shall be:

1. Performed with mechanical tamping units and the material shall be placed at a rate which will permit efficient use of mechanical tampers in securing the required compaction.
2. Backfill shall be compacted to 90 percent maximum density.
3. Backfill material shall be placed in uniform horizontal layers not exceeding 8 inches in loose thickness before compaction and shall be brought up uniformly on all sides.
4. Each layer of backfill shall be moistened as necessary and thoroughly tamped until 90 percent of maximum density is achieved.
5. Compaction of backfill material by flooding or jetting is not permitted in Nevada State Department of Transportation right-of-ways.
6. Contractor shall otherwise comply with all other requirements imposed by NDOT.

3.14 PIPE INSTALLATION

The Contractor is cautioned that hydrogen sulfide, methane, and other potentially hazardous and/or explosive gasses or other materials may be present in existing or new sanitary sewers. There also may not be sufficient oxygen to support life. Therefore, the Contractor is advised to take suitable precautions to protect its work forces and the general public from exposure and shall provide odor control and other systems suitable for such conditions.

Gravity sewer pipe shall be laid in accordance with the latest editions of: ASCE Manual of Practice No. 60, the Uni-Bell PVC Pipe Association Handbook of PVC Pipe, Design and Installation, and the pipe manufacturer's recommendations. Force mains shall be installed in accordance with AWWA C605 and pipe manufacturer's recommendations. HDPE and FRP shall be installed by contractors certified by the pipe manufacturer.

3.14.1 General:

The following general requirements shall apply to the installation of pipe:

1. The pipe runs between manholes shall be a single pipe size, pipe material and structural classification.

2. Pipe shall be laid in dry finished trenches free from water or debris. Before pipe-laying, remove all water that may have entered the trench. Commence pipe-laying at the lowest point and lay continuously, with the spigot ends pointing in the direction of the flow.
3. Protect the pipe during handling against impact shocks and free fall. Do not permit hooks to come in contact with pre-molded joint surfaces.
4. Handle pipe having pre-molded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material.
5. Avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard surface
6. The internal beads on butt-fusion welded HDPE shall be reamed flush with the interior pipe wall.
7. After delivery alongside the trench, carefully examine each piece of pipe for soundness and specification compliance.
8. Acceptable pipe may be marked by the Agency's Representative with paint or other permanent marking material.
9. The marks should be plainly visible after installation in the trench and before the pipe is covered.
10. Clean joint contact surfaces immediately prior to jointing.
11. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.
12. Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade.
13. Excavate bell holes for each pipe joint. When jointed in the trench, the pipe shall form a true and smooth line.
14. All pipes shall be installed per sections 3.14.4 through 3.14.8.
15. Installation of new sewer facilities that cross over or under existing utility pipes, sewer mains or laterals, except water mains and water services shall be in accordance with Standard Drawings SD-18 and SD-19. Water main and water service crossings shall be in accordance with UDACS requirements.
16. Under no circumstances shall water, that has infiltrated into the trenches, be allowed to enter into the existing sanitary sewer system. The pipeline under construction may be used to remove water that has infiltrated into the trenches provided it is removed before entering the existing sanitary sewer system.

3.14.2 Curvilinear Sewers:

In addition to the general requirements noted in 3.14.1, curvilinear sewers shall also be installed per the following requirements:

1. The maximum allowable deflection per joint shall be 75-percent of the maximum allowable deflection per joint recommended by the pipe manufacturer.

3.14.3 Ductile Iron Pipe:

In addition to the general requirements noted in 3.14.1, ductile iron pipe sewers shall also be installed per the following requirements:

1. Ductile iron pipe and fittings shall be protected with a minimum of 2 layers of 8 mil polyethylene encasement material in accordance Agency's AML as applicable.
2. The polyethylene encasement materials shall extend a minimum of 3-feet or 3 pipe-diameters, whichever is greater, beyond the ends of DIP pipe or fittings where DIP pipe transitions to non-metallic pipe materials.
3. The overall installation of the encasement and the making of joints between sections of the encasement material shall be in accordance with AWWA C 105, the DIP manufacturer's recommendations and the encasement material manufacturer's recommendations.
4. In case of conflict among these recommendations, the recommendation yielding the greater protection of the ductile iron pipe/fitting shall generally apply. The Agency Representative shall have final authority to determine which individual recommendations or composite of recommendations shall be followed.
5. The encasement shall be installed such that punctures and/or tears are minimized. Minor punctures shall be and tears shorter than 6-inches shall be repaired as recommended by the encasement material manufacturer.
6. Encasements having tears greater than 6-inches shall be removed and replaced.
7. Pipe cover materials shall be placed in a manner that does not puncture or tear the encasement material.

3.14.4 Groundwater:

1. When pipe is to be installed at or below the groundwater table and wherever groundwater is encountered whether above or below the groundwater table, water dams shall be installed along the trench through the area of high groundwater at not more than 100-foot intervals, unless otherwise approved by the Agency.
2. The water dams shall be constructed of a 1-foot nominal thickness of CLSM or a 3-foot nominal thickness of clay compacted to a minimum of 95-percent modified Proctor Density and having a permeability when completed of not more than 0.00001 centimeters per second.

3. The water dams shall extend the full width of the trench and keyed in to the undisturbed trench wall and shall extend from the undisturbed trench bottom to a height equal to top of established water table or 2-feet above top of pipe, whichever is greater.

3.14.5 Debris Traps:

1. Following completion of the first manhole(s) upstream of the new connection(s) to the Agency's existing sanitary sewer system, a debris trap as shown in SD-27 shall be installed in said manhole.
2. If the Contractor plans to place particular portions of the new sanitary sewers in operation before the entire system is completed, then each portion to be brought into service early shall also be protected from debris entry from upstream systems by similar such debris traps.
3. The debris trap shall remain in place until all sanitary sewer improvements in the Project have been constructed, infiltration-tested, cleaned, mandrel-tested, televised and initially accepted by the Agency.
4. Additional trap(s) shall be placed at the downstream end of each sewer segment being cleaned, as required, to prevent the discharge of debris to either the existing sanitary sewer or to other downstream segments of the new sewer that have already been cleaned and tested.
5. Contractor shall inspect the debris trap weekly during construction and immediately following any sewer cleaning operations and shall immediately remove any debris that has accumulated.
6. After the new sanitary sewers are accepted by the Agency, the Contractor shall remove all traps in the presence of the Agency's Representative.
7. At times when pipe-laying is not in progress, the open end of the pipe shall be closed with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe.

3.14.6 Pipe Locator Ribbon:

1. Pipe locator ribbon conforming to Section 4.8 shall be placed no less than 18 inches nor more than 24 inches above the top of pipe, centered along the entire lengths of public interceptor sewers, public collector sewers and private collector sewers, force mains, effluent reuse lines, and laterals as shown in Standard Drawings SD-15 through SD-23.
2. The metallic component shall be extended into the pump station dry well and the force main discharge manhole at the main gravity sanitary sewer.

3.14.7 Marker Balls:

1. Marker balls shall be per the Agency's approved materials list (AML).

2. Marker balls shall be placed above each lateral connection to the main sewer and above the upstream end of each lateral as shown on Standard Drawings SD-20, SD-21 and SD-23.
3. Marker balls shall be placed at uniform intervals not exceeding 25 feet above curvilinear sewers and stub-outs.
3. Marker balls shall be placed at uniform intervals not exceeding 50-feet and at changes in horizontal or vertical alignment above each force main in dual force main installations, or pressurized water reuse lines.
4. Where marker balls are installed during project on adjacent or crossing pipelines, the marker balls need to be offset from one other by 25-feet.
5. Where possible, marker balls shall be at least 3-feet below finish grade, but not more than 5-feet below finish grade under any circumstances.

3.14.8 Plugs:

1. Watertight plugs shall be placed at the ends of all sewer stub-outs and laterals.
2. These plugs shall be restrained from blow-out by concrete thrust blocks at least one cubic foot in volume.
3. Concrete shall conform to Section 4.7.

3.15 SOIL TESTING

The Contractor shall furnish to the Agency the following tests and/or analyses of all bedding, cover and backfill material:

1. Sieve analyses (per ASTM C 136),
2. Plasticity indexes (PI - per ASTM D 4318)
3. Baseline maximum density tests (Modified Proctor per ASTM D 1557)
4. In-situ compaction testing by a certified laboratory (Modified Proctor per ASTM D 1557)
5. Compaction testing shall be performed using a Nuclear Density/Moisture Gauge in accordance with ASTM D-2922
6. Test locations shall be as directed by the Agency Representative
7. Test frequency shall be per table H or as directed by Agency's Representative.

Submittals shall be in accordance with Agency requirements. Agency approval of the sieve analysis, Plasticity Index (PI), and maximum density tests shall be required prior to using these materials. All costs for having the sieve analyses, plasticity indexes, and baseline maximum density tests taken by a soils lab shall be paid for by the Contractor. In all cases, all soil samples shall be taken in the presence of the Agency's Representative.

In-place soils shall be tested in accordance with ASTM D-1556, with the exception that no samples shall contain particles larger than 3/4 inch. The laboratory shall provide certified testing results for all tests performed. Contractor shall furnish updated Proctor, sieve and PI to the Agency for any changes in bedding, cover or backfill material prior to in-situ density testing by the certified laboratory and whenever the Agency believes that the previously tested/approved materials have changed sufficiently in properties to impact material compaction.

Where compaction tests indicate a failure to meet the required compaction, additional tests shall be taken at the cost of the Contractor every 50 feet in each direction until the failing area is defined. The entire area between the passing test locations shall be reworked until the proper compaction requirements are achieved.

If the Contractor questions the results of in-situ density testing, Contractor shall engage a second testing laboratory at its cost to re-take tests following the same requirements as the initial tests. The locations of the second tests shall be as directed by the Agency Representative.

3.16 MANHOLE AND CAST-IN-PLACE STRUCTURE INSTALLATION

Construction shall consist of furnishing all materials and constructing manholes and cast-in-place concrete structures complete in place, as detailed in the Construction Documents and in Standard Drawings SD-1 through SD-13 as applicable, including foundation, base, walls, cones/tops, grade rings, manhole frames, covers, and any incidentals thereto, at locations shown on the approved Construction Documents.

3.16.1 Manhole Base Construction:

Manhole base construction shall be as follows unless otherwise required by the Agency:

1. All manholes on new public interceptor sewers, public collector sewers private collector sewers and new laterals shall have pre-cast manhole bases.
2. New manholes on existing sewers or existing laterals may have cast-in-place bases or pre-cast bases at the Contractor's option.
3. Pre-cast manholes shall conform to Agency's AML and Standard Drawing SD-1.
4. Cast-in-place bases shall conform to Standard Drawing SD-7.
5. Contractor shall use an impression ring when forming cast-in-place manhole bases. This impression ring shall match the manhole components.
6. Concrete for cast-in-place bases and flow channels within manholes shall conform to Section 4.7.2. At no time when placing concrete for cast-in-place manhole bases or other sanitary sewer structures shall the concrete be permitted to fall from a height greater than 6 feet (6') without the use of chutes, tremies or an elephant trunk. All structural concrete pours shall be performed in accordance with A.C.I. recommendations. The Contractor shall furnish the Agency's Representative with a copy of the concrete delivery ticket, which

indicates the type of concrete and bonafide time stamp of when the truck was loaded, prior to any pouring operations. All concrete shall be poured from the truck within 90 minutes from the time on the concrete delivery ticket.

7. Changes in direction of flow, and size and grade of manhole flow channels shall be in accordance with Section 2.2.10.b. and Standard Drawing SD-9.
8. Where cast-in-place manhole bases are allowed, the invert channels in the manhole shall be formed in accordance with Standard Drawings SD-7.
9. Straight-through flow channels in cast-in-place manhole bases shall be created by using a full sewer pipe closely matching the internal diameter of the existing main sewer pipe upstream and downstream of the manhole as a form for the flow channel. After the manhole base has cured at least seven days, the pipe in the base of the manhole shall be carefully sawed out to form a smooth invert through the manhole.
10. Where branch sewers will enter cast-in-place manhole bases, at least 14-days prior to the manhole construction, Contractor shall submit a shop drawing of the manhole base construction for Agency approval. Flow channels shall conform to Section 2.2.10.b, Section 2.2.17 and Standard Drawing SD-9.
11. The pipe(s) through the manhole base shall be connected to the existing upstream and downstream sewer pipes outside the new manhole using correctly sized flexible, water-tight couplings conforming to Agency's AML to match the existing sewer line in which the manhole is being installed.
12. Contractor shall provide the Agency's Representative all concrete mix tickets upon delivery to the site of the work.

3.16.2 Assembling Pre-Cast Concrete Manhole Components:

Pre-cast manhole sections and grade rings on manholes and cast-in-place structures shall be joined by one of the following:

A. Pre-Cast Manhole Sections:

1. The "tongue" of the lower pre-cast section shall be placed pointing upward.
2. In areas where groundwater is not likely to be present, place one row of preformed butyl rubber rope sealant conforming to Agency's AML in the lower step of the joint.
3. In areas of higher groundwater and where designated by the Agency, place a double row of sealant in each pre-cast section joint to and including the barrel-to-cone joint. Place one row each on the upper step and the lower step of each tongue-and-groove joint.
4. Corrosion protection of the manhole sections shall be in accordance with Section 3.16.8. The Engineer shall contact the Agency as early as possible

in the Project design process to identify any additional requirements for design and installation of corrosion protection in areas of high groundwater.

B. Grade Ring Joints:

Initial Placement Prior To Final Elevation Adjustment: As a temporary measure to prevent entry of debris into newly constructed sewer systems grade rings may be joined by placing a single row of butyl rubber rope sealant conforming to Agency's AML between the manhole cone or top of structure and the first grade ring, between grade rings and between the top grade ring and the manhole frame. This temporary measure shall be used prior to adjusting manholes and structures to final grade, placing paving or final landscaping around the manholes/structures and installing concrete collars,

C. Final Manhole/Structure Adjustment:

1. Set grade rings with non-shrink cement grout conforming to Section 4.7. Grout shall cover the full width of the grade ring(s).
2. The ring(s) shall be set fully concentric with the inside diameter of the manhole cone section or opening in the structure top. Grade rings not concentric shall be removed and replaced at no cost to the Agency.
3. After grade ring is placed and prior to the grout taking a "set", any excess grout that extruded into the manhole or structure shall be removed flush with the interior of the grade ring and top of the cone section or structure opening.

3.16.3 Cast-in-Place Concrete Structures:

Construction shall consist of furnishing all materials and constructing cast-in-place concrete structures complete in place, including foundation, base, walls, top, grade adjustment rings, manhole frames, covers, and any incidentals thereto, at locations shown on the approved Construction Documents.

1. Concrete for cast-in-place structures shall generally conform to Section 4.7.
2. At no time when placing concrete for cast-in-place sanitary sewer structures shall the concrete be permitted to fall from a height greater than 6 feet (6') without the use of chutes, tremies or an elephant trunk.
3. All structural concrete pours shall be performed in accordance with A.C.I. recommendations.
4. The Contractor shall furnish the Agency's Representative with a copy of the concrete delivery ticket, which indicates the type of concrete and bonafide time stamp of when the truck was loaded, prior to any pouring operations. All concrete shall be poured from the truck within 90 minutes from the time on the concrete delivery ticket.
5. Before being positioned, all reinforcing steel shall be free from loose mill and rust scale, and from coatings that may destroy or reduce the bond. Where there is

delay in depositing concrete, reinforcement steel shall be re-inspected and cleaned where necessary.

6. Reinforcing steel shall be accurately positioned in accordance with the drawings and secured by using annealed iron wire ties or suitable clips at intersections and shall be supported by concrete dobies, metal or plastic supports, spacers, or metal hangers.
7. When it is necessary to splice reinforcing steel at points other than shown on the drawings, the character and location of the splice shall be determined by the Agency's Representative. Unless otherwise shown on the drawings or specified, splices shall be lapped a minimum of 32 bar diameters.
8. All bends in reinforcing steel shall be cold bends accurately bent to shapes and angles as shown on the approved Construction Documents.
9. All welding required for cast-in-place concrete structures and other Project components shall be by the shielded arc method and shall conform to the AWS D1.1 "Structural Welding Code." Welds on stainless steel shall be made with stainless steel electrodes. Qualification of welders shall be in accordance with the "Specifications for Standard Qualification Procedure" of the AWS. Welders must furnish proof of certification prior to start of any welding.

3.16.4 Pipe Connection Installation:

1. Pipe connections to new manholes, existing pre-cast manholes and cast-in-place concrete structures shall conform to Agency's AML as applicable.
2. Flexible connectors for pipe connections to new manholes shall be factory installed. Flexible connectors for pipe connections to existing manholes or cast-in-place concrete structures shall be field installed.
3. Connections to pre-cast manhole bases shall conform to Standard Drawings SD-1. Connections to new cast-in-place manhole bases shall conform to Standard Drawing SD-7.
4. Outside piping for drop manholes shall be as shown on Standard Drawing SD-12.
5. Holes for connections to existing manholes and new or existing cast-in-place concrete structures shall be cored completely through the existing manhole/structure wall at the specific diameter required for the particular connection coupling/boot being utilized.
6. The finished hole shall be circular and sufficiently smooth for proper sealing of the coupling/boot.
7. If, in the sole opinion of the Agency Representative, the existing manhole/structure is damaged beyond reasonable repair by the coring operation, the existing manhole/structure shall be replaced by a new manhole/structure meeting all requirements of these Standards at no cost to the Agency.

8. Break-in connections or oversized cored holes are not allowed.
9. For existing manholes where ASTM C-923 compliant connections to manholes or structures are utilized, the sewer pipe shall be fully inserted into the manhole/structure such that it contacts the flow channel system with no appreciable gaps. If gaps are present either between the pipe and bench system or around the pipe between the outside of the pipe wall and the cored hole, these gaps shall be filled and finished flush on the inside of the manhole with non-metallic, non-shrink grout conforming to Agency's AML prior to the application of field-applied corrosion protection.
10. For new pre-cast manhole bases, the gaps and annular space between the end sewer pipe section protruding into the manhole, the manhole wall, and the manhole bench shall be grouted with full strength non-metallic, non-shrink Type V grout conforming to Agency's AML. The grout shall fully encase the reinforcing bars shown in Standard Drawing SD-9 located over the tops of the incoming pipes and extend to the ends of the incoming pipes.

3.16.5 Frame and Cover Installation:

1. Manhole and structure frames and covers shall conform to Agency's AML and as shown in Standard Drawings SD-2 and SD-3.
2. All machined surfaces on the frame and cover shall be such that the cover will lie flat in any position in the frame and have a uniform bearing through its entire circumference.
3. Any frame and cover which creates any noise when passed over by automobiles shall be replaced.
4. Frames shall be set firmly in a bed of cement grout conforming to Agency's AML and shall be set true to finish grade as shown on the Construction Documents and as called for in these Standards. The grout shall extend across the full width of the base of the frame such that there are no voids under the frame. After the frame is placed and prior to the grout taking a "set", any excess grout that extruded into the manhole or structure shall be removed flush with the interior of the frame and top of the cone section.
5. Bolts shall be installed in the cover where required by Agency.

3.16.6 Exterior Waterproofing:

1. Exteriors of manholes and cast-in-place concrete structures in areas of high groundwater and in other areas as directed by the Agency shall be coated with waterproofing in accordance with Agency's AML.
2. The waterproofing material shall be roller-applied over the entire exterior surface of the completed manhole/structure, including base section, barrel sections and cone/top section in accordance with the waterproofing manufacturer's recommendations prior to backfilling the manhole/structure.

3. The waterproofing material shall be allowed to dry sufficiently before backfilling to assure that the waterproofing is not damaged or displaced during backfilling.

3.16.7 Excavation and Backfilling:

Excavations shall be made only large enough in size to permit sheeting if necessary and leave room to set necessary components in a workmanlike manner. Backfilling shall be done in accordance with Section 3.13.5.

3.16.8 Corrosion Protection (as required by Agency):

Contractor shall contact the Agency for the specific corrosion protection measures required for manholes and cast-in-place structures.

A. Manhole Corrosion Protection – Factory-Installed Coatings:

1. Factory installed coatings shall conform to Agency's AML.
2. Coatings shall be applied only after the manhole/structure has been completed.
3. Coatings shall cover the manhole/structure base including the flow channel, walls, cone/top and grade rings.
4. Following final adjustment of the manhole/structure frame to finish grade, any grade adjustment rings added to the manhole/structure shall also be coated and conform to Agency's AML. This additional coating shall be blended into the initial manhole/structure coating in accordance with manufacturer's recommendations.

B. Manhole and Cast-in-Place Structure Corrosion Protection – Field-Applied Coatings:

1. Field-applied coatings shall conform to Agency's AML.
2. Coatings shall be applied only after the manhole/structure has been completed including back-filling and initial adjustment to grade.
3. Coatings shall cover the manhole/structure base including the flow channel, walls, cone/top and grade rings.
4. Following final adjustment of the manhole/structure frame to finish grade, any grade adjustment rings added to the manhole/structure shall also be coated. This additional coating shall be blended into the initial manhole/structure coating in accordance with manufacturer's recommendations.
5. Coatings shall be applied in accordance with manufacturer's recommendations on new manhole or other structures that have been thoroughly cleaned in accordance with the manufacturer's recommended cleaning immediately prior to coating installations. New concrete shall not

be considered sufficiently “clean” in its installed condition without performing the manufacturer recommended cleaning.

6. Coatings shall be applied at 125% of manufacturer’s minimum thickness recommendations on new manholes and other structures that have been thoroughly cleaned immediately prior to coating installations. Coatings shall be applied at 250% of manufacturer’s minimum thickness recommendations on existing manholes and other structures that have been thoroughly cleaned immediately prior to coating installations.
7. Coatings on new and existing manholes and other structures shall be applied within 48-hours of cleaning, but not until the cleaned surfaces have been inspected and approved for coating by the Agency Representative. Coatings applied without said approval shall be removed to the base structure for Agency inspection prior to re-coating.
8. The Agency Representative’s inspection of the cleaning of manholes and other structures shall in no way relieve the Contractor of its responsibility to install the coatings in accordance with the manufacturer’s recommendations and in no way relieve the Contractor of its ultimate responsibility for the quality and performance of the coating.
9. Worker(s) performing the cleaning and coating shall be trained by the coating manufacturer.
10. Manufacturer shall provide a written certification to the Agency attesting that said training has been conducted. This certification shall be effective for one-year after its date of issuance after which time the worker(s) must receive follow-up training and re-certification.
11. The coating manufacturer shall provide a representative on site to witness the cleaning and coating of at least the first manhole and structure installed and shall provide a written certification that the cleaning and coating was performed in accordance with manufacturer’s requirements.

C. Manhole Corrosion Protection – Polymer Manholes:

Pre-cast polymer manholes may be used when corrosion protection is required. Polymer manholes shall be per Agency’s approved materials list.

3.16.9 Debris Trap:

Following completion of the first manhole(s) upstream of the new connection(s) to the Agency’s existing sanitary sewer system, a debris trap shall be installed in the manhole(s) per 3.14.2 and SD-27.

3.16.10 Odor Control Equipment:

1. Contractor shall install the odor control equipment shown on the approved Construction Documents in those manholes and structures so designated.

2. The installation shall be in accordance with manufacturer's recommendations.
3. The odor control equipment shall be installed not less than 30 days nor more than 90 days prior to the time when the Contractor expects to begin sanitary wastewater flows through the new sewer system.

3.17 LATERAL SEWER CONNECTIONS

The Contractor is cautioned that hydrogen sulfide, methane, and other potentially hazardous and/or explosive gasses or other materials may be present in existing or new sanitary sewers. There also may not be sufficient oxygen in the sanitary sewer system to support life. Therefore, the Contractor shall take suitable precautions to protect its work forces and the general public from exposure and shall provide odor control and other systems suitable for such conditions. Contractor shall comply with all applicable State Industrial Safety requirements and Federal Occupational Safety and Health Act (OSHA) requirements.

Lateral connections into new or existing public interceptor sewers, public collector sewers and private collector sewers shall be made in accordance with Section 2.3.10 and Standard Drawings SD-20 through SD-24 as applicable. Lateral connections will require the same bedding and backfill materials and installation procedures requirements as main line sewers. Deep lateral connections, if approved, shall be constructed in accordance with Standard Drawing SD-25.

The locations and configurations for lateral connections to new and existing sewers shall be in accordance with the approved Construction Documents. Field changes to the locations/configurations of laterals shown in the Construction Documents shall be approved by the Agency's Representative prior to installation. The Representative shall inspect lateral installations after the pipe is installed but prior to any CLSM placement and backfilling. Any laterals backfilled without Agency Representative observation shall be re-excavated for inspection at no cost to the Agency.

3.17.1 Lateral Connections to New Sewers:

Lateral connections into new mainline sewers shall be by use of appropriately sized wye fittings conforming to Agency's AML.

3.17.2 Lateral Connections to Existing Sewers:

To maintain the structural integrity of the existing mainline pipe, lateral connection taps shall be constructed in accordance with and using materials in accordance with existing sewer main pipe material manufacturer's recommendations. In the event that pipe manufacturer can't be determined, the Contractor shall follow the applicable pipe material trade association recommendations. The Contractor shall advise the Agency immediately and prior to performing any existing sewer taps, if it discovers any conflicts between that the sewer pipe manufacturer's (or trade association's) recommendations and these Standards. The Contractor shall propose modifications to these Standards as necessary to resolve the conflict for Agency review and Approval.

Laterals may be connected to existing sanitary sewers by two methods at the Contractor's option, unless otherwise directed by the Agency.

1. A section of the existing sewer shall be removed and replaced with a new wye fitting matching the pipe materials of the existing sewer (if an approved material) and conforming to Agency's AML.
2. A hole shall be cored into the existing sewer and an appropriately sized wye tapping saddle conforming to Agency's AML shall be installed in accordance with the saddle manufacturer's recommendations.

Both the wye-fitting and wye tapping-saddle type connections shall be supported by controlled low strength materials (CLSM) having a seven-day strength of not less than 150 psi and not more than 300 psi and conforming to Section 4.7.1. The CLSM shall be a minimum of 6-inches in thickness and shall fully encase the main longitudinally at least one foot from both edges of saddle or wye. CLSM material for supporting new lateral connections to existing mains may be mixed on-site, provided that all aggregates used are washed and free of fines; and, Type V cement is used.

Prior to agency acceptance of any tap, repair, rehabilitation, and replacement existing sewer shall be televised, per Section 3.19.1.e.

3.17.3 Damage to Existing Sewers During Lateral Connection Installation:

Should the lateral connection process fracture or otherwise irreparably damage the existing sanitary sewer in to sole opinion of the Agency, the Contractor shall remove the damaged section of main by sawing it out and replacing it with a 45-degree wye service connection section of the same pipe material (if approved material), size and structural rating at no cost to the Agency. The replacement wye shall be connected to the existing main using natural or synthetic rubber couplings conforming to Agency's AML and shall be supported with CLSM as described in Section 3.17.2.

If, during the process to expose the existing main but prior to lateral connection installation, the Contractor finds that existing main is damaged, deteriorated or otherwise unsuitable for service connection installation, the Contractor shall advise the Agency Representative immediately. At the Agency's discretion, all repairs will be performed to damaged and/or deteriorated existing mains by the Agency. Otherwise the Contractor shall develop a plan for correcting the damage/deterioration/unsuitability for review and approval by the Agency and the cost of such correction shall be borne by the Agency. If the Contractor fails to notify the Agency Representative of such damage, deterioration, or other unsuitability and proceeds with the service connection installation prior to Agency inspection of the subject damage/deterioration/unsuitability, it shall be presumed that the damage/deterioration/unsuitability was caused by the Contractor, who then shall correct the damage/deterioration/unsuitability at no cost to the Agency.

3.17.4 Tapping Requirements:

To the maximum extent practical, the Contractor shall endeavor to minimize disturbance to the bedding below the spring line of the pipe when tapping mains. Flexible natural or synthetic rubber tapping saddles conforming to Agency's AML shall be used for all taps. Any bedding material disturbed or removed from beneath the pipe for installation of saddles shall be fully replaced and compacted to prevent future

failure of the pipe. Any pipe not listed below shall be by Agency approval. Additional tapping requirements for pipe types shall be as follows:

A. VCP:

1. Only one lateral tap per section of pipe
2. Placed equidistant

B. NRCP & ACP:

1. Only one lateral tap per section of pipe
2. At least 4-feet away from any pipe end joint or other pipe connection

C. RCP:

1. Taps shall be a minimum of 3 feet apart and a minimum of 18 inches from the bell/spigot.
2. Where pipe wall thickness permits, flexible pipe connections conforming to Agency's AML may be utilized at the Contractor's option.

D. CIP & DIP:

1. Taps shall be a minimum of 3 feet apart and a minimum of 18 inches from the bell/spigot.

E. PVC, FRP & HDPE:

1. Taps shall be a minimum of 6 feet apart and a minimum of 24 inches from the bell/spigot or collar
2. Connections to PVC pipe shall be made using tapping saddles fully compatible with the pipe material of the existing sewer.
3. Connections to HDPE shall be made using thermal-welded tapping saddles fully compatible with the pipe material of the existing sewer.

3.18 ABANDONMENT OF EXISTING FACILITIES

The Contractor is cautioned that hydrogen sulfide, methane, and other potentially hazardous and/or explosive gasses may be present in existing or new sanitary sewer facilities. There also may not be sufficient oxygen to support life. Therefore, the Contractor is advised to take suitable precautions to protect its work forces and the general public from exposure and shall provide odor control and other systems suitable for such conditions.

3.18.1 Main Lines and Laterals:

Prior to beginning abandonment procedures, the Contractor shall televise the existing mainline sewer to locate all existing pipe connections.

1. Televising procedures and products shall be in accordance with the requirements in Section 3.19.1.e.
2. Connection locations shall be delineated by the horizontal distance along the pipe centerline from the closest manhole.
3. Contractor shall provide the televising record together with a written log of connection locations prior to beginning the abandonment process.

Abandonment of main lines and laterals shall be by one of the following four methods, as approved by the Agency:

- Method a. Crush line in place;
- Method b. Excavate and remove line; or
- Method c. Pressure grout line with approved grout
- Method d. Cured in Place Sectional Liner (Laterals Only)

A. Method a. (Crush line in place): Existing crushed pipe may remain in place.

B. Method b (Excavate and Remove Line):

1. Where ACP are removed utilizing Method b, the following conditions shall be met:
 - a. Disposal of removed asbestos-bearing pipe materials and soil in accordance with all applicable environmental regulations.
 - b. Identify disposal site and submit copies of required transportation and disposal permits to Agency.
2. Where laterals are removed utilizing Method b, the following work shall be provided:
 - a. A properly sized cap shall be installed at the end of the wye where the lateral was removed and shall be sealed in place in accordance with manufacturer's recommendations.
 - b. A concrete thrust block at least one-cubic-foot in size shall be poured at the wye cap to prevent the cap from being displaced during sewer cleaning and other maintenance operations.
 - c. After the laterals are removed and the wyes capped, the main sewer shall be televised.
 - d. The television camera shall be stopped and pointed up each wye where a lateral was removed to show that the required cap is in place.

- e. Other televising procedures and products shall be in accordance with the requirements in Section 3.19.1.e.

C. Method c (Pressure Grout Line):

1. Where utilized to abandon ACP, the following conditions shall be met:
 - a. Do not break, crush or damage ACP designated for abandonment.
 - b. ACP designated for abandonment that is damaged by the contractor shall be abandoned per method b at no additional cost to the Agency.
 - c. Coat field cut pipe ends with lockdown encapsulant, in accordance with manufacturer's recommendations.
2. Where utilized to abandon laterals, the following work shall be provided:
 - a. The lateral connection to the mainline sewer shall be excavated and a properly sized cap shall be installed at the end of the wye where the lateral was removed and shall be sealed in place in accordance with manufacturer's recommendations.
 - b. A concrete thrust block at least one-cubic-foot in size shall be poured at the wye cap to prevent the cap from being displaced during sewer cleaning and other maintenance operations.
 - c. The contractor shall also excavate the upstream end of the lateral and grout the lateral from the downstream end to the upstream end until grout material flows out of the lateral at its upstream end.
 - d. As an alternative the Contractor shall place a continuous 1-inch hose inside the lateral extending from the excavation at the main sewer to the upstream end of the lateral. The lateral shall then be grouted from the downstream end at the main sewer until grout material flows from the end of the 1-inch hose, demonstrating that the lateral has been completely filled.
 - e. Where pressure grouting is utilized, the main sewers that receive flows from the sewer that was grouted shall be televised to verify that the main sewer was not obstructed by grout. Televising procedures and products shall be in accordance with the requirements in Section 3.19.1.e. Insides of manholes in main sewers remaining in service after the connecting pipes being abandoned have been fully grouted shall be troweled smooth to eliminate pockets in the areas of the abandoned pipes that could trap debris or sewer solids.
 - f. Any grout in the main sewers and/or manholes remaining in service shall be removed by the Contractor at no cost to the Agency.

D. Method d (Cured In Place Sectional Liner):

Cured in place sectional liner may only be used for the abandonment of laterals at the point of connection, when approved by Agency. The liner shall be installed per manufacturer's recommendations.

3.18.2 Manholes:

Manholes may be abandoned by one of the following methods as approved by the Agency. The Agency reserves the right to retain the salvaged manhole frames and covers that are found to be in reusable condition. The Contractor shall deliver the salvaged frames and covers to the location designated by the Agency Representative. Contractor shall dispose of those frames and covers not wanted by the Agency.

A. Method a (Existing sewer is also to be abandoned):

- a. Remove the manhole frame/cover, grade adjustment, cone and wall section to the base or a to depth of 15-feet below the ground surface whichever is less;
- b. If manhole is equal or less than 15 feet below ground surface, crack the manhole base to permit drainage; and, dispose of all removed materials in accordance with local regulations.
- c. For manholes greater than 15-feet below ground surface, fill remaining manhole components with CLSM
- d. Backfill the void created for removing the manhole in accordance with Section 3.13.5.

B. Method b (Existing sewer to be abandoned as permitted by the Agency (case-by-case only)):

1. Remove the manhole frame/cover, grade adjustment, and cone to a depth of at least 4-feet below the ground surface;
2. Fill remaining manhole components with CLSM
3. Backfill the void created for removing the manhole in accordance with Section 3.13.5.

C. Method c (Existing main sewer to remain in service):

1. Remove the manhole in accordance with Methods a. or b. above except that the manhole base shall also be removed.
2. Place a new section of sewer pipe matching the existing sewer in material, size, and structural capacity in the location of the removed manhole base and connected to the existing sewer main utilizing natural or synthetic rubber couplings conforming to Agency's AML.

3. Sewer bedding and cover shall be placed and compacted around the new sewer pipe in accordance with Section 3.13.3 and the sewer pipe backfilled in accordance with Sections 3.13.4 and 3.13.5.

D. Method d (Existing main sewer to remain in service, case by case only):

1. The main sewer shall be kept in service per Standard Drawing SD-8.
2. Care shall be taken in affixing the half-pipe section to the existing manhole base to prevent infiltration into the main sewer and to permit unobstructed passage of sewer maintenance equipment.

3.19 TESTING

The new facilities will be accepted by the Agency in a two-step process:

3.19.1 Sanitary System Construction – Initial Acceptance:

Initial Acceptance occurs after the new mainline sanitary sewers, manholes, force mains, pump stations, lateral connections to the property line and other sanitary system appurtenances depicted in the approved Construction Documents are installed and tested, but prior to the introduction of sanitary wastewater flows into the completed facilities.

The sanitary sewer system testing that must be completed prior to Initial Acceptance consists of:

1. sewer low-pressure air testing
2. force main pressure testing, refer to Agency requirements
3. pumping system run testing, refer to Agency requirements
4. manhole visual inspection
5. manhole corrosion protection testing
6. sanitary sewer cleaning
7. PVC sewer deflection testing
8. sanitary sewer televising
9. any re-testing required following correction of the system defects discovered in the initial testing.

The Agency shall establish the particular sequence of testing required for the new facilities. The new facilities must pass all of the above testing prior to the introduction of sanitary wastewater to the completed portions of the system.

3.19.2 Gravity Sewers and Appurtenances – Initial Acceptance:A. Low Pressure Air Testing:

All public interceptor sewers, public collector sewers, private collector sewers and portions of laterals installed by the Contractor as part of the Project shall be low-pressure air-tested for leakage after the initial backfill has been placed. Testing shall conform to ASTM F 1417 and C 828. Tests may be conducted by the Contractor or an independent testing firm. All acceptance tests shall be made only in the presence of the Agency's Representative. Testing shall be as follows:

1. Contractor shall give the Agency a minimum of two work days notice prior to performing any sanitary system air testing.
2. No testing shall be performed until all sewer pipes have a minimum of 3-feet of cover or are encased or otherwise protected per Agency requirements.
3. Documentation of each round of air testing, inspection and defect correction shall be prepared by the Contractor and submitted to the Agency.
4. The Contractor shall seal off the section of pipe to be tested at each manhole connection. Test plugs shall be securely braced within the manholes.
5. Connect the air hose to the inlet cap and portable air control source. The air equipment shall consist of necessary valves and calibrated pressure gages to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section. Calibration shall be per manufacturer's recommendations. Contractor shall submit manufacturer's recommendations and certificate of calibration to Agency for approval.
6. **UNDER NO CIRCUMSTANCES SHOULD WORKERS BE ALLOWED TO BE PRESENT IN THE CONNECTING MANHOLES OR NEAR TO THE SEWERS BEING TESTED WHILE A PRESSURE TEST IS BEING CONDUCTED.**
7. Add air slowly into the test section. After an internal pressure of 4.0 psi is obtained, allow internal air temperature to stabilize.
8. After stabilization period, adjust the internal air pressure to 3.5 psi, disconnect the air supply and begin timing the test.
9. Refer to Table "J" for plastic gravity sewer (ASTM F 1417) and for vitrified clay or other pipe materials (ASTM C 828) to determine the length of time (minutes) the section under test must sustain while not losing in excess of 1 psi as monitored by the test gauge. If the section of line to be tested includes more than one pipe size, calculate the test time for each size and add the test times to arrive at the total test time for the section.

10. Sections so determined to have lost not more than 1 psi during the test period shall have passed the leakage test. Those sections losing in excess of 1 psi during the test period shall have failed the leakage test.
11. Any sections of pipe that fail leak test shall be inspected and, if necessary, replaced and relayed then retested until the joints and pipe hold satisfactorily under the test. Use of internal or external wraps, bands, sealants, caulks or grouts to correct defective joints is strictly prohibited.

B. Manhole Visual Inspection and Corrosion Protection – Holiday Testing:

All public and private manholes will be visually inspected by the Agency. Visible defects shall be corrected, and the manholes re-inspected by the Agency.

Where corrosion protection is required, and after installation, the additional steps shall apply:

1. Manholes shall be visually re-inspected by the Agency. Any defects found in the coatings shall be corrected by the Contractor and the coatings visually re-inspected by the Agency.
2. Following passage of visual inspection, corrosion protection coatings shall be holiday tested by the Contractor in accordance with Section 3.19.3.
3. Any corrosion protection coatings failing testing shall be inspected by the Contractor and all defects causing the failure located and corrected. The coatings shall be re-tested, re-inspected if necessary, and defects corrected until they pass the holiday testing process.
4. Written logs of each round of holiday testing, inspection and defect correction shall be prepared by the Contractor and submitted to the Agency.

C. Sewer Cleaning:

Following passage of low-pressure air testing, manhole visual inspection and manhole corrosion protection testing and sewer trench backfilling, all public interceptor sewers, public collector sewers and private collector sewers shall be thoroughly cleaned.

1. Cleaning shall be performed in the presence of the Agency's Representative, as required by Agency.
2. Contractor shall give the Agency a minimum of two work days notice prior to performing any cleaning operations.
3. Debris shall be removed from the sewer and **NOT** be permitted to pass into existing sewers downstream. See Standard Drawing SD-27 for approved traps.

4. Sewers shall be jet-cleaned prior to deflection testing and televising and must be cleaned again following street paving and/or permanent patch replacement.

D. Deflection Testing:

All public interceptor sewers, public collector sewers and private collector sewers shall be tested for deflection by passing a mandrel through said sewers.

1. Contractor shall give the Agency a minimum of two work days notice prior to performing any deflection testing operations.
2. Contractor shall perform deflection tests in the presence of the Agency's Representative.
3. Deflection testing shall be conducted not less than 30 days after the sewer trench has been backfilled to the desired finish grade including the roadway granular base courses, compacted to the required densities, and all backfill compaction density testing performed and passed, but prior to placement of any hard-surface paving.
4. The deflection test shall consist of:
 - a. Hand-pulling a mandrel which is not smaller in diameter than 95-percent of the required inside diameter of the sewer being tested per ASTM D3034 and ASTM F-679 as applicable. The mandrel shall be pulled through the pipe with a force not greater than the weight of the mandrel.
 - b. The mandrel shall be rigid and shall have an odd number of legs (nine legs minimum).
 - c. The mandrel shall be tested for its dimensional integrity in the presence of the Agency Representative or authorized agent's, at a testing facility satisfactory to and approved by the Agency Representative prior to its testing.
 - d. If the mandrel is unable to pass through the pipe, the portion of the pipe that would not pass the mandrel shall be removed, reinstalled, re-air-tested, re-cleaned and re-mandrel-tested at no cost to the Agency.
 - e. The re-installation and re-testing shall conform to all requirements of these Standards and the approved Construction Documents.
 - f. Any pipe found to have suffered a permanent deflection shall be removed and replaced with new pipe.
 - g. Use of re-rounding machines or other devices that create vibrations or other stresses inside the pipe to return the pipe to its required inside diameter shall not be permitted.

- h. Written logs of each round of mandrel testing, inspection and defect correction shall be prepared by the Contractor and submitted to the Agency.

E. Sewer Televising:

All public interceptor sewers, public collector sewers and sanitary sewers shall be televised.

1. Contractor shall give the Agency a minimum of two work days notice prior to performing any sewer televising operations.
2. Defects identified through televising shall be corrected and the system re-televised. Re-televising shall be from manhole to manhole in the sections of sewer where defects were found and corrected.
3. Contractor shall submit all televising performed in an electronic format conforming to the latest NASSCO PACP/MACP, and LACP standards by a certified operator. All submittals shall be provided in a file format acceptable to the Agency.
4. The televising shall not be performed until after the sewer lines have been completely backfilled including backfill compaction testing performed and passed testing, deflection testing performed, and defects corrected.
5. The Agency requires 2 working days per 1000 feet of sewer televised or minimum of 5 work days, whichever is longer for review.
6. Once televising has been reviewed and accepted, an acceptance of the televising will be issued by the Agency.

3.20 FINAL ACCEPTANCE

Before final acceptance of sanitary sewer systems, the following must be completed to sole satisfaction of the Agency and as a minimum:

1. The Contractor shall notify the Agency at least two work days prior to performing the final inspection as part of the Final Acceptance process.
2. Additional items and/or information regarding the completion of the sanitary sewer system improvements in conformance with the approved Construction Documents may also be requested by the Agency and shall be submitted prior to final acceptance of the improvements.
3. Permanent paving installed and accepted by roadway controlling agencies.
4. Removal of excess paving materials, soils, debris, plywood, and other construction materials from sewers and then hydraulic jet clean sewer lines after paving installation. Removal of spoil materials and cleaning of sewers shall be performed only in the presence of an Agency Representative.

5. For cast-in-place manhole bases, tops of pipes passing through manhole invert cut out, if any. The cutout shall fully expose the interior of the pipe between the manhole walls in accordance with Standard Drawing SD-7.
6. Area cleanup completed.
7. All discrepancies from the approved Construction Documents corrected and accepted by the Agency.
8. The Agency has the right to require additional televising of sewers if defects appear to be present during the visual inspection of the sanitary sewer system. The Contractor shall complete the televising in accordance with Section 3.19.1.e at no cost to the Agency and correct any defects discovered in accordance with the Construction Documents.
9. Provide consolidated electronic file of all final accepted televising performed on the project.
10. All debris removed from the inside of sewers and manholes.
11. All monies owed the Agency paid in full.
12. All manhole collars installed where required.
13. All locking devices installed where required.
14. Verify stamped curbs, location indicators, and clean-outs per Agency's requirements.
15. Removal of any approved trap installed at the most downstream manhole(s) of the developer-installed sanitary sewer main(s) immediately prior to the discharge into the Agency's existing sanitary sewer system.
16. Record drawings submitted per Section 3.10.
17. Appropriate documents indicating transfer of ownership of improvements, including utility services, from contractor/developer to Agency per applicable rules and regulations.

3.21 CERTIFICATE OF OCCUPANCY

The Agency participates in the Certificate of Occupancy System initiated by the Building Department. Requirements established by enacted ordinances, along with other requirements established by the Building Department, must be met before the Building Department will issue a Certificate of Occupancy for a structure. The following Agency requirements must be satisfied in order for the Agency to approve issuance of the Certificate of Occupancy.

The following items are defined by the Agency as major requirements necessary for the Agency to approve issuance of the Certificate of Occupancy (other items may be included on a case-by-case basis):

A. Apply for Service:

1. Submit application for sanitary sewer service.
2. Pay System Development Approval Charge (Connection Fee).

B. Testing and Final Acceptance:

1. All criteria in sections 3.19 and 3.20 have been met.

3.22 BOND RELEASE:

Before Bond Release of sanitary sewer systems, the contractor/developer shall complete all of the criteria as set forth in sections 2.2.3, 3.19 and 3.20. Agency reserves the right to do a bond inspection.

3.23 WARRANTY:

Agency within one (1) year after the date of final acceptance and release of all bonds reserves the right to perform an inspection per section 1.9.

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**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 4

CONTROL OF MATERIALS

TABLE OF CONTENTS
CONTROL OF MATERIALS

SECTION 4

<u>Section</u>	<u>Description</u>	<u>Page No.</u>
4.1	Source of Materials and Quality	4-1
4.2	Approval of New Materials	4-1
4.3	Storage of Materials	4-1
	4.3.1 Testing Re-Certification	4-1
4.4	Handling Materials	4-2
4.5	Unacceptable Materials	4-2
4.6	Odor Control Equipment	4-3
	4.6.1 Odor Control Manhole Inserts	4-3
	4.6.2 Gas Phase and Liquid Phase Odor Control Equipment	4-3
4.7	Cement / Concrete	4-3
	4.7.1 Controlled Low Strength Material (CLSM)	4-3
	4.7.2 Concrete	4-3
4.8	Pipe Locator Ribbon and Marker Balls	4-3
	4.8.1 Locator Ribbon for All Buried Sanitary System Pipes	4-3
	4.8.2 Metallic Locator Ribbon for Force Mains and Reuse Pipes	4-4
4.9	Reinforcing Steel	4-4

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SECTION 4

CONTROL OF MATERIALS

4.1 SOURCE OF MATERIALS AND QUALITY

All construction materials to be used on the work or incorporated into the work, equipment, plant, tools, appliances or methods to be used on the work shall be subject to the inspection and approval or rejection by the Agency Representative.

The materials used on the work shall be new and shall meet all quality requirements as defined by these Standards, all referenced standards, and other locally or nationally recognized standards.

4.2 APPROVED MATERIALS

Refer to governing agency's approved materials list. Contact Agency for approval process for any materials not on the approved materials list.

4.3 STORAGE OF MATERIALS

The Contractor shall provide storage facilities and exercise such measures as shall ensure the preservation of the quality and fitness of all materials and/or equipment to be used in the work.

Stored materials and/or equipment, even though approved before storage, may again be inspected prior to its use in the work.

Stored items shall be located for ease of inspection.

The Agency shall be allowed to inspect all materials during normal business hours upon reasonable notice.

All pipe and fittings shall be stored at the jobsite in a unit package provided by the manufacturer and shall be sheltered from sunlight. Long-term storage with exposure to sunlight shall not be permitted.

All pipe and fittings shall not be stored at the jobsite for more than sixty days prior to incorporation into the work and backfilling.

All pipe and fittings shall be marked with the date of their manufacture. Pipe and fittings having dates of manufacture more than one year old shall not be used.

4.3.1 TESTING RE-CERTIFICATION

If the manufactured date for pipe and/or fittings is greater than six months prior to installation into the Project, samples shall be taken from the oldest pipe and/or fittings and tested by the manufacturer in accordance with the ASTM testing requirements for new pipe to verify that no degradation of the material has occurred, unless otherwise directed by the Agency.

1. At least one test shall be conducted for each 100-feet of pipe and each ten fittings having ages is within 60-days of the oldest pipe and/or fitting.
2. All test samples shall be taken from the oldest 10-percent of the pipe and/or fittings in question.
3. The manufacturer shall provide a certification to the Agency that no detrimental degradation has occurred in the tested materials and that these materials still meet all applicable ASTM standards.
4. If manufacturer testing shows that detrimental deterioration has occurred, all pipe and/or fittings manufactured within 60-days of the tested pipe shall be removed from the Project site.
5. The next oldest pipe and/or fittings shall then be tested by the manufacturer following the same procedures.
6. This testing and material removal process shall continue until the pipe and fittings are found to be free of degradation.

Any pipe or fittings discolored or otherwise damaged by exposure to sunlight shall not be used and shall be removed from the site regardless of the date of manufacture or manufacturer test results.

All pipe shall not be stored close to a source of heat, such as heaters, or engine exhaust.

Gaskets shall be kept free of dirt, foreign matter and exposure to heat, sunlight, ozone, oil and grease.

Other materials used for manufacture of sanitary sewer system components or directly incorporated into the construction shall not exceed the manufacturer's recommendations regarding the maximum safe "shelf life" prior to use of such products. When requested by Agency, the Contractor shall provide certifications from material manufacturers and/or system component fabricators that that the manufacturer's recommended shelf life of incorporated products has not been exceeded.

4.4 HANDLING MATERIALS

All materials and/or equipment shall be handled in such a manner as to preserve their quality and integrity.

Unloading shall be in units using appropriate equipment, such as forklift trucks, cherry pickers or front end loaders with forks. Pipe may also be unloaded by hand. If any units are unloaded using chains or cables, this shall be cause for rejection of pipe.

4.5 UNACCEPTABLE MATERIALS

All materials and/or equipment not conforming to the requirements of the specifications, whether in place or not, may be rejected. Rejected materials and/or equipment shall be

removed from the Project area immediately. Damaged, burnt, permanently deflected or bowed pipe shall be rejected. Any imperfections, including discoloration, warping, ovality, or surface pitting, shall be cause for rejection. No rejected material and/or equipment shall be used.

4.6 ODOR CONTROL EQUIPMENT

4.6.1 Odor Control Manhole Inserts:

See governing agency’s approved materials list for odor control manhole inserts. Odor control inserts shall be adequately sized and installed per manufacturer’s recommendations. Odor control inserts shall be sized to fit in the inner opening of dual manhole covers shown in Standard Drawing SD-2 and SD-3 as applicable.

4.6.2 Gas Phase and Liquid Phase Odor Control Equipment:

Gas phase and liquid phase odor control equipment shall be as specified by the Agency. Engineer shall contact the Agency early in the Project design process for specific Agency requirements. Equipment sizing shall be as recommended by the manufacturer and as approved by the Agency.

4.7 CEMENT / CONCRETE

Cement for CLSM and structural concrete shall be Type V Portland Cement in accordance with ASTM C-150 (latest revision).

4.7.1 Controlled Low Strength Material (CLSM):

CLSM shall be as specified in Section 208.02.07 of the Standard Specifications, mixed with washed mortar sand.

4.7.2 Concrete:

Concrete materials and mixing shall conform to Section 501 of the Standard Specifications. Concrete shall be as follows:

Minimum Compressive 28 Day Strength	4500 psi
Slump (Maximum)	4 inches
Water/Cement Ratio	0.45

No additives shall be permitted unless prior approval of the Agency is obtained. Testing shall be taken at the Agency's request.

4.8 PIPE LOCATOR RIBBON

4.8.1 Locator Ribbon for All Buried Sanitary System Pipes:

Pipe locator ribbon shall be a highly durable plastic material that shall have a minimum 50-year service life in buried applications, regardless of soil or groundwater conditions. Locator ribbon shall be green in color for the raw wastewater lines and purple in color for the effluent reuse lines and shall have the clearly printed legend, "Buried Sewer

Line Below," printed continuously along its length with minimum 1-inch letters. The ribbon shall be not less than 2 inches wide.

4.8.2 Metallic Locator Ribbon for Reuse Pipes:

Locator ribbon for water reuse pipe and other pressurized wastewater transmission pipes shall conform to Section 4.12.1 and additionally shall have an embedded metallic component, such as plastic-coated aluminum, that shall be suitable for transmitting an electric current to aide in locating buried pipes.

4.9 REINFORCING STEEL

Reinforcing steel shall conform to the following reference standards as applicable to the function of the structure:

- ACI 318-05 Building Code Requirements for Structural Concrete
- ACI 350-01 Code Requirements for Environmental Engineering Concrete Structures
- ACI 350.3-01 Seismic Design of Liquid Containing Concrete Structures

**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 5

STANDARD DRAWINGS

**DESIGN AND CONSTRUCTION
STANDARDS**

**STANDARD DRAWINGS
SECTION 5**

TABLE OF CONTENTS

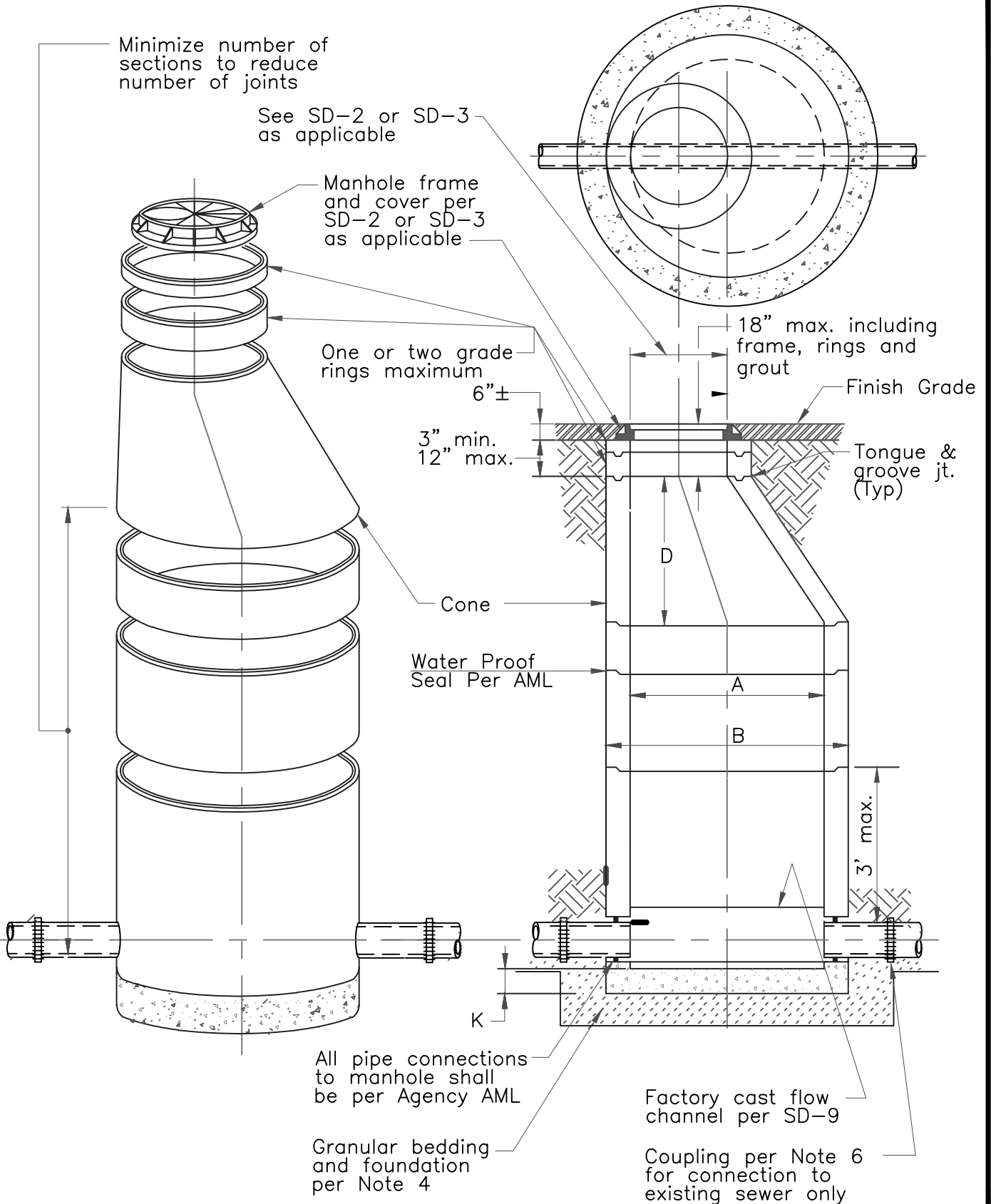
Title	Standard Drawing No.
Standard Pre-Cast Manhole	SD-1
Standard Concentric Dual Manhole Cover and Frame	SD-2
Standard Manhole Cover and Ring	SD-3
Manhole Concrete Collar	SD-4
Grade Ring Sequence	SD-5
Manhole Cover Securing Device	SD-6
Cast-in-Place Manhole Base Installed in Existing Sewer	SD-7
Removal of Existing Manhole	SD-8
Typical Flow Channel Details	SD-9
Force Main Connections to Sewer Manhole	SD-10
Force Main Connections to Public Sewer Manhole.....	SD-11
Special Manholes-Agency Authorization Required	SD-12
Special Shallow Manholes.....	SD-13
Pipe Bedding Methods	SD-14
Pipe Bedding, Haunch Support and Initial Cover	SD-15
Trench Section for Sewer Mains Within Subdivision and Unpaved Areas.....	SD-16
Typical Trench Section for Paved Areas.....	SD-17
Protection of Sanitary Sewer or Lateral Over a Utility	SD-18
Protection of Sanitary Sewer Under a Utility	SD-19
Lateral Connection to Sewer Main 21" Dia and Smaller	SD-20
Lateral Connections to Sewer Mains 21" Dia and Smaller Around Obstructions	SD-21
Lateral Connections to Sewer Mains 24" and Larger	SD-22
Sewer Lateral Marker	SD-23
Lateral Cleanout.....	SD-24
Deep Lateral Connection.....	SD-25
Typical Sewer Easement Requiring Block Walls	SD-26A
Typical Sewer Easement Requiring Block Walls	SD-26B

**DESIGN AND CONSTRUCTION
STANDARDS**

**STANDARD DRAWINGS
SECTION 5**

TABLE OF CONTENTS (Continued)

Title	Standard Drawing No.
Approved Trap for Sewer Line Construction	SD-27
Below Grade Air Relief Valves.....	SD-28
Above Grade Air Relief Valves	SD-29
Rigid Pipe Field Closure	SD-30
Pretreatment Sampling Manhole	SD-31
Typical Siphon Outlet Structure.....	SD-32A
Typical Siphon Inlet Structure.....	SD-32B
Typical Force Main Clean-Out.....	SD-33A
Typical Force Main Clean-Out.....	SD-33B
Bollard Detail (Removable, Locking).....	SD-34



STANDARD PRE-CAST MANHOLE

ISSUED:

NUMBER: SD-1

TABLE OF DIMENSIONS				
Size	A	B	D*	K
48	48	58	36	8
60	60	72	36	8
72	72	86	36	8

Table of Dimensions not applicable to polymer manholes. Polymer manhole thickness per manufacturer's recommendation.

*Varies per manufacturer

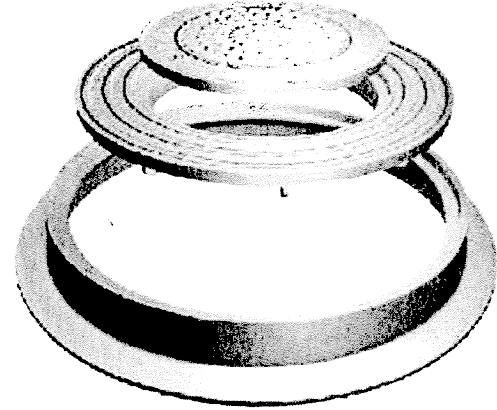
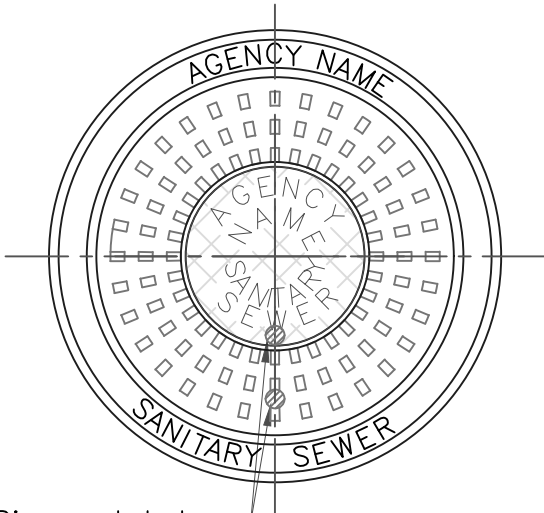
NOTES:

1. Pre-cast concrete manhole sections and adjusting rings shall conform to ASTM C-478 and approved Agency's Material List (AML).
2. Provide interior corrosion protection meeting Agency requirements and Section 2.3.19.H.
3. In high groundwater areas and where directed by the Agency, seal exterior of pre-cast manhole sections with bitumastic or equal waterproofing coating and provide double seals per AML between all pre-cast sections, including adjusting rings.
4. Where the trench bottom is undisturbed soil, 4-inches of granular bedding material meeting Agency requirements shall be placed under the pre-cast manhole base. Where the trench bottom has been disturbed and in fill areas, 12-inches of granular bedding meeting Agency requirements shall be placed under the pre-cast manhole base. Provide additional suitable foundation per Section 3.13 and as required by the Agency in areas of unstable trench bottom, wet conditions, over-excavation, rocky trench bottom and elsewhere as directed by the Agency.
5. Pre-cast manhole bases shall be used for construction of new sewer systems, whether publicly or privately owned. Pre-cast manhole bases or cast-in-place manhole bases per SD-7 may be used at the contractor's option for new manholes being installed along existing sanitary sewers.
6. Flexible rubber couplings per AML shall be provided for connections to existing sewers where new manholes are installed.
7. All manhole bases shall be 8" thick, minimum.

STANDARD PRECAST MANHOLE

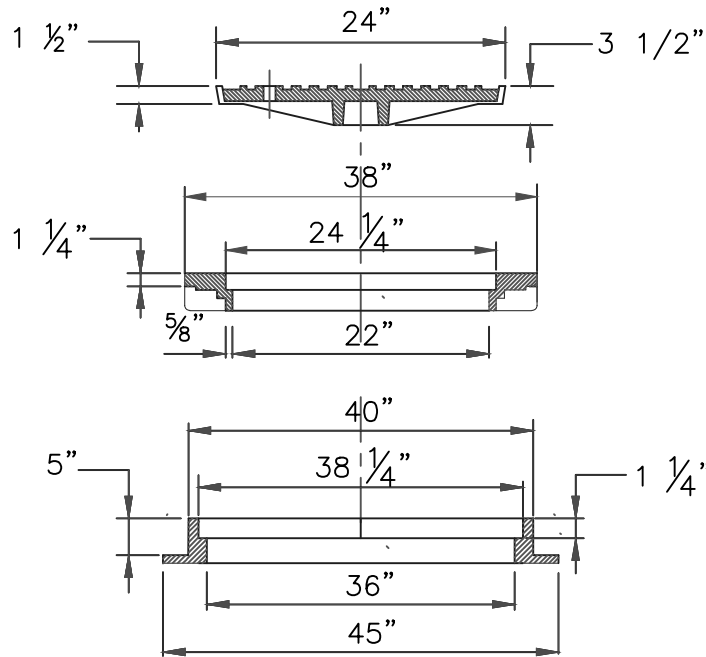
ISSUED:

NUMBER: SD-1 CONT.



1" Dia. vent hole

COVER



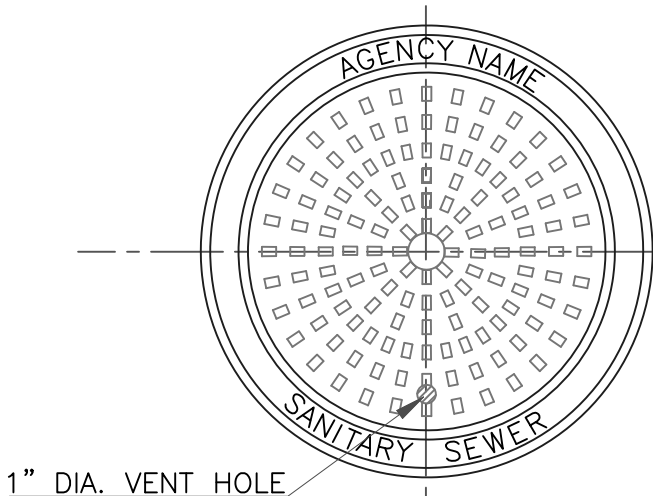
NOTES:

1. Contact Agency for approved frame/cover manufacturers and casting numbers.
2. Cast iron shall meet ASTM A-48 and have minimum tensile strength of 35000 lbs/sq. inch.
3. Mating surfaces of frame and cover shall be machined to fit without rocking with covers in any position within frame or outer cover.
4. Weight of frame and cover 800 lbs. minimum.
5. Name of Agency if public. Both inner and outer cover shall have Agency name.
6. Private manholes shall be marked "PRIVATE" where "Agency Name" is shown above.
7. Outer 36-inch and inner 24-inch cover shall be bolted where required by Agency.

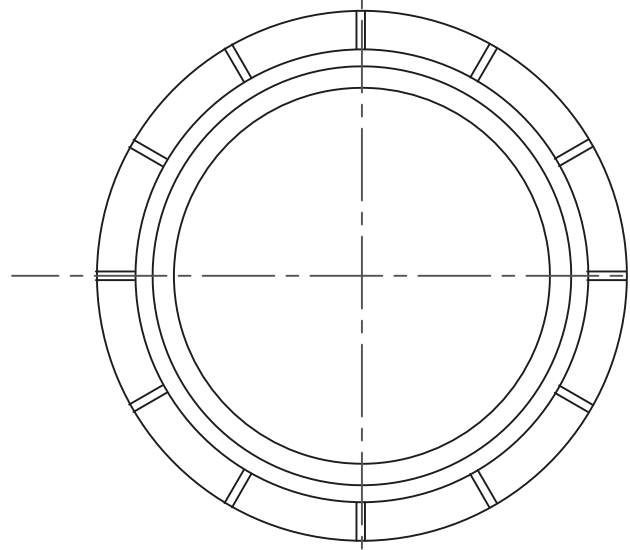
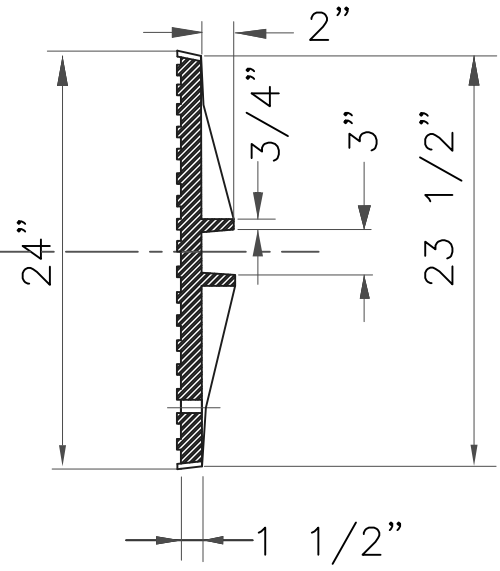
**STANDARD CONCENTRIC DUAL MANHOLE
COVER AND FRAME**

ISSUED:

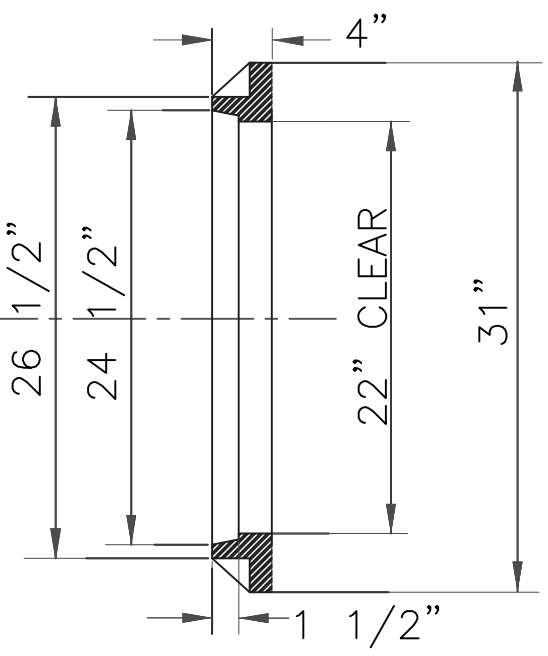
NUMBER: SD-2



COVER



RING



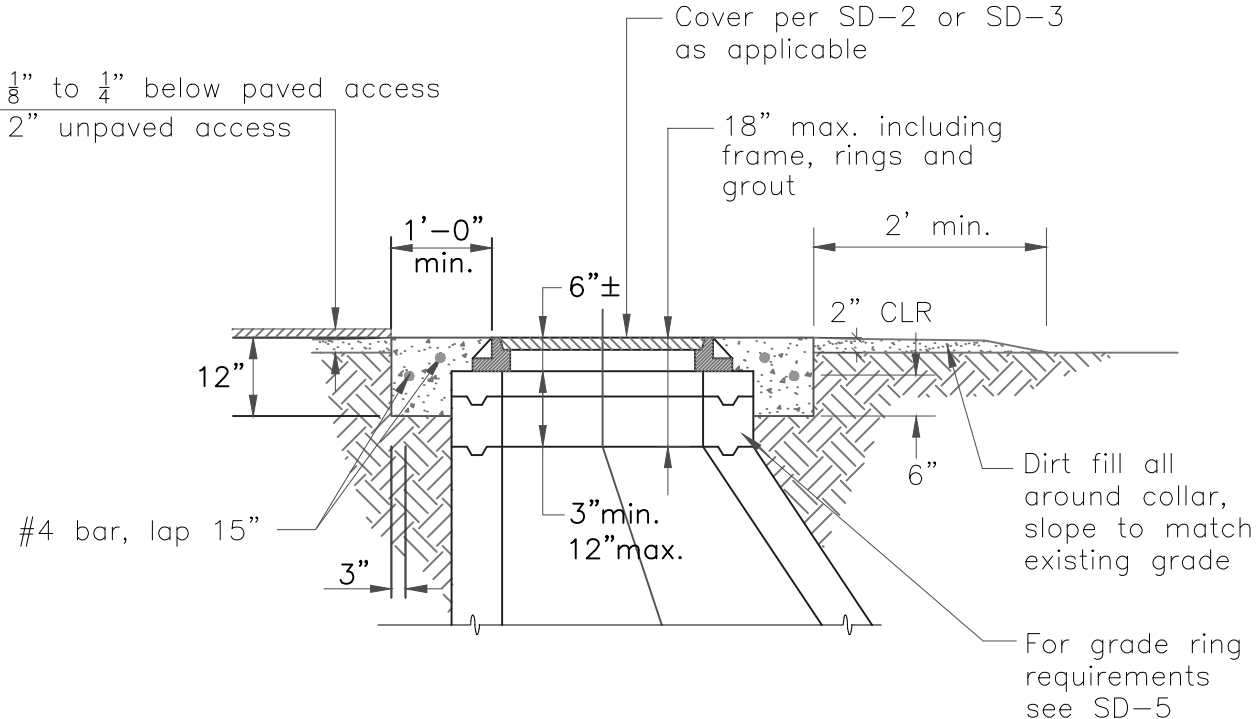
NOTES:

1. Ring and cover per AML.
2. Cast iron shall have minimum tensile strength of 30,000 or 35,000 lbs/sq. inch.
3. Frame and cover machined to fit.
4. Weight of frame and cover 300 lbs. minimum.
5. Name of Agency if public.
6. Private manholes shall be marked "PRIVATE".

STANDARD MANHOLE COVER AND RING

ISSUED:

NUMBER: SD-3



MANHOLE CONCRETE COLLAR

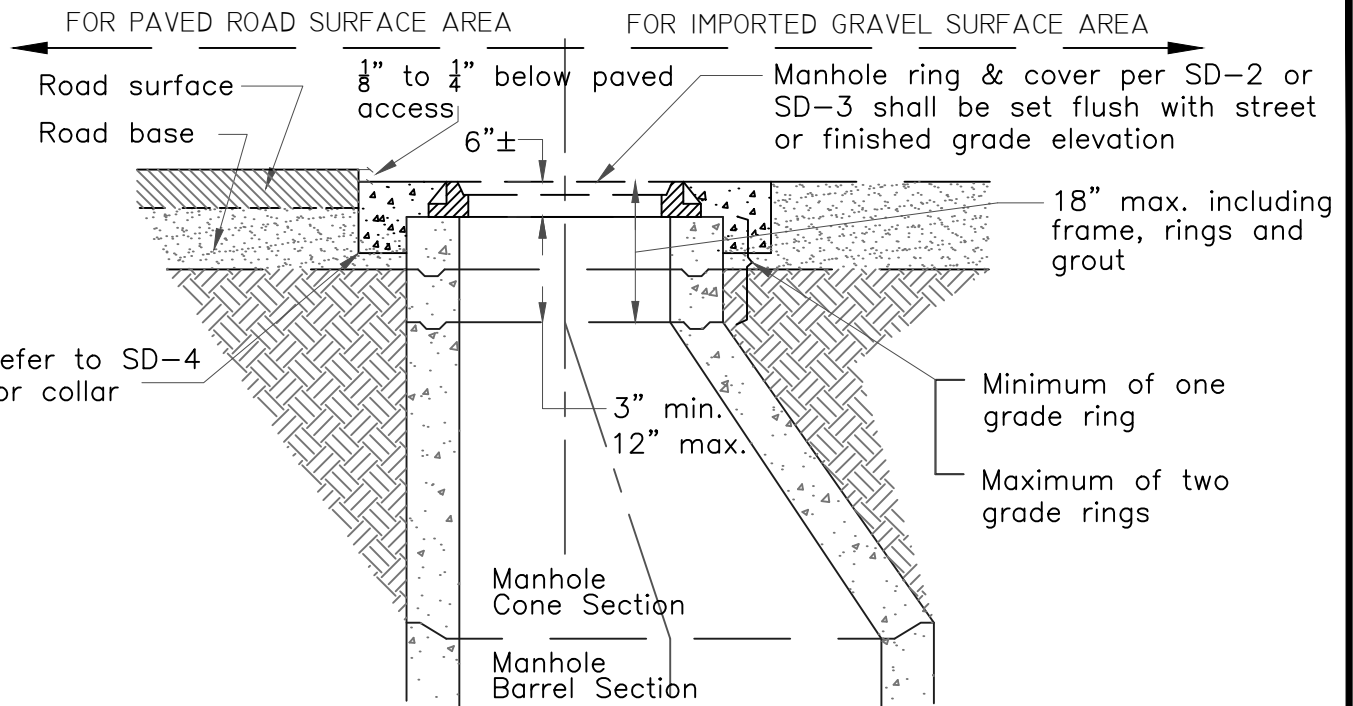
NOTES:

1. Concrete shall be type V 4500 psi per Section 4.7.
2. Collars for paved and landscaped areas shall be circular. Collars for unimproved areas may be circular or square.

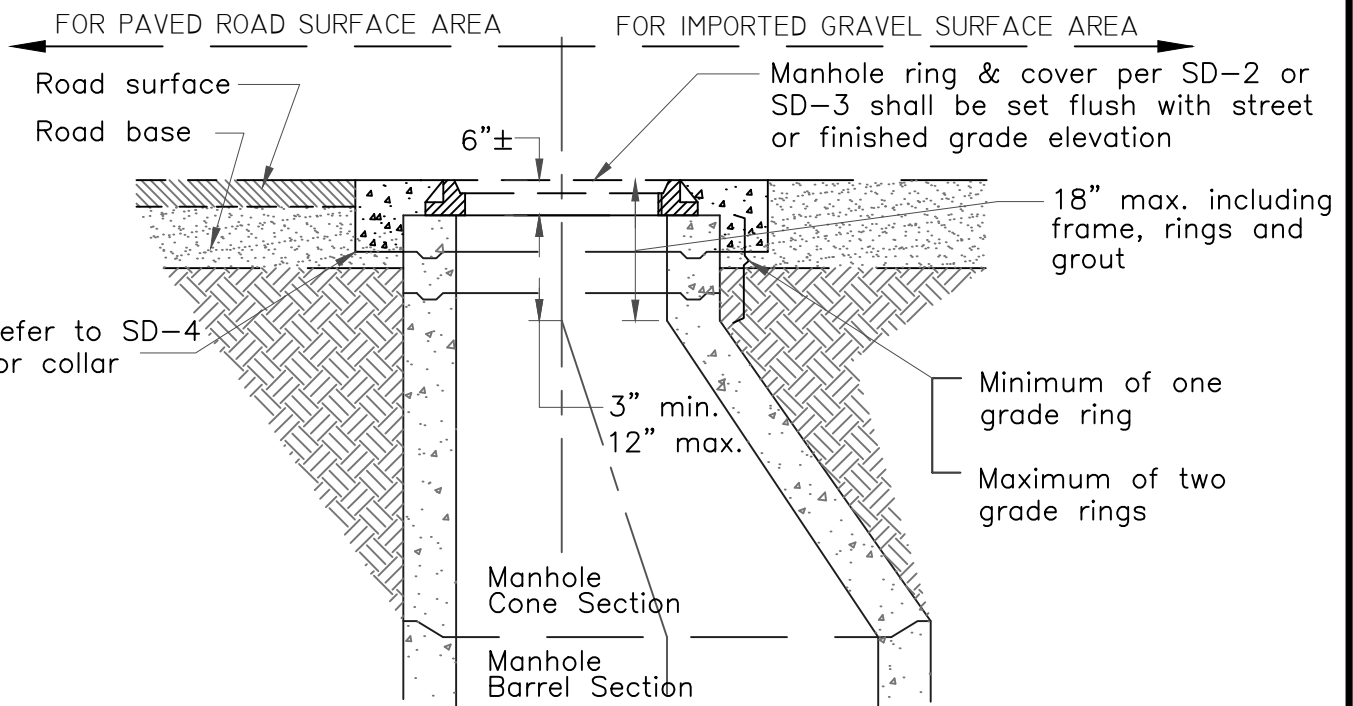
MANHOLE CONCRETE COLLAR

ISSUED:

NUMBER: **SD-4**



ADJUSTMENT REQUIREMENTS FOR CONVENTIONAL MH CONES



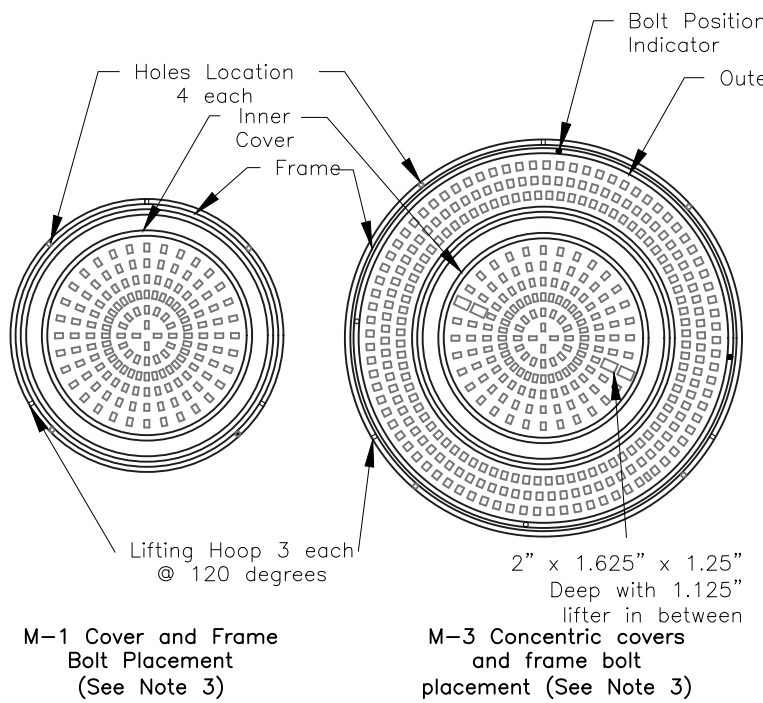
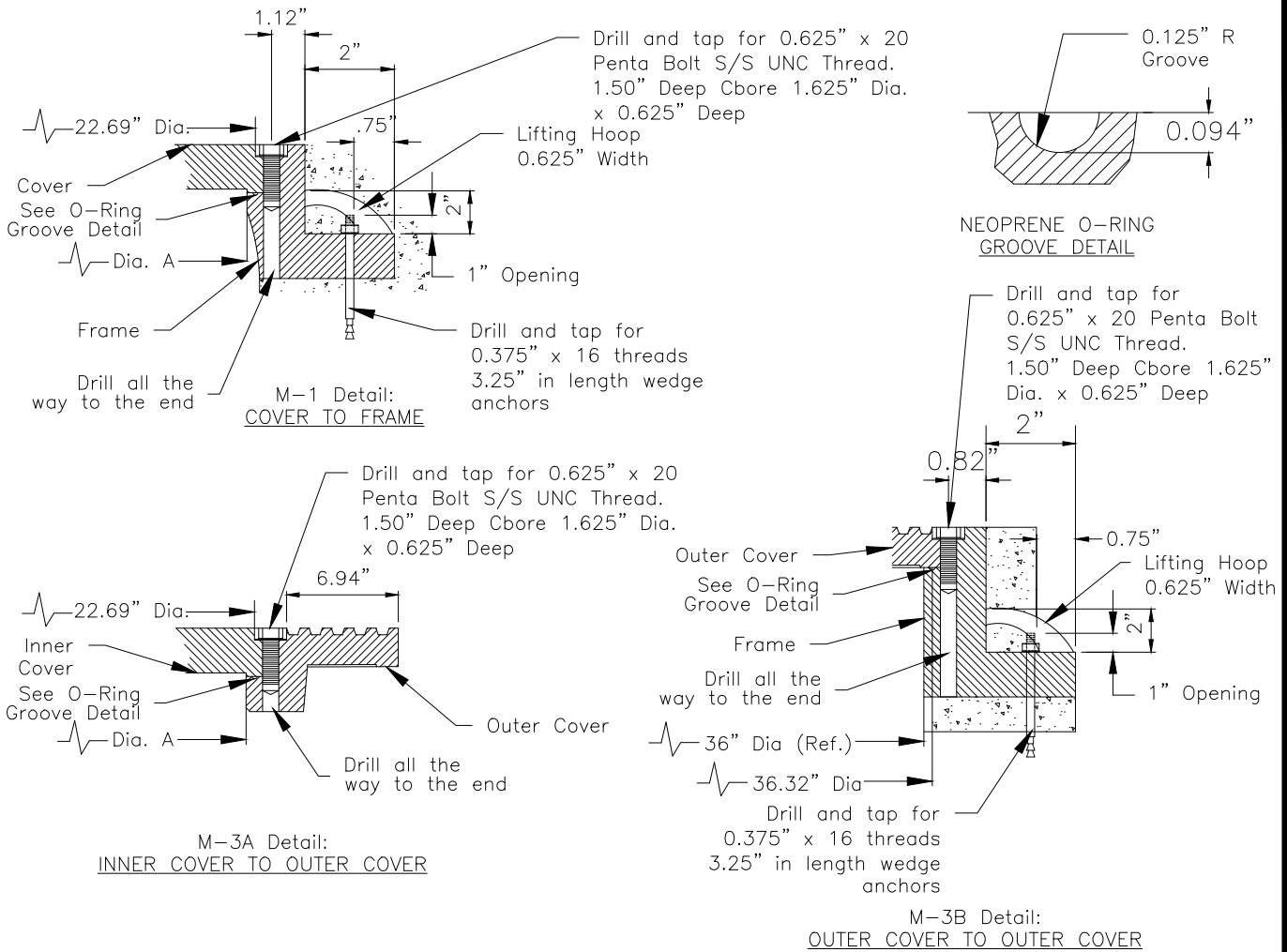
NOTES ADJUSTMENT REQUIREMENTS FOR EXTENDED MH CONES

1. Manhole frame and grade rings shall be installed fully concentric with top opening of manhole cone.
2. Final grade adjustment shall be 3" min. to 12" max including grade rings and grout.
3. Grade rings shall be reinforced concrete 2" min. thickness to 11" max. thickness or per Agency AML.
4. Grout for setting grade rings and MH frame shall be per Agency AML and shall be placed across the full width of grade ring and frame, and shall be 1/2" min. to 1" max. in thickness or approved water proof sealant.

GRADE RING SEQUENCE

ISSUED:

NUMBER: SD-5



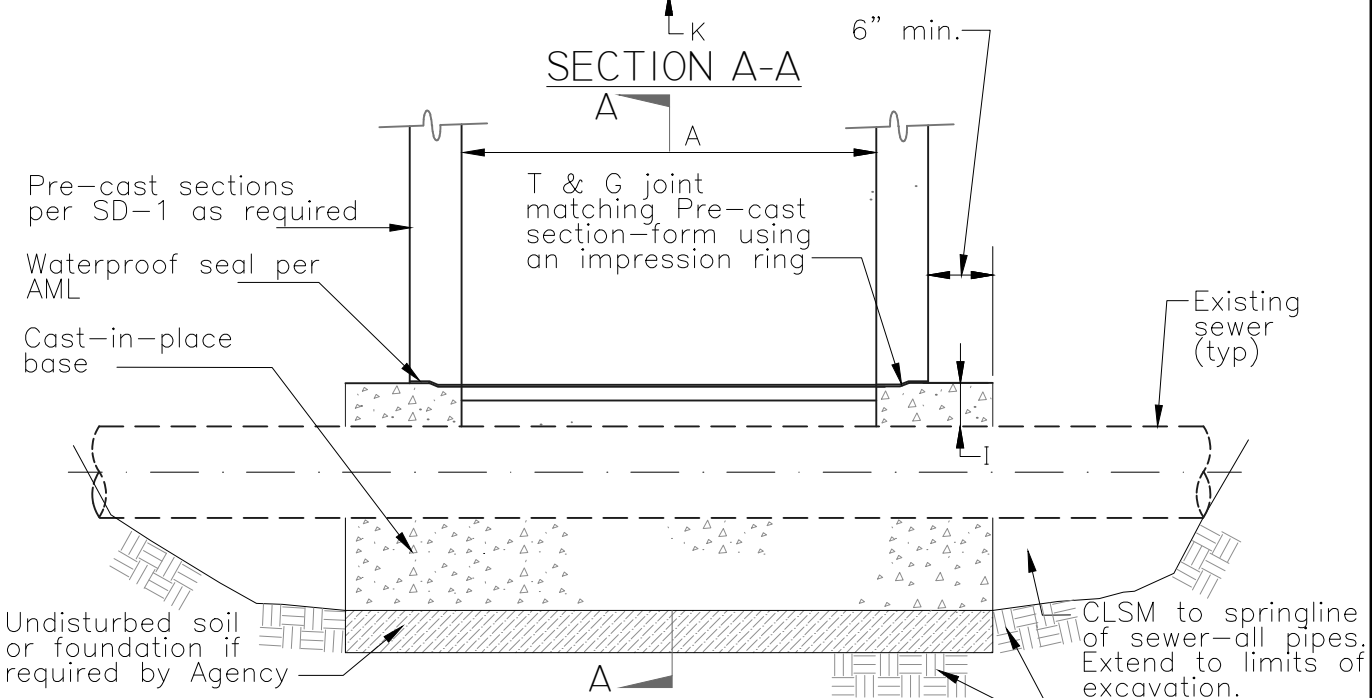
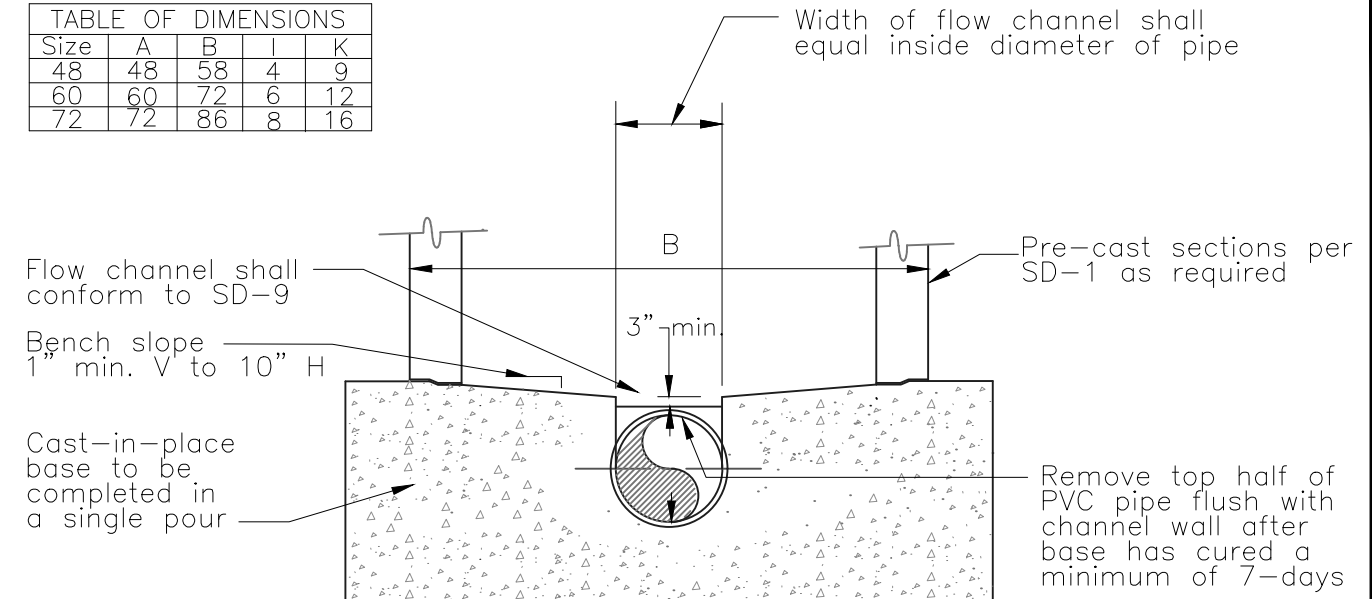
- NOTES:**
- 0.625" x 20 Penta Bolt S/S UNC thread. 316 Stainless Steel socketed head cap screw and 1.50" O.D. x 0.687" I.D. x 0.078 thick 316 Stainless Steel washer.
 - 0.25" Neoprene O-Ring gasket shall be glued into machined groove. Glue shall meet the requirements of MIL-M-81288 (AMEND. 1)
 - BOLTDOWN PATTERNS:**
 - M-1 Detail (24" Cover & Frame): install two (2) bolts at 180 Degrees.
 - M-3A Detail (Concentric Covers): Between Inner and Outer Covers install two (2) bolts at 180 Degrees.
 - M-3B Detail (Outer Cover & Frame): Between Outer cover & Frame install four (4) bolts at 90 Degrees.
 - For M-1 and M-3 Outer Cover frame drill 4 holes for 0.375" x 16 Stainless Steel wedge anchors 3.75" in length at 90 Degrees.

MANHOLE COVER-SECURING DEVICE

ISSUED:

NUMBER: SD-6

TABLE OF DIMENSIONS				
Size	A	B	I	K
48	48	58	4	9
60	60	72	6	12
72	72	86	8	16



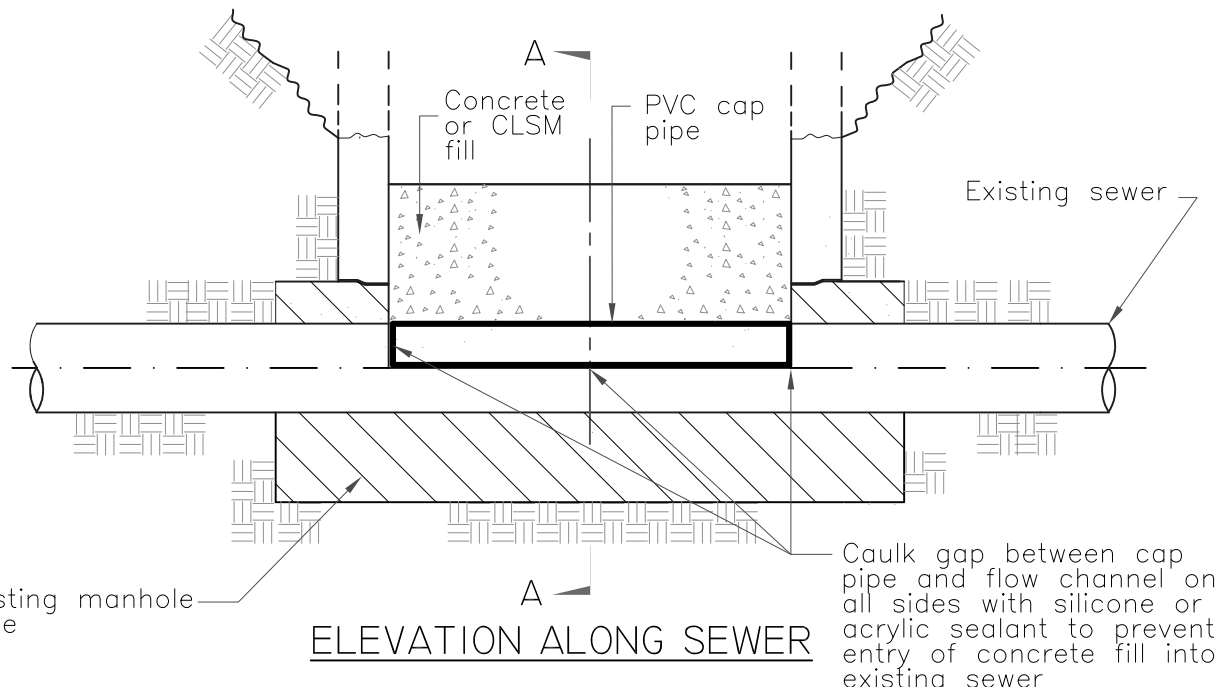
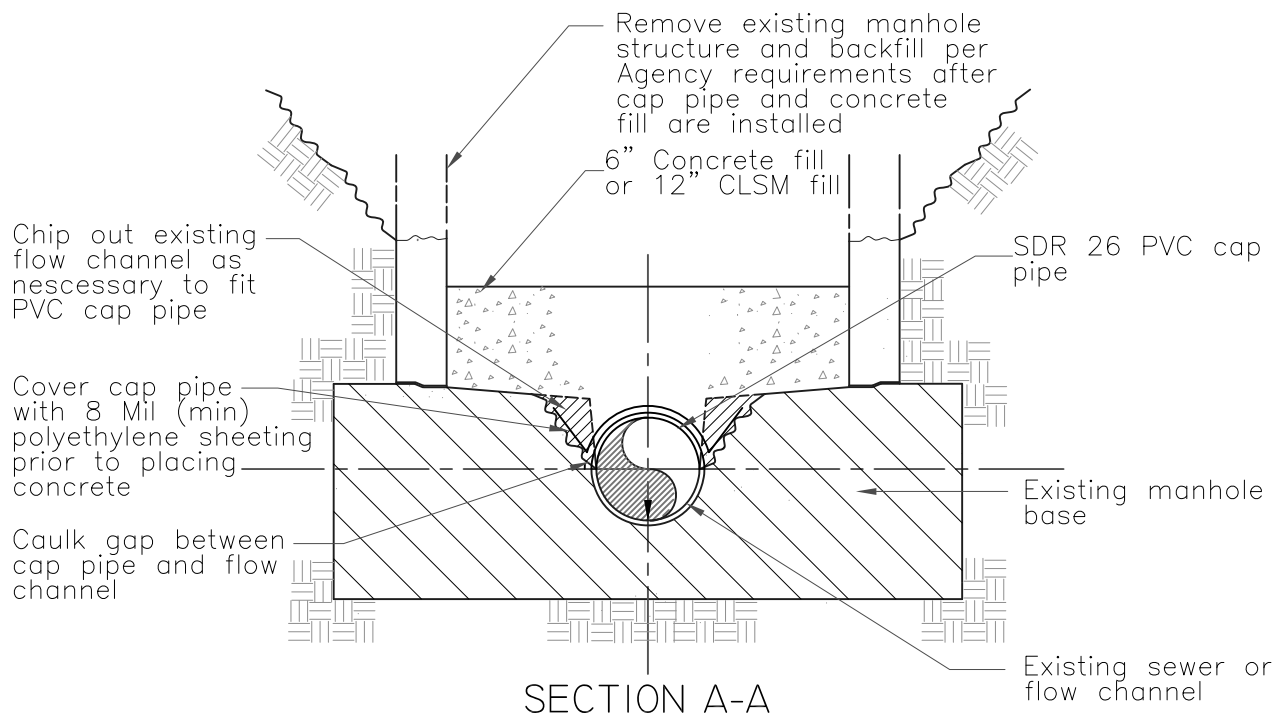
NOTES:

1. Along new or existing sewers, cast-in-place manhole base may be used in lieu of pre-cast base for new manholes.
2. A cast-in-place base may be used in lieu of a pre-cast base for new sewers only when the new manhole is a "through" manhole.
3. Concrete shall conform to Section 4.7.
4. Base may be round or square.
5. Provide suitable foundation per Section 3.13 and as required by the Agency in areas of unstable trench bottom, wet conditions, over-excavation, rocky trench bottom, and elsewhere as directed by the Agency.
6. If existing sewer pipe is damaged or if a pipe joint falls within the manhole base pour, the existing sewer pipe shall be replaced with PVC per Agency AML. The replacement PVC pipe shall be reconnected to the existing sewer using flexible couplings per Agency AML.
7. Provide corrosion protection per Section 3.16.8.

CAST-IN-PLACE MANHOLE BASE INSTALLED IN EXISTING SEWER

ISSUED:

NUMBER: SD-7



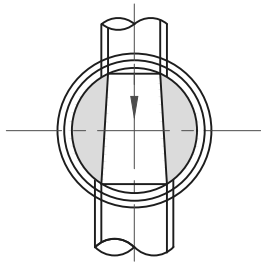
NOTES:

1. To be used as directed by the Agency where an existing manhole is to be abandoned but the existing sewer is to remain in service.
2. Concrete fill material shall be 4-inch slump and otherwise conform to Section 4.7.
3. Agency representative shall inspect cap pipe installation before concrete fill is placed.
4. Televis existing sewer after cap and fill are placed but before manhole is backfilled.
5. The fitted cap pipe shall match the full diameter of the existing sewer.
6. Provide corrosion protection per Section 3.16.8.b.

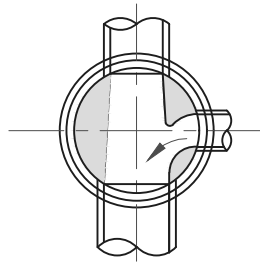
REMOVAL OF EXISTING MANHOLE

ISSUED:

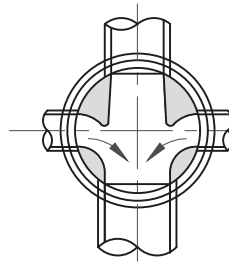
NUMBER: SD-8



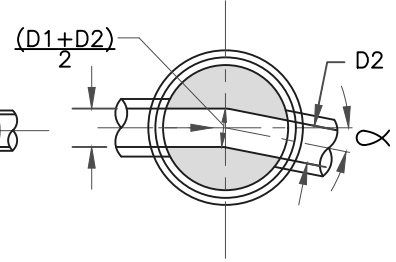
THROUGH PIPE



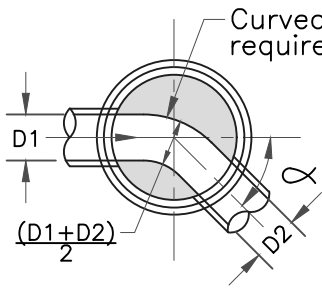
THROUGH PIPE
ONE LATERAL



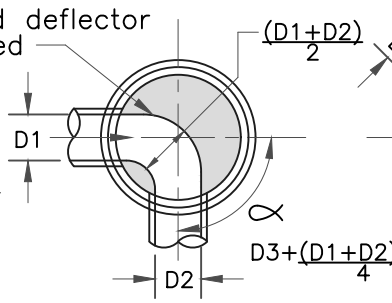
THROUGH PIPE
TWO LATERAL



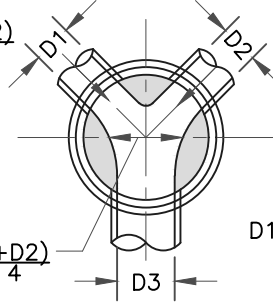
SLIGHT ANGLE
 $0^\circ \leq \alpha < 15^\circ$



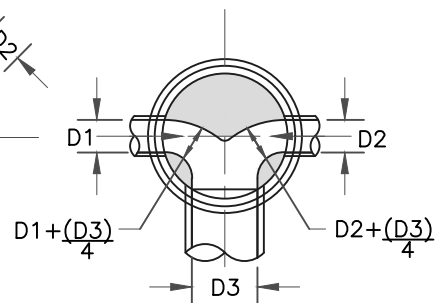
INTERMEDIATE ANGLE
 $15^\circ \leq \alpha < 45^\circ$



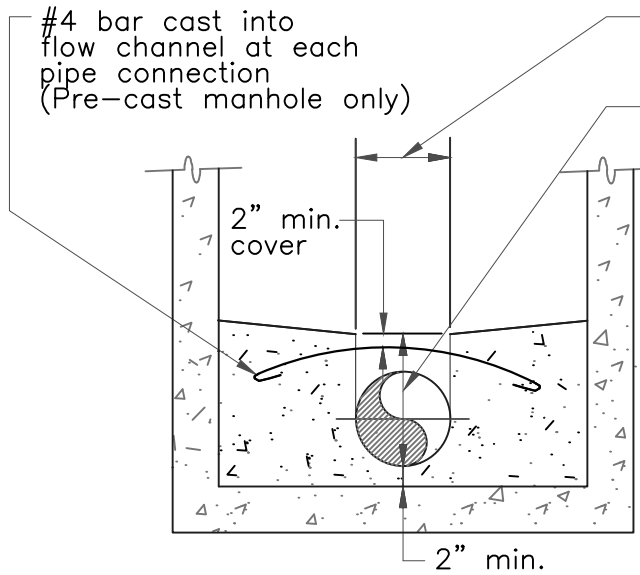
SHARP ANGLE
 $45^\circ \leq \alpha \leq 90^\circ$



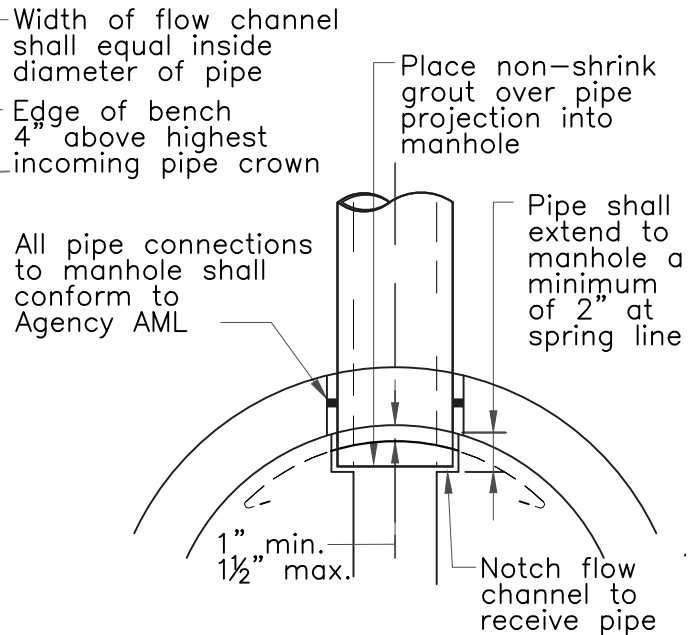
ANGLED LATERALS



OPPOSED LATERALS



TYPICAL FLOW CHANNEL
CROSS SECTION



PLAN OF PIPE CONNECTION
FOR PRE-CAST MANHOLE

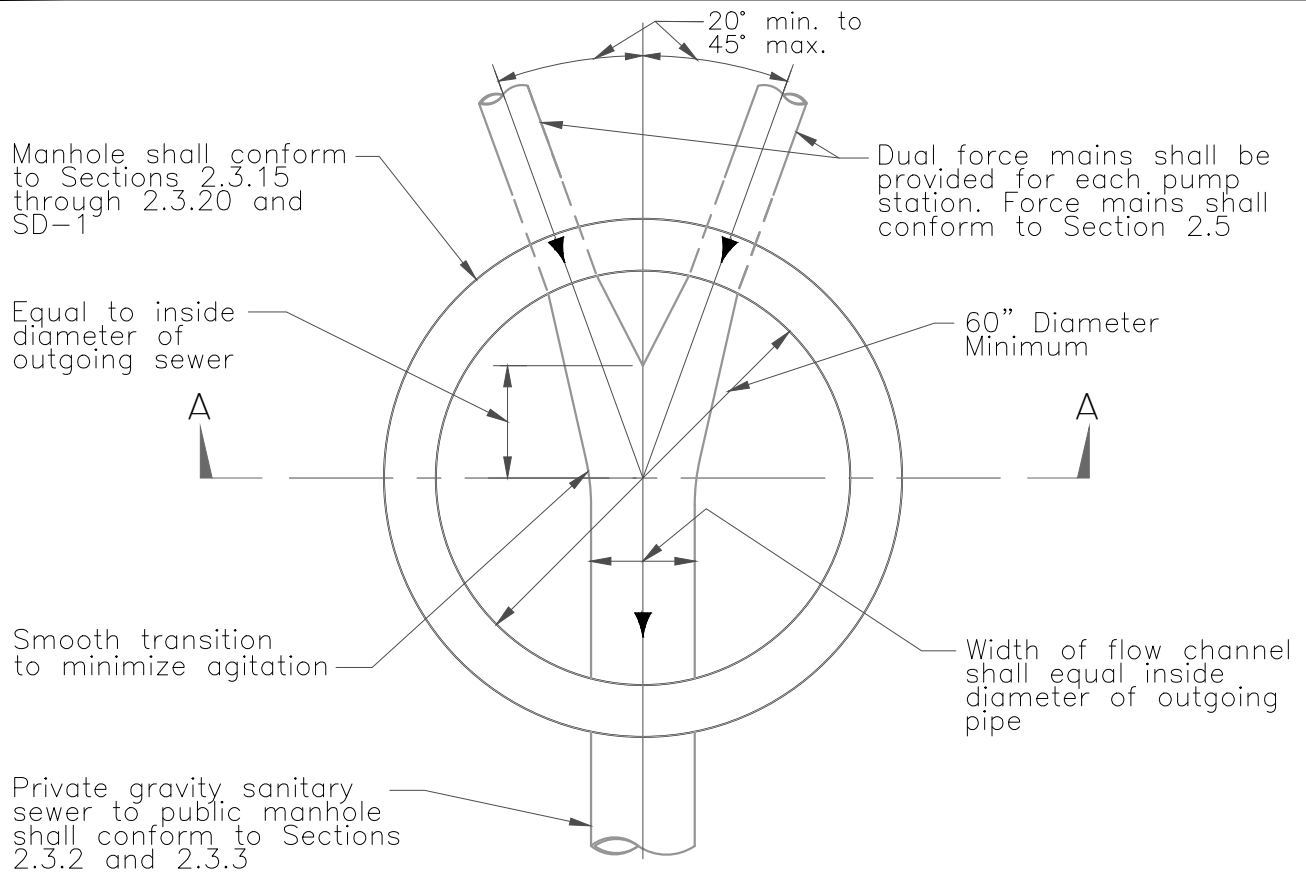
NOTES:

1. Flow channels in pre-cast manholes shall be cast in the factory.
2. Flow channels in cast-in-place manhole bases shall be formed to same contours as pre-cast manhole flow channels.
3. Provide manhole corrosion protection as required by Agency.

TYPICAL FLOW CHANNEL DETAILS

ISSUED:

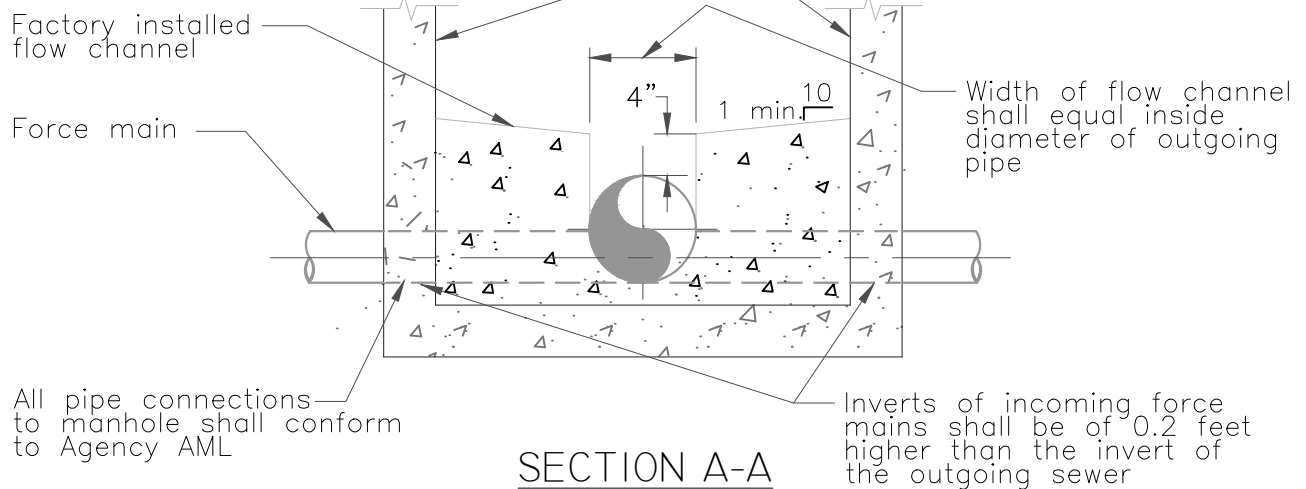
NUMBER: SD-9



PLAN

NOTE:

Manholes shall have corrosion protection as required by Agency



SECTION A-A

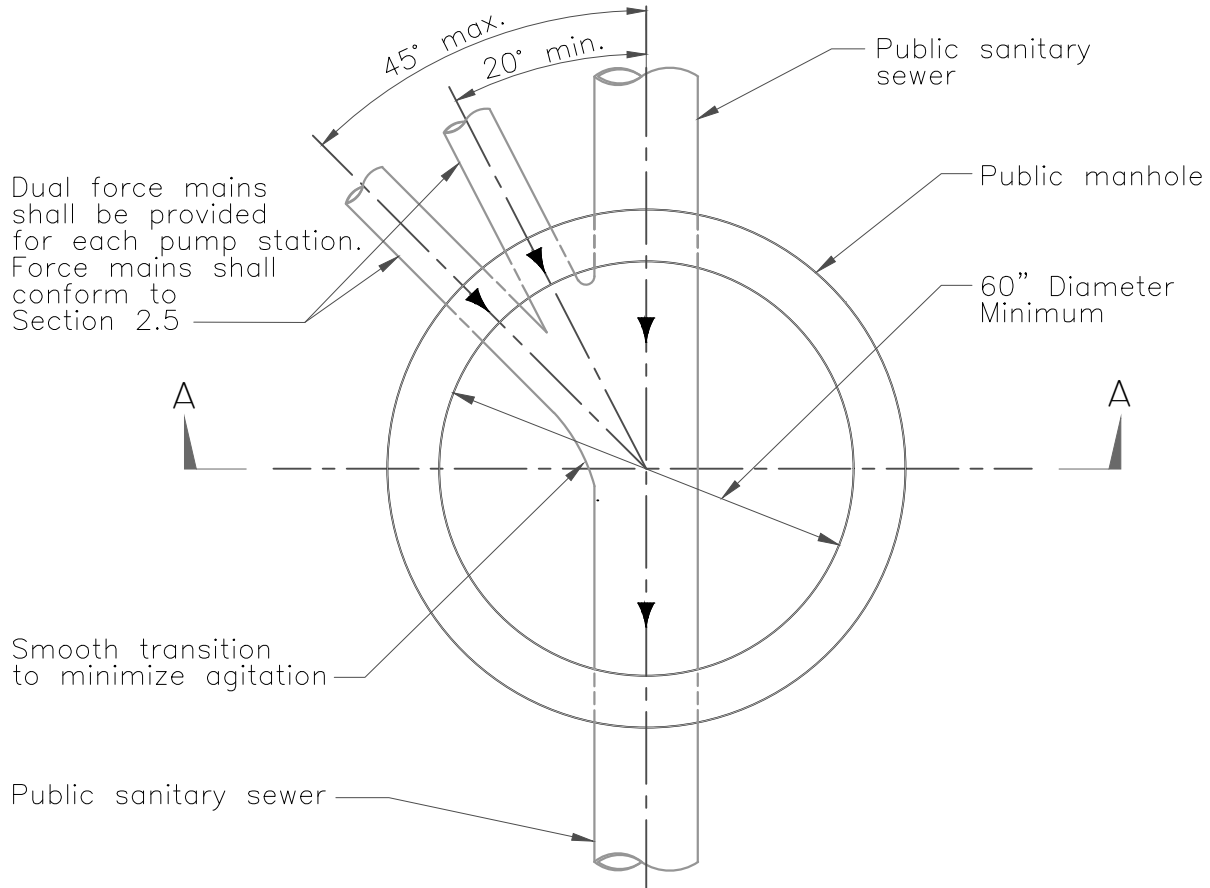
NOTE:

1. Private force mains shall discharge into a private manhole and then flow by gravity through a private sewer that discharges into a public manhole on the public sanitary sewer main.

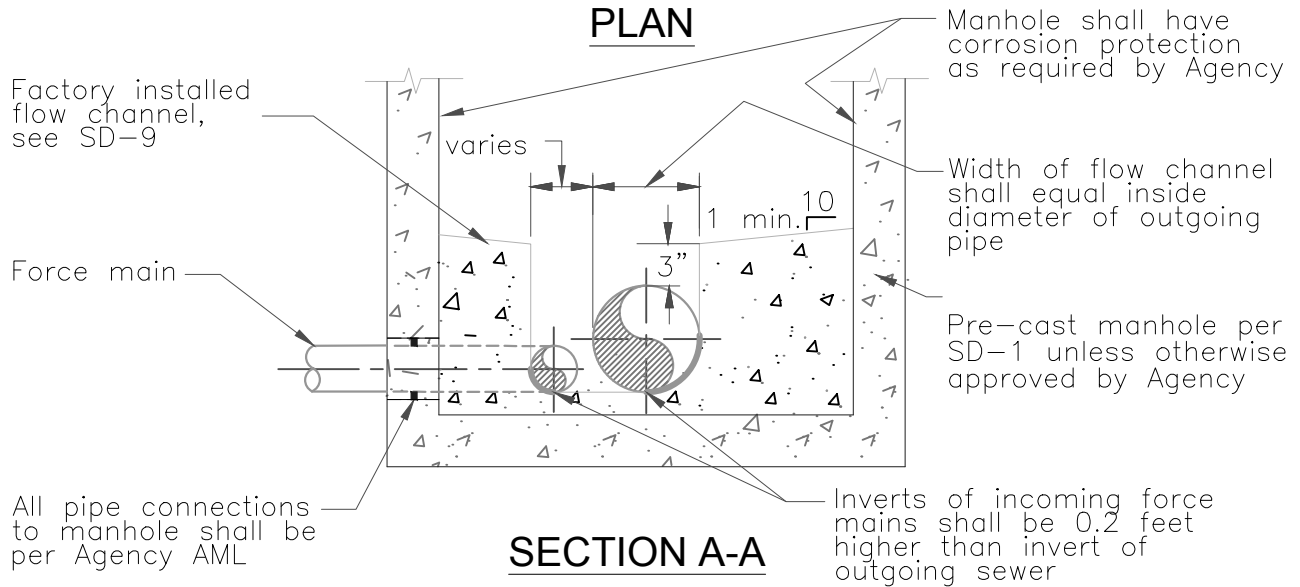
FORCE MAIN CONNECTIONS TO SEWER MANHOLE

ISSUED:

NUMBER: SD-10



PLAN



SECTION A-A

NOTES:

1. Force mains to Public sewer may be used only if authorized by Agency.
2. New manhole required.
3. Cast-in-place base may be used only if authorized by Agency.

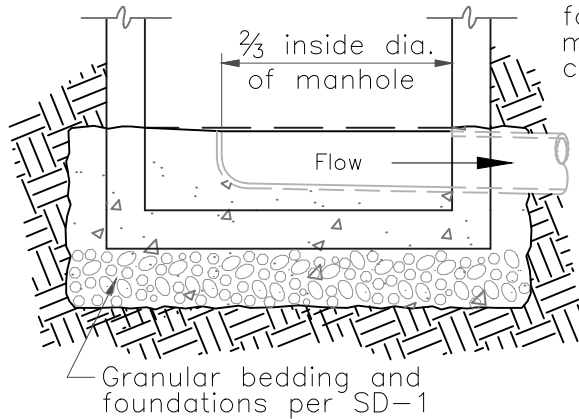
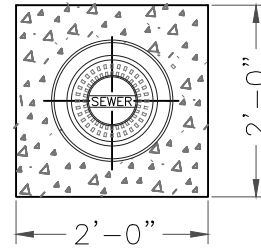
FORCE MAIN CONNECTIONS TO PUBLIC SEWER MANHOLE

ISSUED:

NUMBER: SD-11

NOTES:

1. Manhole shall conform to SD-1.
2. Flow channel shall conform to SD-9.
3. Special manholes upon Agency approval.
4. Wye, piping and elbows shall be one size larger than the incoming sewer line. Material shall be SDR 26 PVC.
5. High drop and low drop connections may be used only where no other lateral connection alternative including parallel sewer per SD-22 is possible.
6. Manholes receiving high drop and low drop, connections shall have corrosion protection as required by Agency.
7. All pipe connections to manhole shall conform to Section 3 & Standard Drawings.

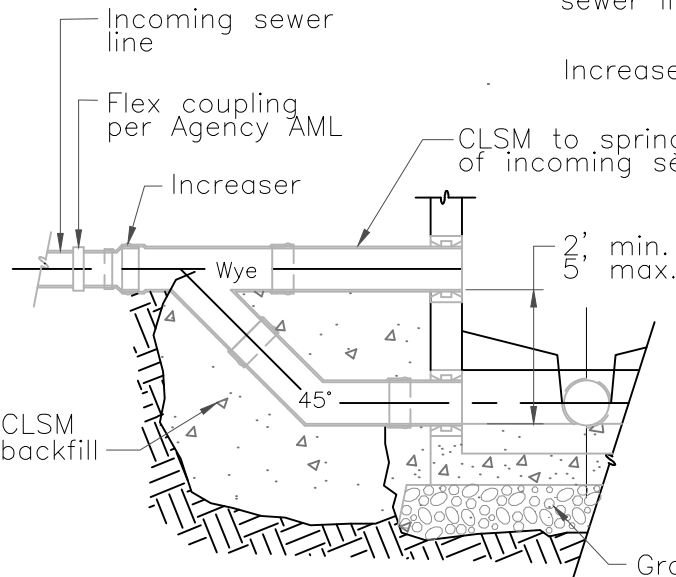
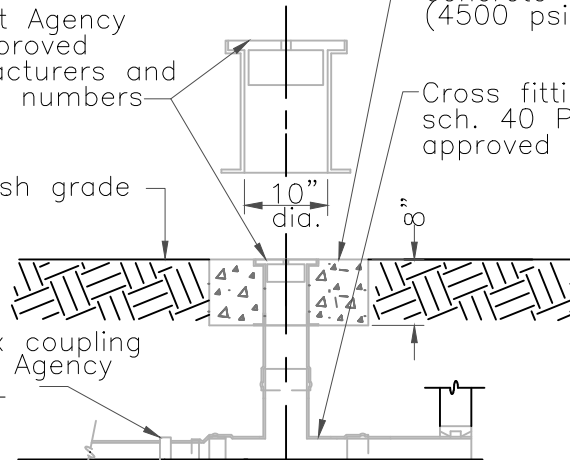


TERMINAL MANHOLE

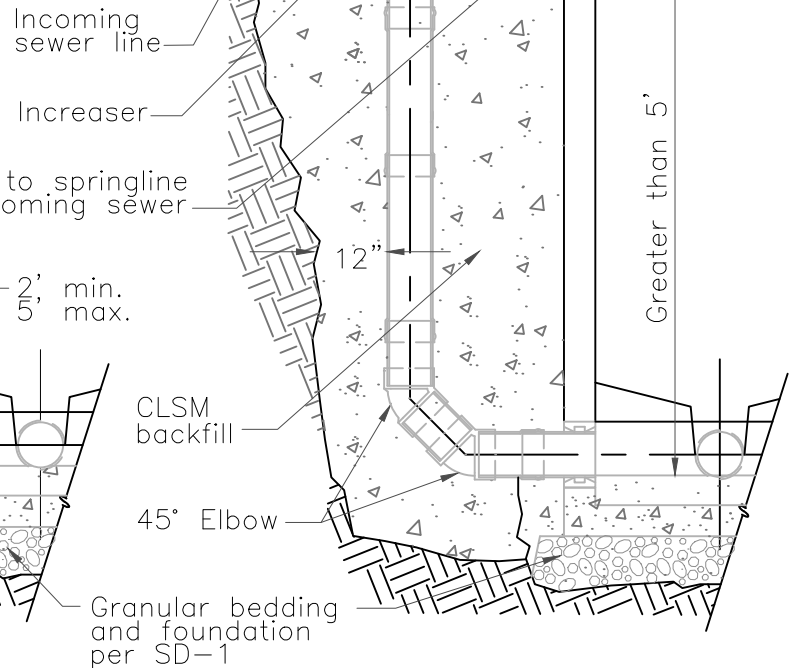
Contact Agency for approved manufacturers and casting numbers

Finish grade
Flex coupling per Agency AML

2'x2'x8" concrete pad (4500 psi)
Cross fitting sch. 40 PVC or approved equal



LOW DROP MANHOLE

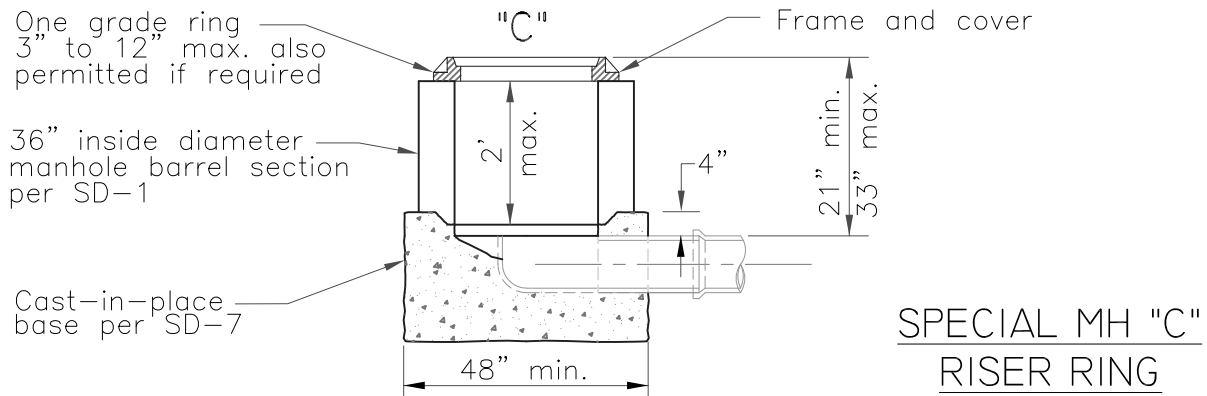
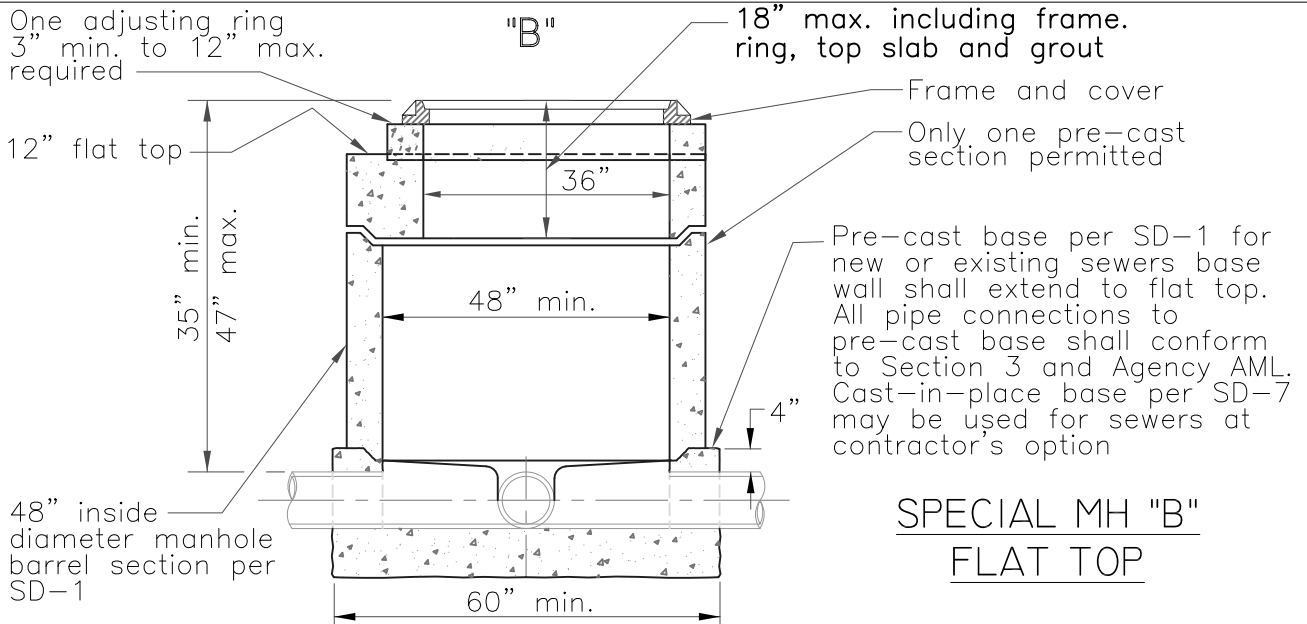
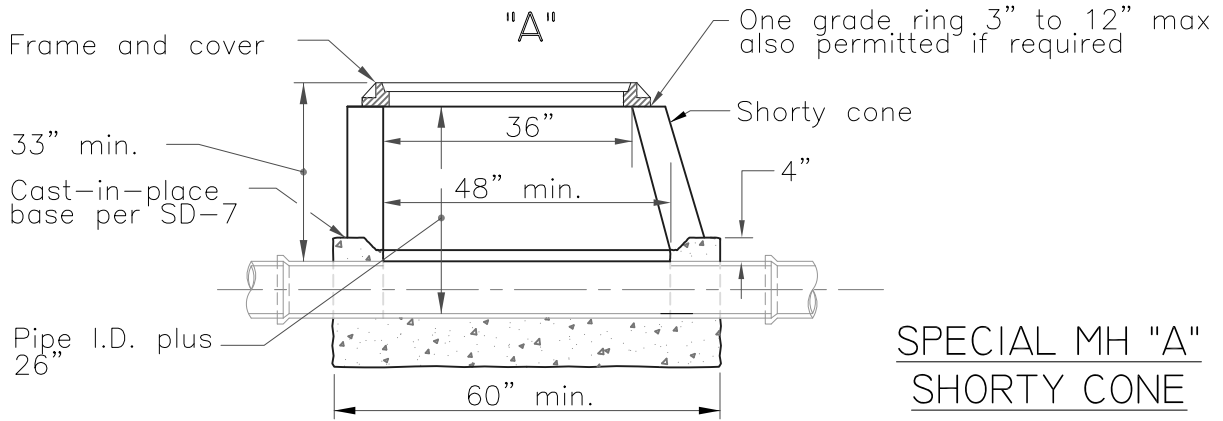


HIGH DROP MANHOLE

SPECIAL MANHOLES-AGENCY AUTHORIZATION REQUIRED

ISSUED:

NUMBER: SD-12



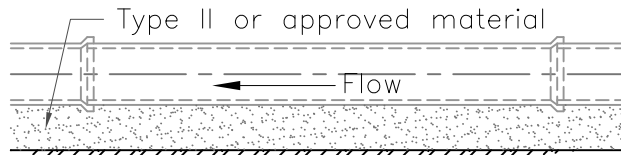
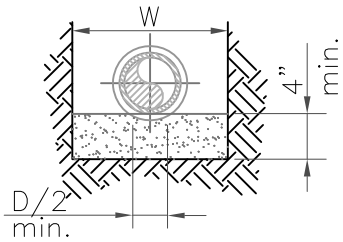
NOTES:

1. **Special shallow manholes may be used upon Agency approval only.**
2. Concrete collar required around manhole frame per SD-4.
3. Manhole frame and cover per SD-2 or SD-3 as applicable.
4. Flow channel per SD-9.
5. For shallow manholes sewer pipe having less than 5-feet of cover shall be C-900 PVC or DIP as required by Agency per 2.3.7. The C-900 or DIP pipe shall extend to the next manholes upstream and downstream.
6. Granular bedding and foundation under special shallow manholes shall conform to SD-1 and/or SD-7 for manhole bases.

SPECIAL SHALLOW MANHOLES

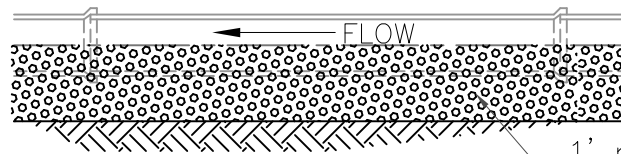
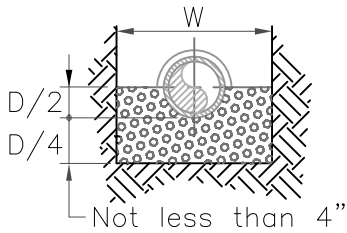
ISSUED:

NUMBER: **SD-13**



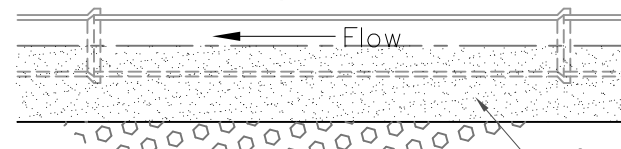
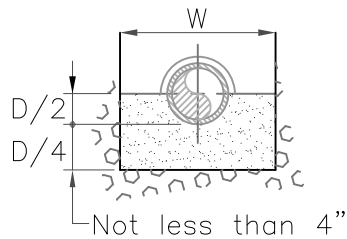
NORMAL BEDDING
(Unyielding material)

Outside diameter of the pipe barrel firmly bedded in a hand-shaped unyielding material



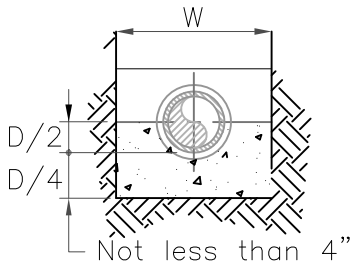
GRANULAR MATERIAL BEDDING
(Yielding material)

1' minus crushed rock or type II per table H

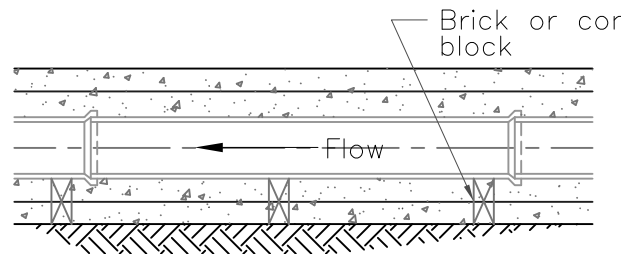
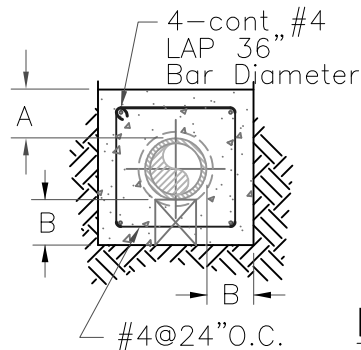


ROCK OR CALICHE-BEDDING
90% compaction

Granular material



CONCRETE BEDDING



REINFORCED CONCRETE ENCASEMENT

Size	B	A
6"	6"	6"
8"	6"	6"
10"	6"	6"
12"	6"	6"
15"	6"	6"
18"	6"	6"
21"	6"	6"
24"	6"	6"
27"	7"	6"
30"	8"	6"
33"	8"	6"
36"	9"	6"
39"	9"	6"
42"	10"	6"

D - Outside diameter of pipe

W - The width of the trench at the top of the flexible pipe shall be the diameter of the pipe plus 16" minimum. In any case, the width shall be sufficient for work in connection with laying, jointing, inspection, placing the bedding and to provide for the safety of workers and shall meet OSHA requirements.

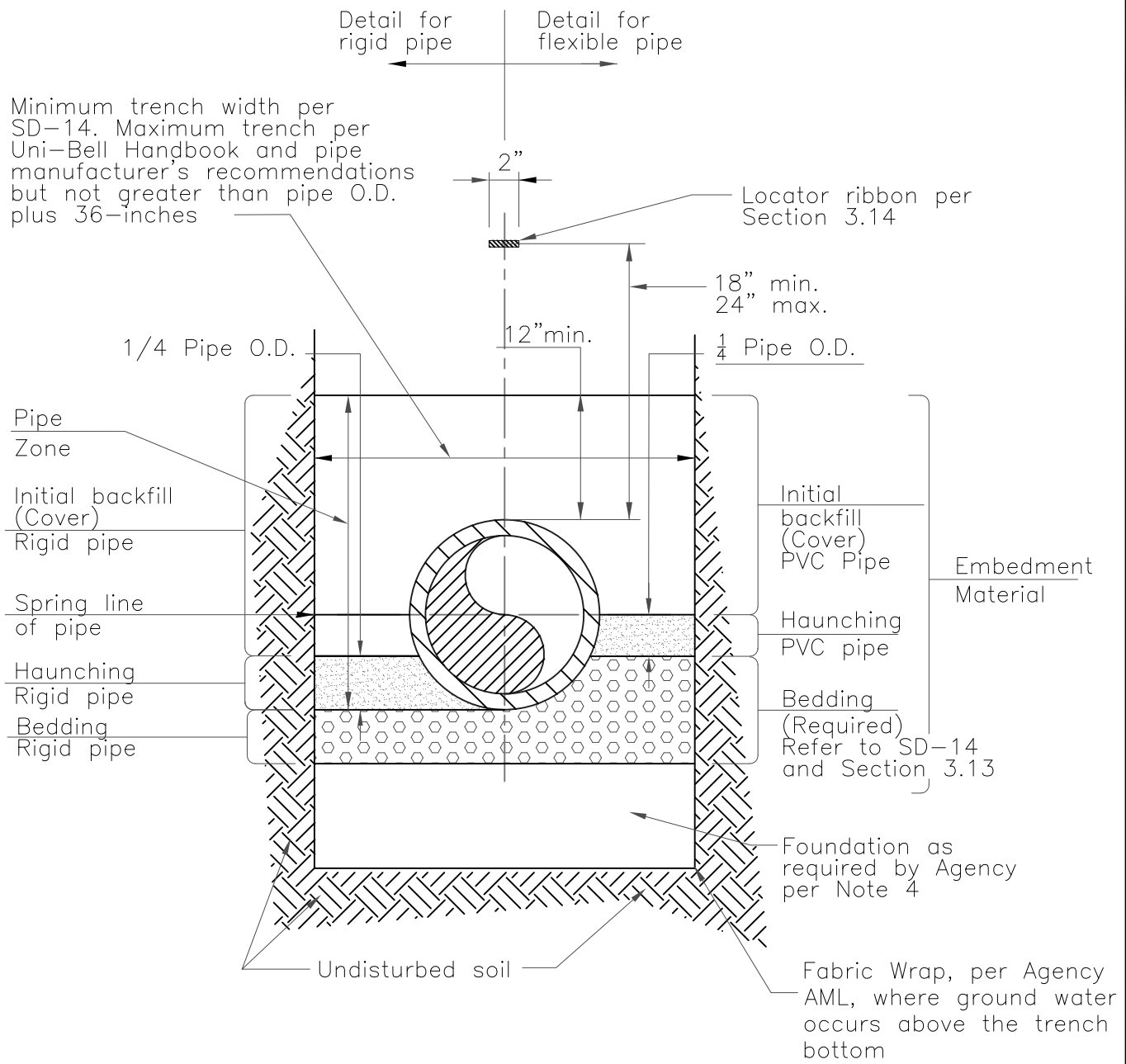
NOTES:

1. All concrete to be type V, 4,500 psi per Section 4.7.
2. In all of the above examples, bedding shall conform to Section 3.13.
3. For PVC pipe, bedding shall also conform to Uni-Bell PVC Pipe Association Handbook and pipe manufacturer's recommendations.
4. DIP shall be wrapped with a double layer of 8 mil poly-wrap.
5. For shallow manholes, sewer pipe having less than 5-feet of cover, shall be C-900 or DIP as required by Agency. The C-900 or DIP pipe shall extend to the next upstream and downstream manholes.

PIPE BEDDING METHODS

ISSUED:

NUMBER: SD-14



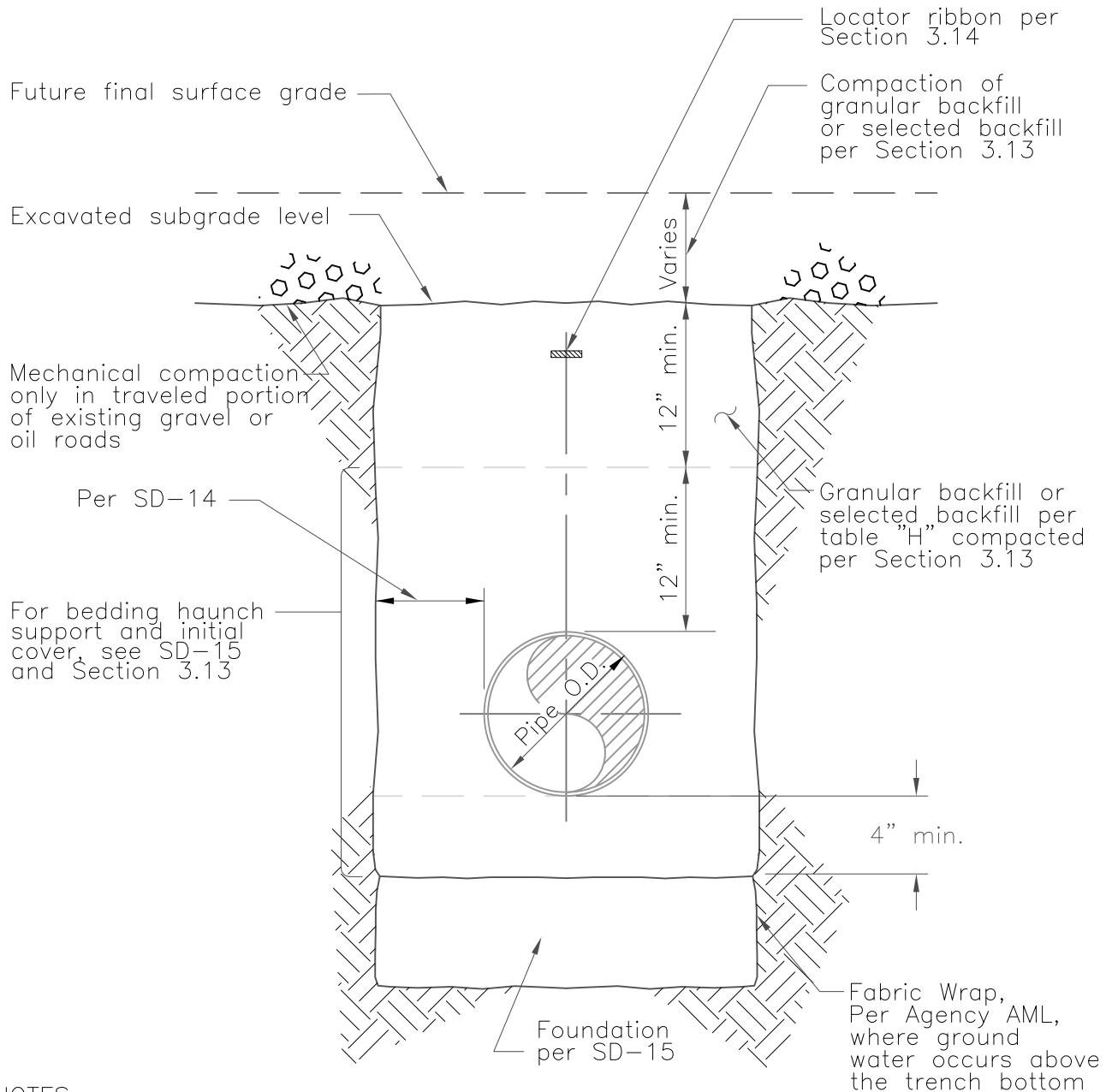
NOTES:

1. See Section 3.13 for other pipe bedding, haunching, cover and backfill requirements.
2. The trench width for flexible pipe shall be as indicated on SD-14 and for rigid pipe, refer to Section 3.13.
3. Bedding, haunching and initial cover for PVC pipe shall conform to the requirements of the Uni-Bell Handbook of PVC pipe, latest edition, and the pipe manufacturer's recommendations.
4. Provide suitable foundation per Section 3.13 and as required by the Agency in areas of unstable trench bottom, wet conditions, over-excavation, rocky trench bottom and elsewhere as directed by the Agency. Depth of foundation shall be 12" for pipe 15" or less, 24" for pipe greater than 15".
5. Trench wall support shall conform to OSHA requirements.

PIPE BEDDING, HAUNCH SUPPORT & INITIAL COVER

ISSUED:

NUMBER: SD-15



NOTES:

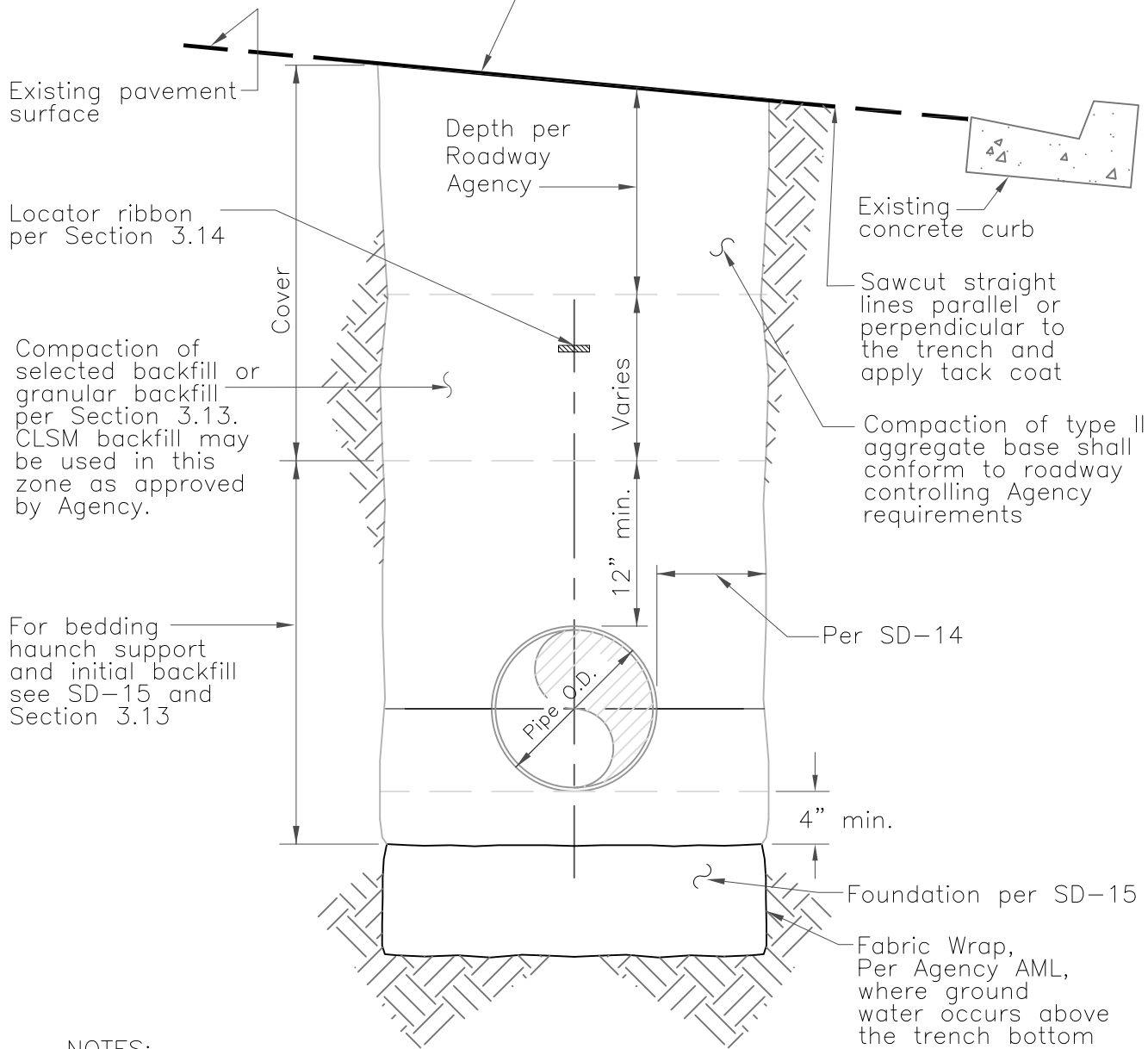
1. Trench wall support shall conform to OSHA requirements.
2. Backfill material within 36-inches of top of pipe shall be compacted using hand-operated compaction equipment only.

TRENCH SECTION FOR SEWER MAINS WITHIN SUBDIVISION & UNPAVED AREAS

ISSUED:

NUMBER: SD-16

Replacement pavement thickness shall match contiguous pavement but not less than that shown for standard street section or 3-inches whichever is greater. Conform to roadway controlling Agency requirements



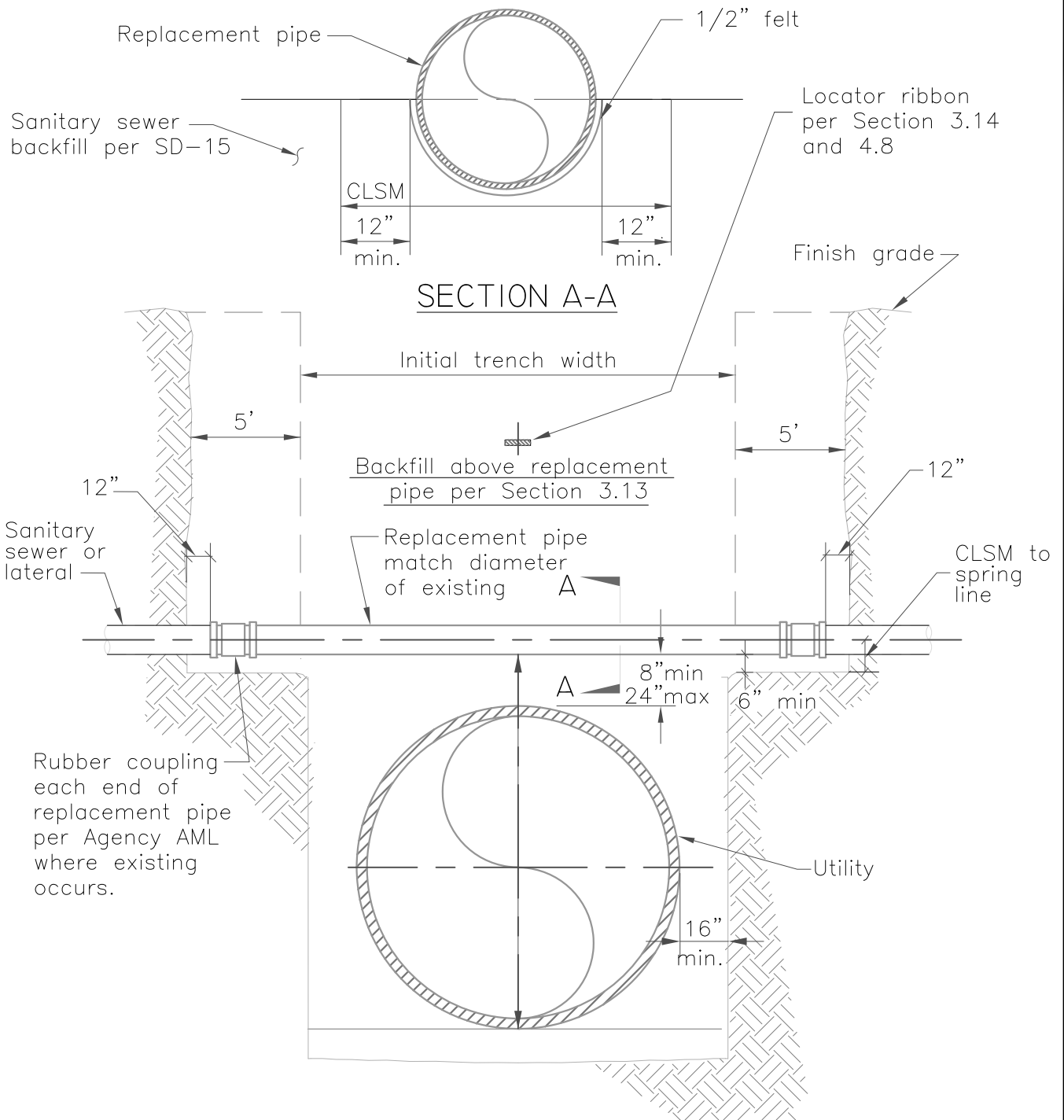
NOTES:

1. Trench wall support shall conform to OSHA requirements.
2. Backfill material within 36-inches of top of pipe shall be compacted using hand-operated compaction equipment only.

TYPICAL TRENCH SECTION FOR PAVED AREAS

ISSUED:

NUMBER: SD-17



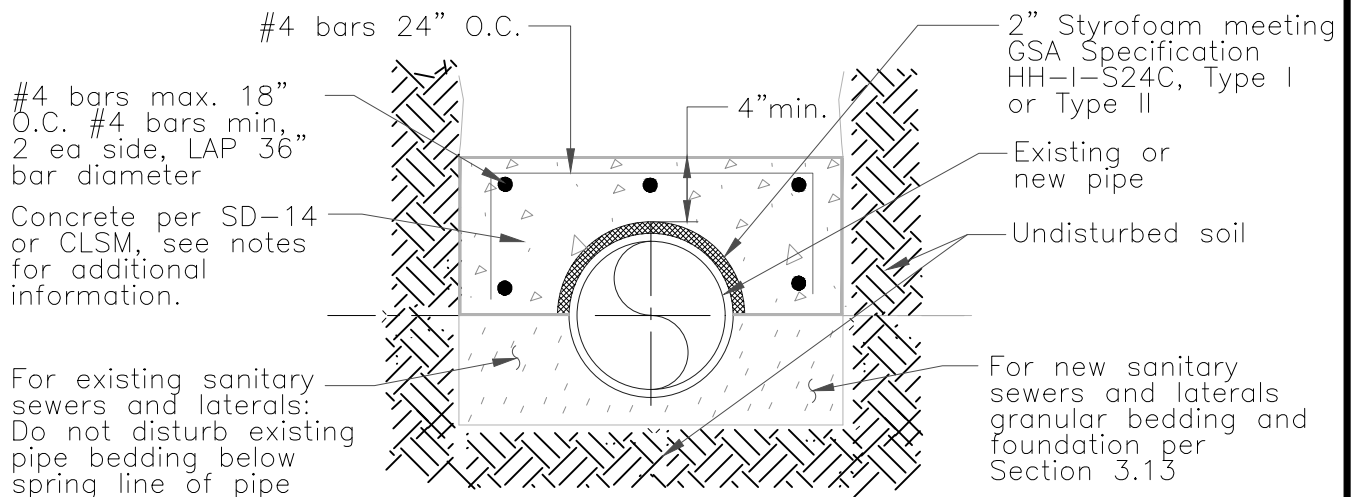
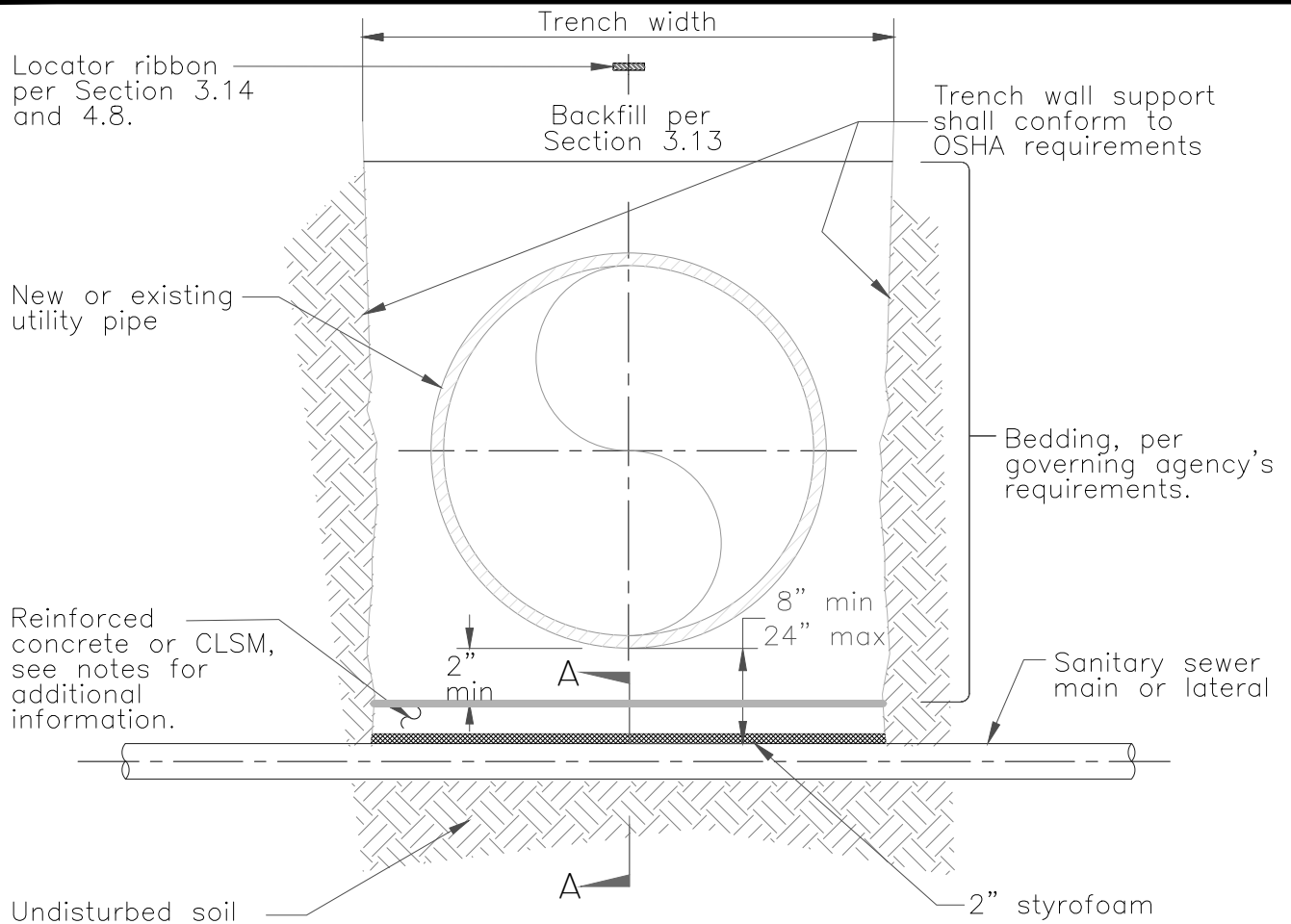
NOTES:

1. Replace all existing sanitary sewers and laterals with C-900 PVC as applicable. Replace storm sewers as required by Agency.
2. Not for water mains or water services. See UDACS for replacement requirements.
3. Upper and lower trench wall support shall conform to OSHA requirements.
4. Use this detail where the vertical clearance from outside of new utility to outside of sewer/lateral is less than 24 inches.
5. If utility is existing, expose top of existing utility.

PROTECTION OF SANITARY SEWER OR LATERAL OVER A UTILITY

ISSUED:

NUMBER: SD-18



SECTION A-A

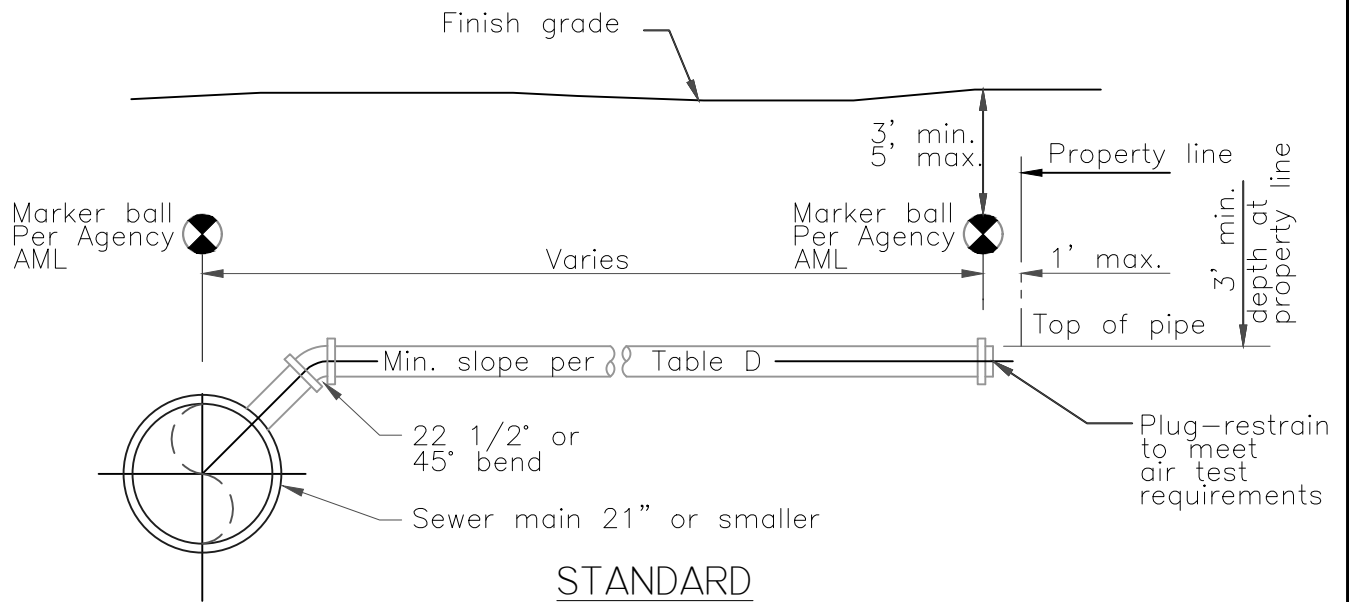
NOTE:

1. Use this detail where the vertical clearance from outside of utility pipe to outside of sewer/lateral is less than 24 inches and greater than 8".
2. Where vertical clearance from outside of utility pipe to outside of sewer/lateral is less than 8", contact governing agency for requirements.
3. For utility pipes greater than 24" in diameter with 24" or less cover, contractor shall use concrete.
4. For utility pipes 24" or less in diameter with 24" or less cover, contractor shall use CLSM.

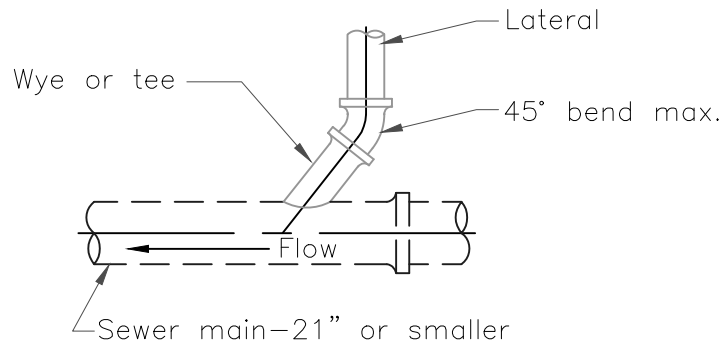
**PROTECTION OF SANITARY SEWER
UNDER A UTILITY**

ISSUED:

NUMBER: **SD-19**



STANDARD
LATERAL CONNECTION



STANDARD WYE
PLAN VIEW

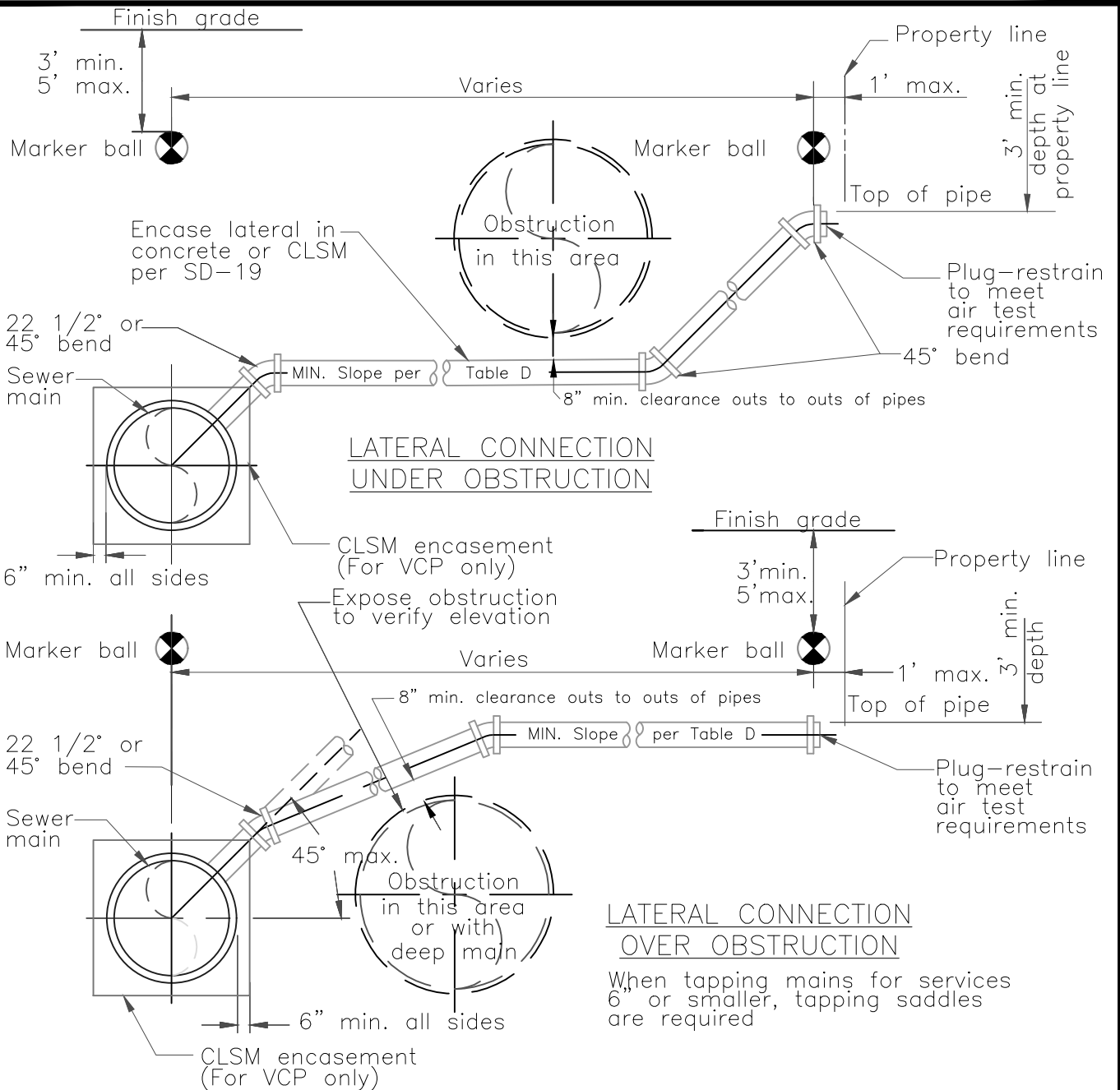
NOTES:

1. All construction shall conform to Section 3.17.
2. All concrete shall be 4500 psi minimum in accordance with Section 4.7.
3. CLSM shall be in accordance with section 4.7.
4. 22 1/2° or 45° bend may be rotated at sewer main only.
5. Lateral connections shown are limited to main line sanitary sewers 21-inches in diameter or smaller unless otherwise directed by Agency.
6. Place locator ribbon per SD-15 above lateral along its full length.
7. Place marker ball per Section 3.14 and Section 4.8 over lateral at connection to main and at upstream end of lateral at property line. Marker ball shall be 3' min. below finish grade where possible.
8. Lateral connection shall be at 45 degrees from top of pipe.

**LATERAL CONNECTION TO SEWER MAIN
21" DIA AND SMALLER**

ISSUED:

NUMBER: SD-20



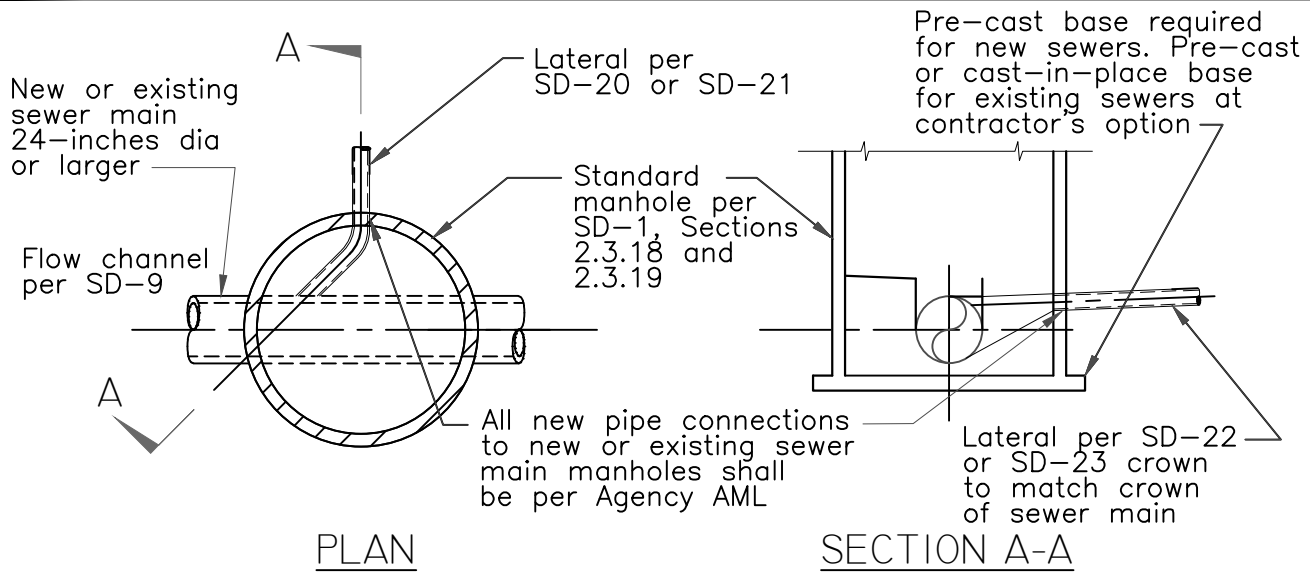
NOTES:

1. All construction shall conform to Section 3.17.
2. All concrete shall be 4500 psi minimum in accordance with Section 4.7.
3. CLSM shall be in accordance with Section 4.7
4. 22 1/2° or 45° bend may be rotated at sewer main only.
5. Lateral connections shown are limited to main line sanitary sewers 21"-inches in diameter or smaller unless otherwise directed by Agency.
6. Place locator ribbon per SD-15 above lateral; along its full length.
7. Place marker ball per Section 3.14 and Section 4.8 over lateral at connection to main and at upstream end of lateral at property line. Marker ball shall be 3' min. below finish grade where possible.
8. Lateral connections shall be at 45 degrees from top of pipe.

LATERAL CONNECTIONS TO SEWER MAINS 21" DIA AND SMALLER AROUND OBSTRUCTIONS

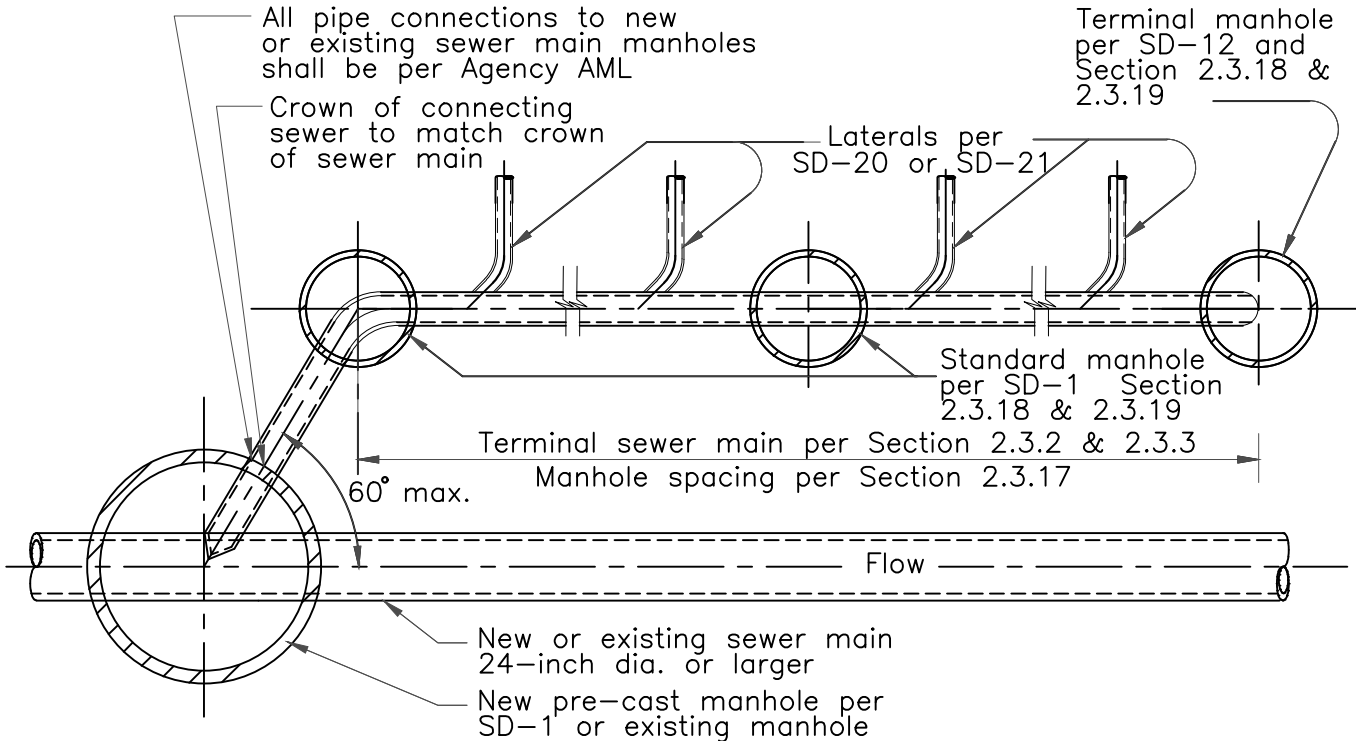
ISSUED:

NUMBER: SD-21



LATERAL CONNECTIONS USING INDIVIDUAL MANHOLES

Permitted at contractor's option where 3 or fewer laterals are to be connected per 500 feet of sewer main unless otherwise required by Agency



LATERAL CONNECTIONS USING PARALLEL SEWER

Required where 4 or more laterals are to be connected per 500 ft of sewer main unless otherwise permitted by Agency

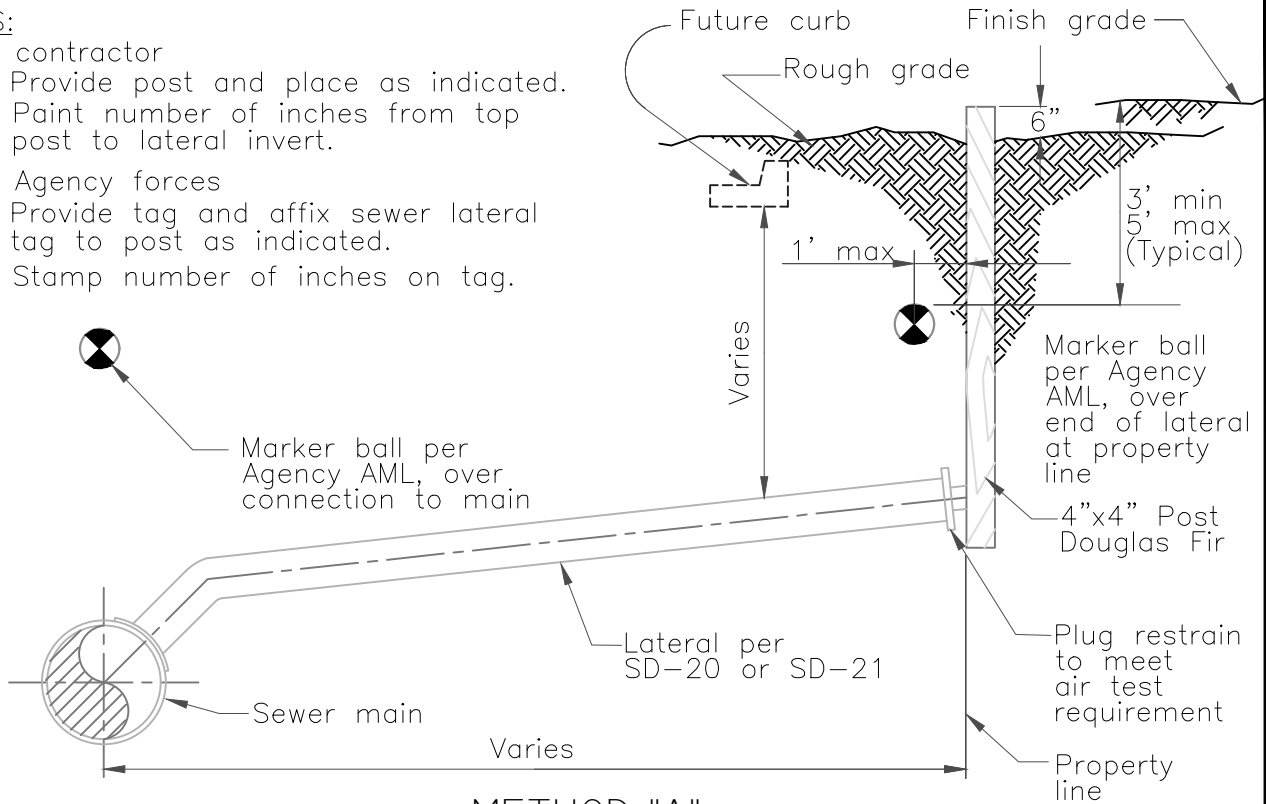
**LATERAL CONNECTIONS TO SEWER MAINS
24" AND LARGER**

ISSUED:

NUMBER: SD-22

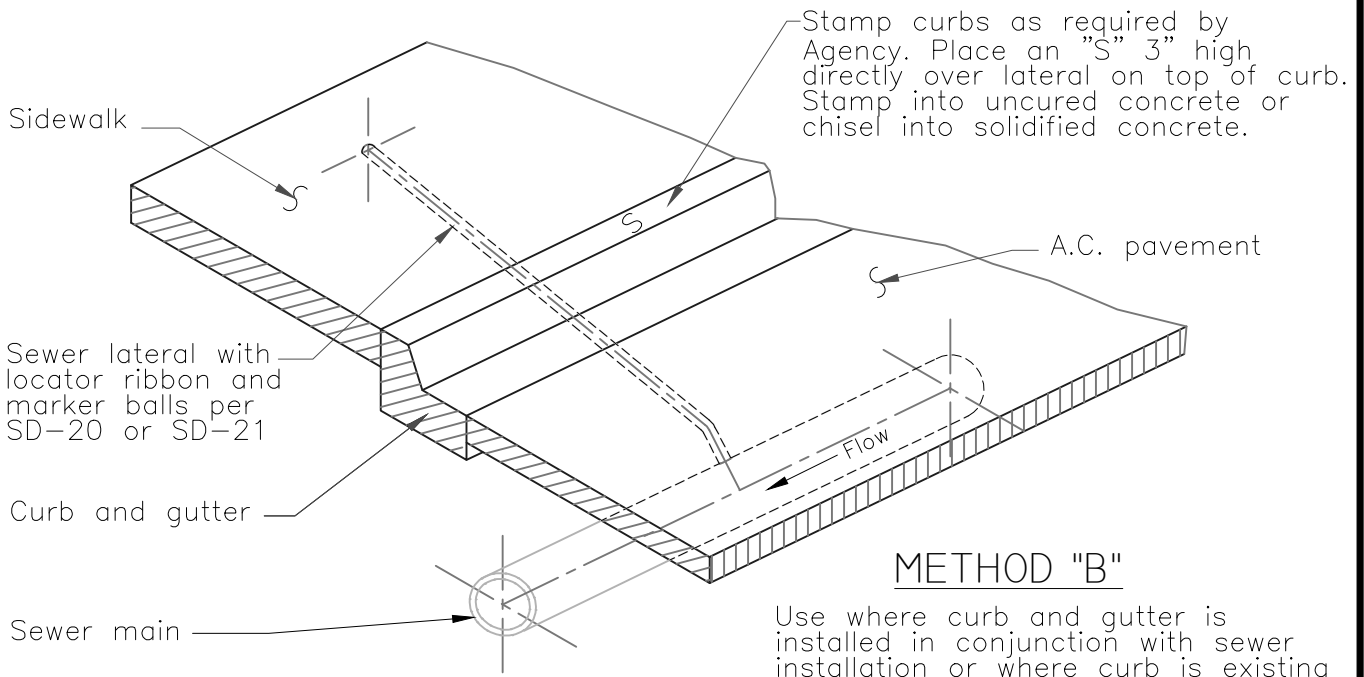
NOTES:

1. By contractor
 - A. Provide post and place as indicated.
 - B. Paint number of inches from top post to lateral invert.
2. By Agency forces
 - A. Provide tag and affix sewer lateral tag to post as indicated.
 - B. Stamp number of inches on tag.



METHOD "A"

Use where no curb & gutter exist



METHOD "B"

Use where curb and gutter is installed in conjunction with sewer installation or where curb is existing

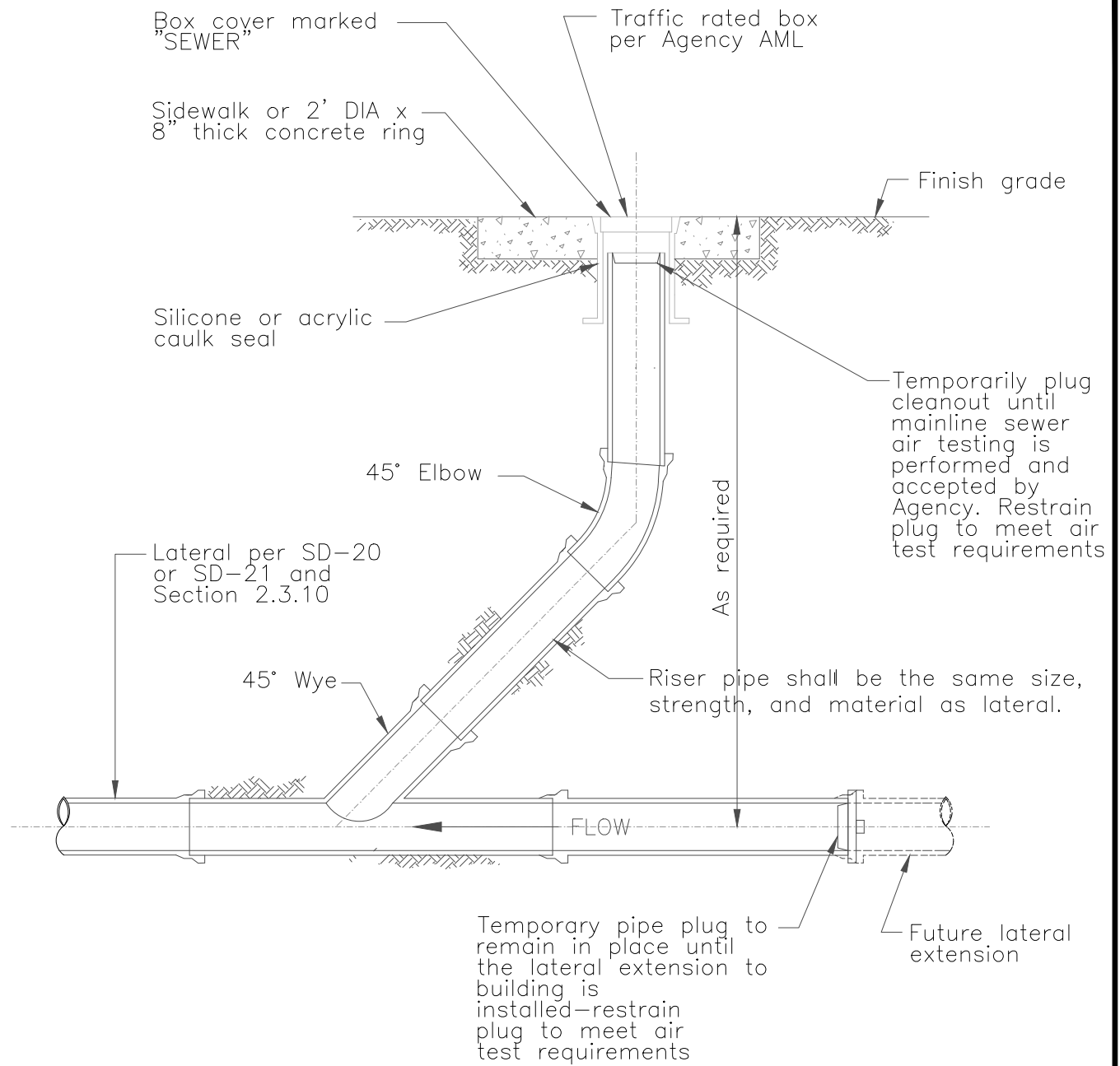
NOTES:

3. When required by Agency, provide cleanout at property line per SD-24.
4. Locator ribbon per Section 4.8 and SD-15 and marker balls per Sections 3.14 and SD-20 shall be placed above all new sanitary sewer mains and laterals for both marker method "A" and "B". Marker ball shall be 3' min. below finish grade where possible.

SEWER LATERAL MARKER

ISSUED:

NUMBER: SD-23



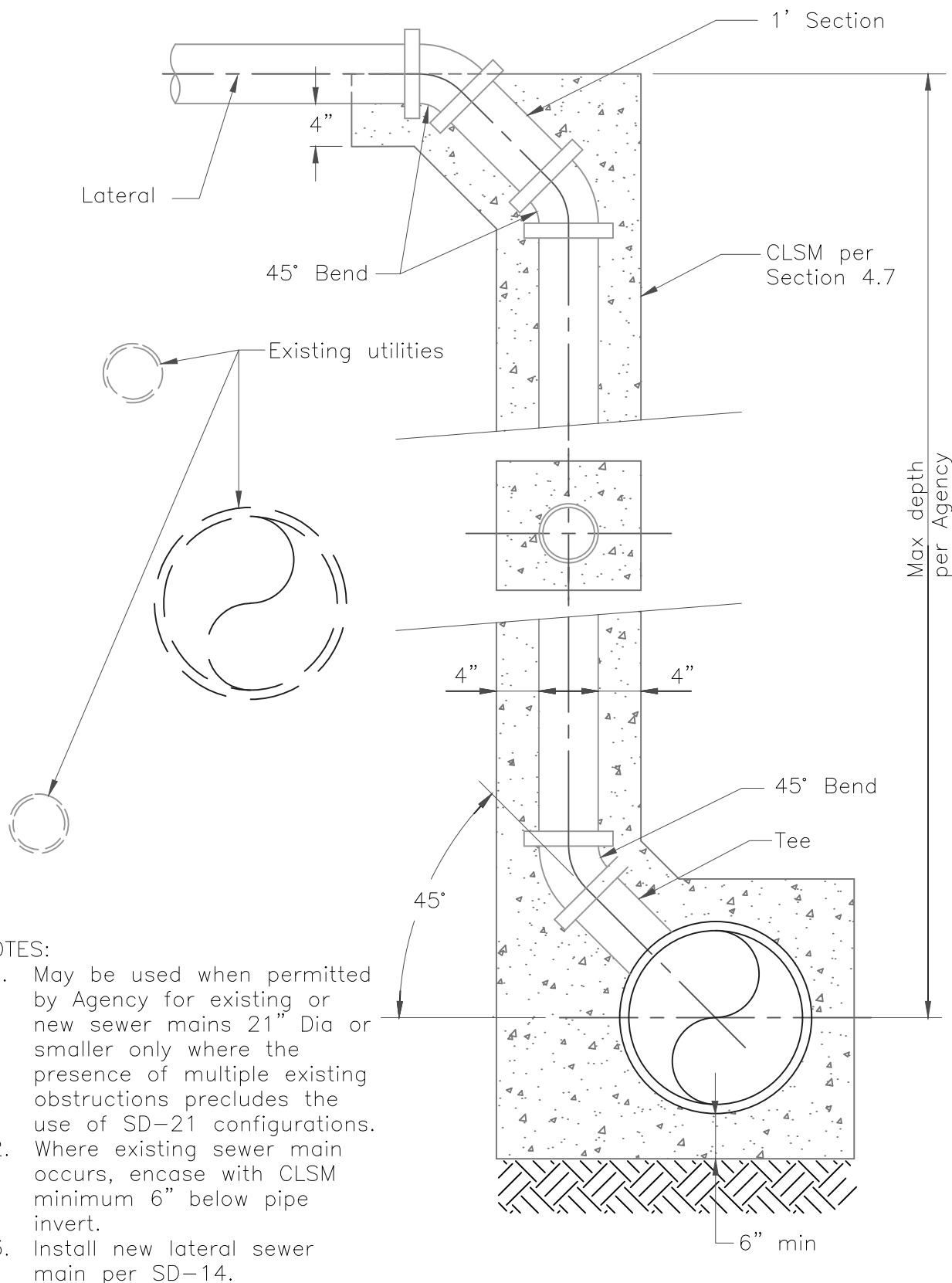
NOTES:

1. Provide cleanouts for laterals where directed by Agency.
2. Marker ball at upstream end of lateral may be deleted for laterals with cleanouts.

LATERAL CLEANOUT

ISSUED:

NUMBER: SD-24



NOTES:

1. May be used when permitted by Agency for existing or new sewer mains 21" Dia or smaller only where the presence of multiple existing obstructions precludes the use of SD-21 configurations.
2. Where existing sewer main occurs, encase with CLSM minimum 6" below pipe invert.
3. Install new lateral sewer main per SD-14.

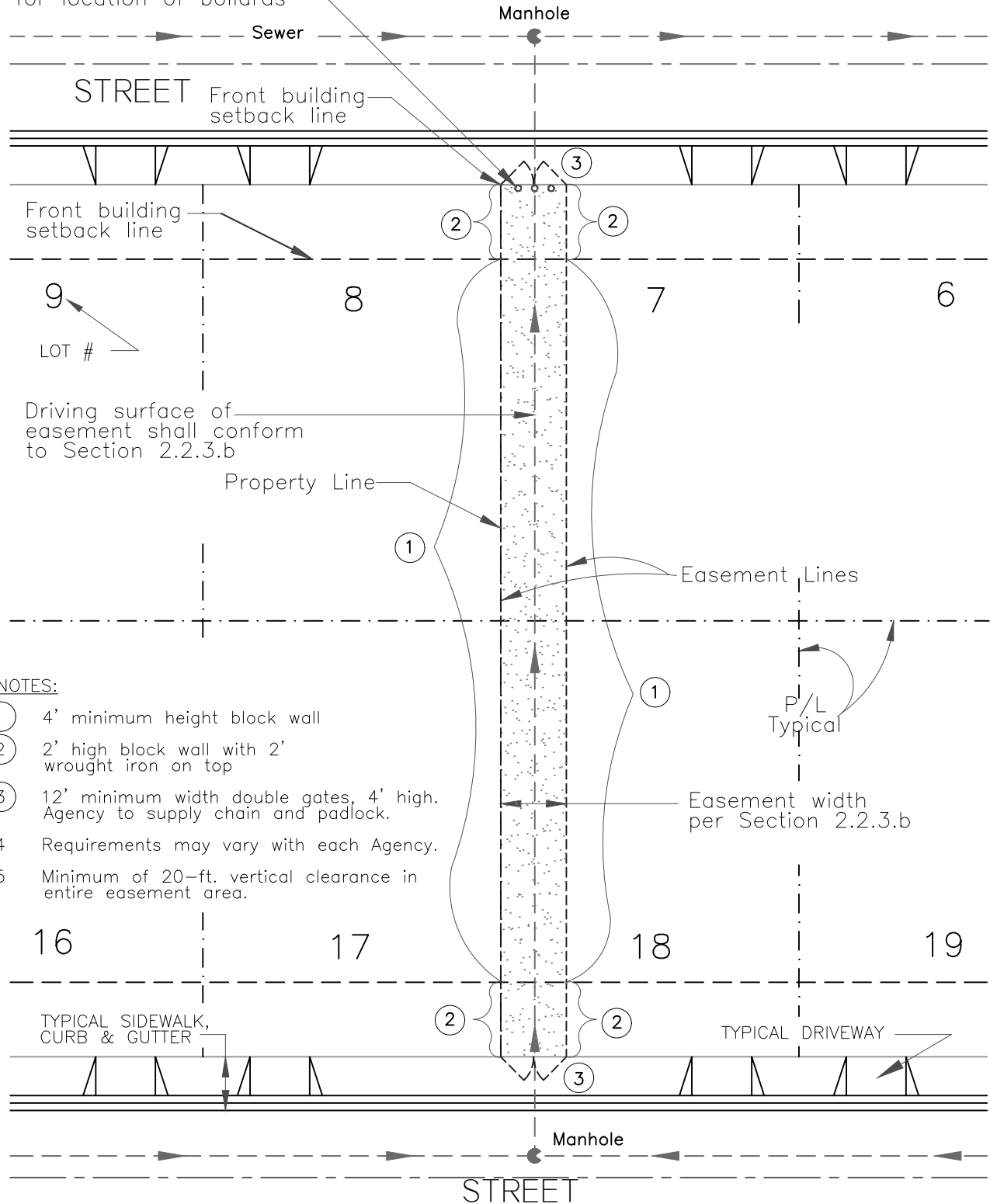
MAY BE USED UPON SPECIAL AGENCY APPROVAL ONLY

DEEP LATERAL CONNECTION

ISSUED:

NUMBER: SD-25

Where required by Agency, provide bollards per SD-34 in lieu of Gates see note 3 – contact Agency for location of bollards



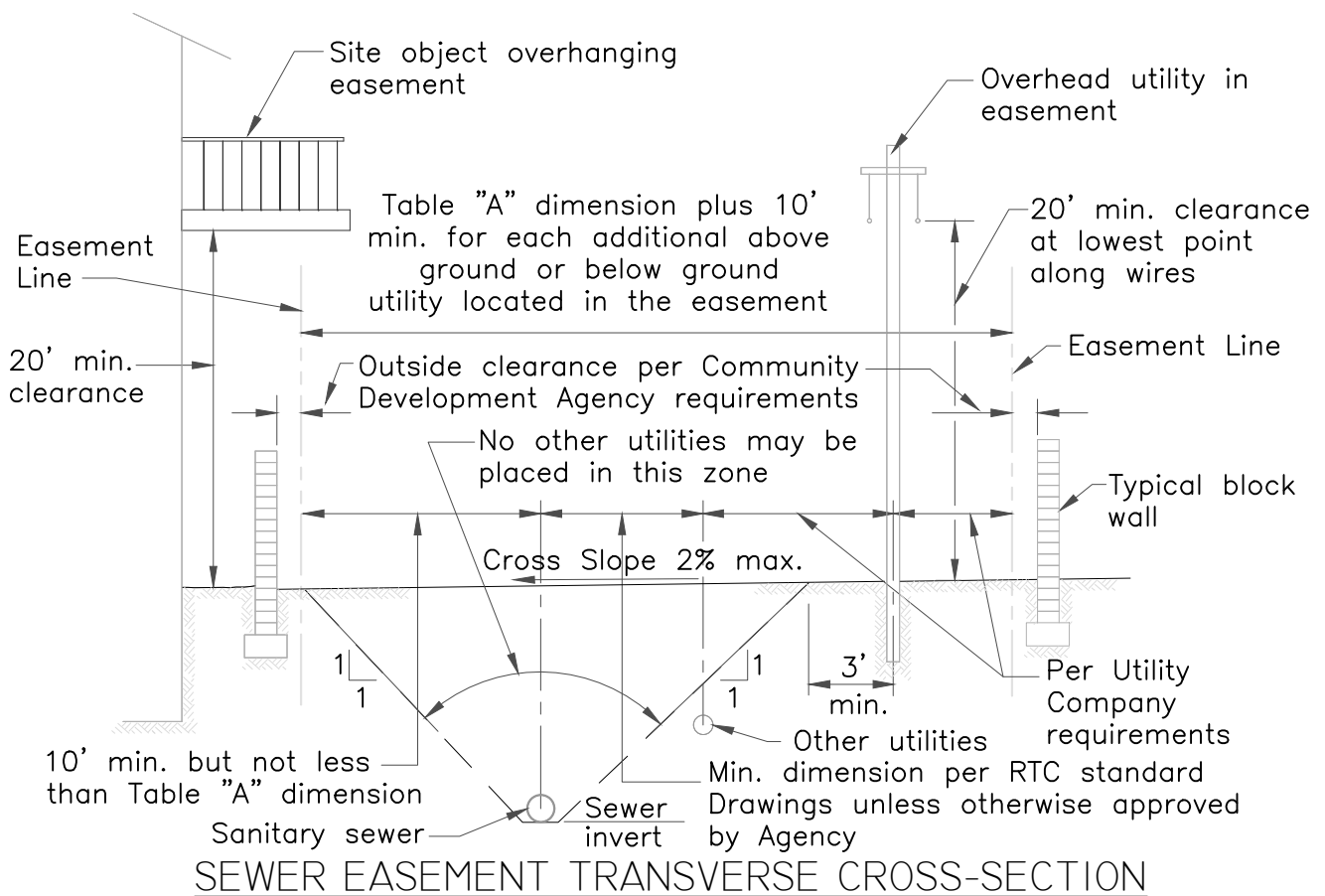
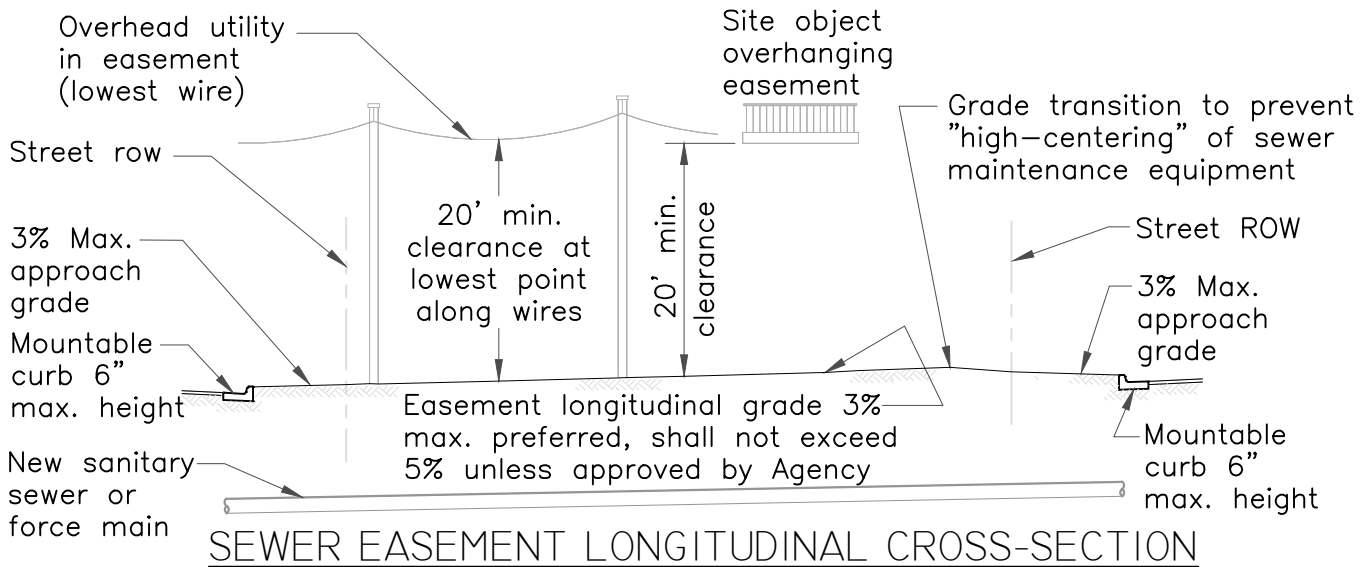
NOTES:

- ① 4' minimum height block wall
- ② 2' high block wall with 2' wrought iron on top
- ③ 12' minimum width double gates, 4' high. Agency to supply chain and padlock.
- 4 Requirements may vary with each Agency.
- 5 Minimum of 20-ft. vertical clearance in entire easement area.

TYPICAL SEWER EASEMENT REQUIRING BLOCK WALLS

ISSUED:

NUMBER: SD-26A



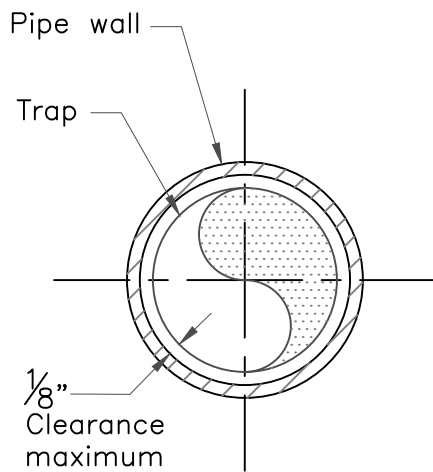
NOTES:

1. Easement widths and clearances between individual utilities and between utilities and site objects shall be increased as necessary to prevent undermining of site objects and/or other utilities during sanitary sewer construction.
2. No landscaping having a mature height greater than 3' shall be placed in easement see Section 2.2.3.b.

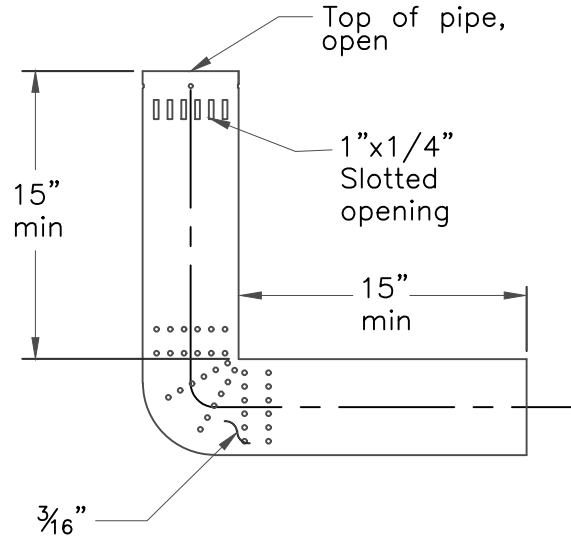
TYPICAL SEWER EASEMENTS REQUIRING BLOCK WALLS

ISSUED:

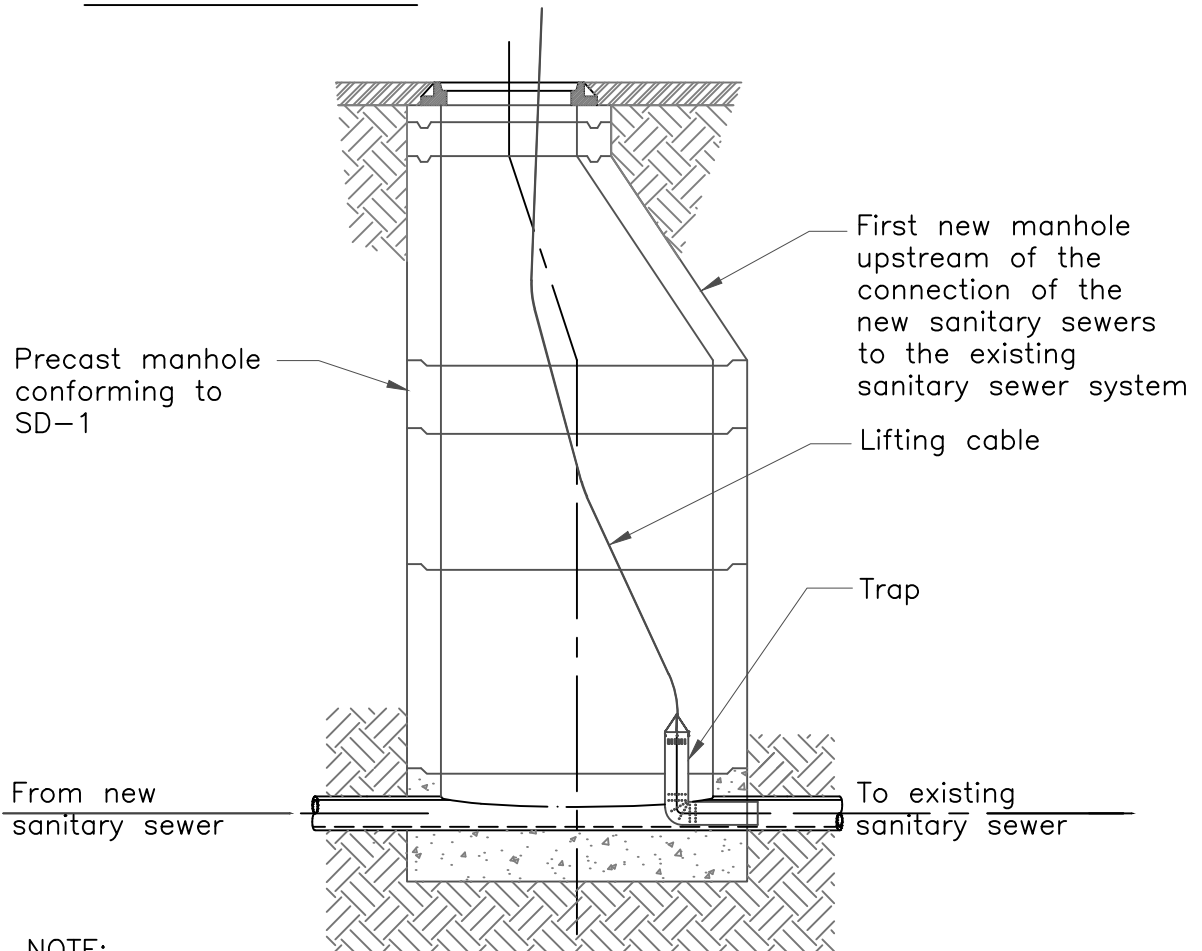
NUMBER: SD-26B



CROSS SECTION OF DISCARD PIPE WITH TRAP INSTALLED



CUSTOM FABRICATED METAL TRAP



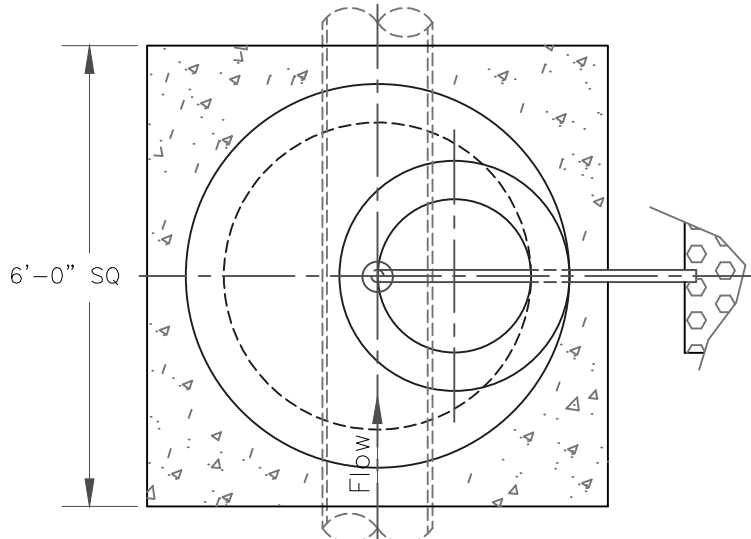
NOTE:

1. Provide debris traps in accordance with Section 3.16.9.

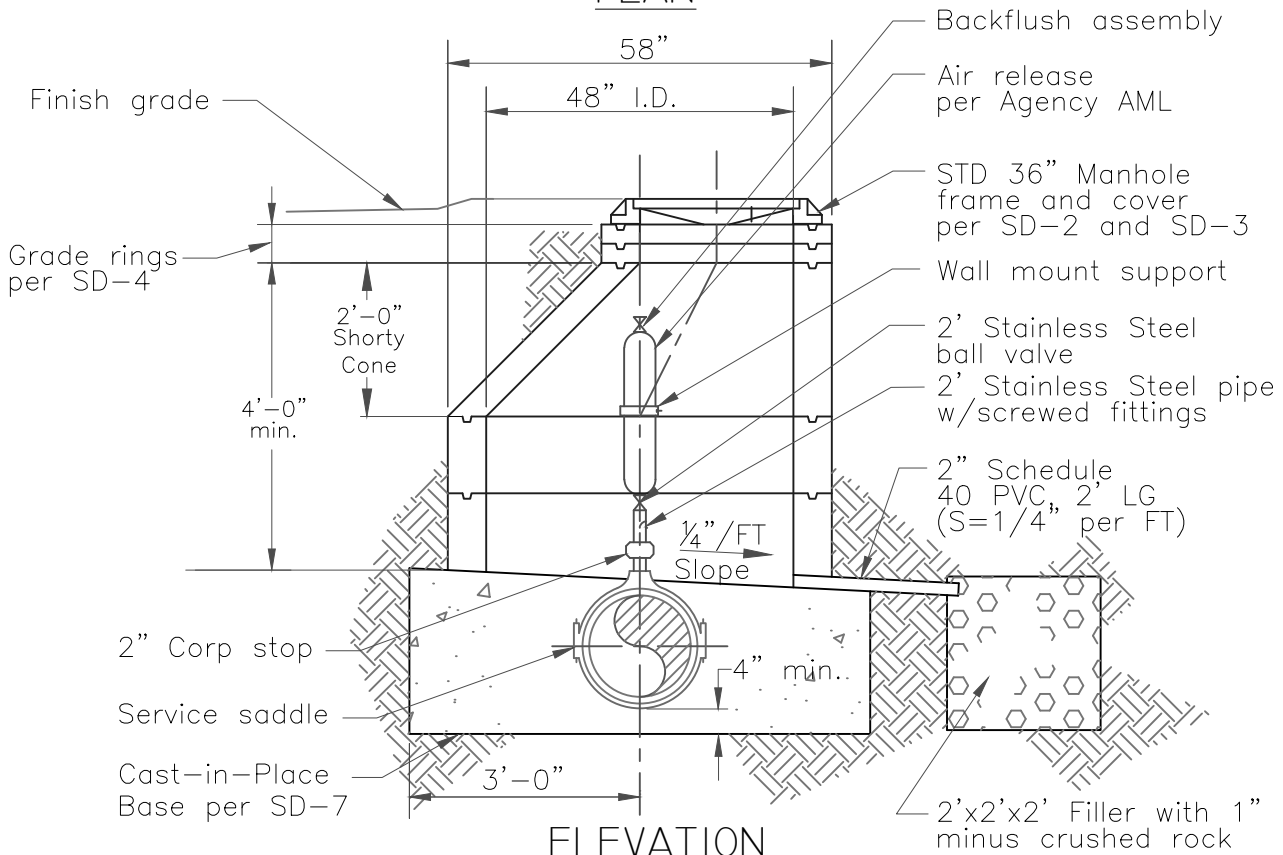
APPROVED TRAP FOR SEWER LINE CONSTRUCTION

ISSUED:

NUMBER: SD-27



PLAN



ELEVATION

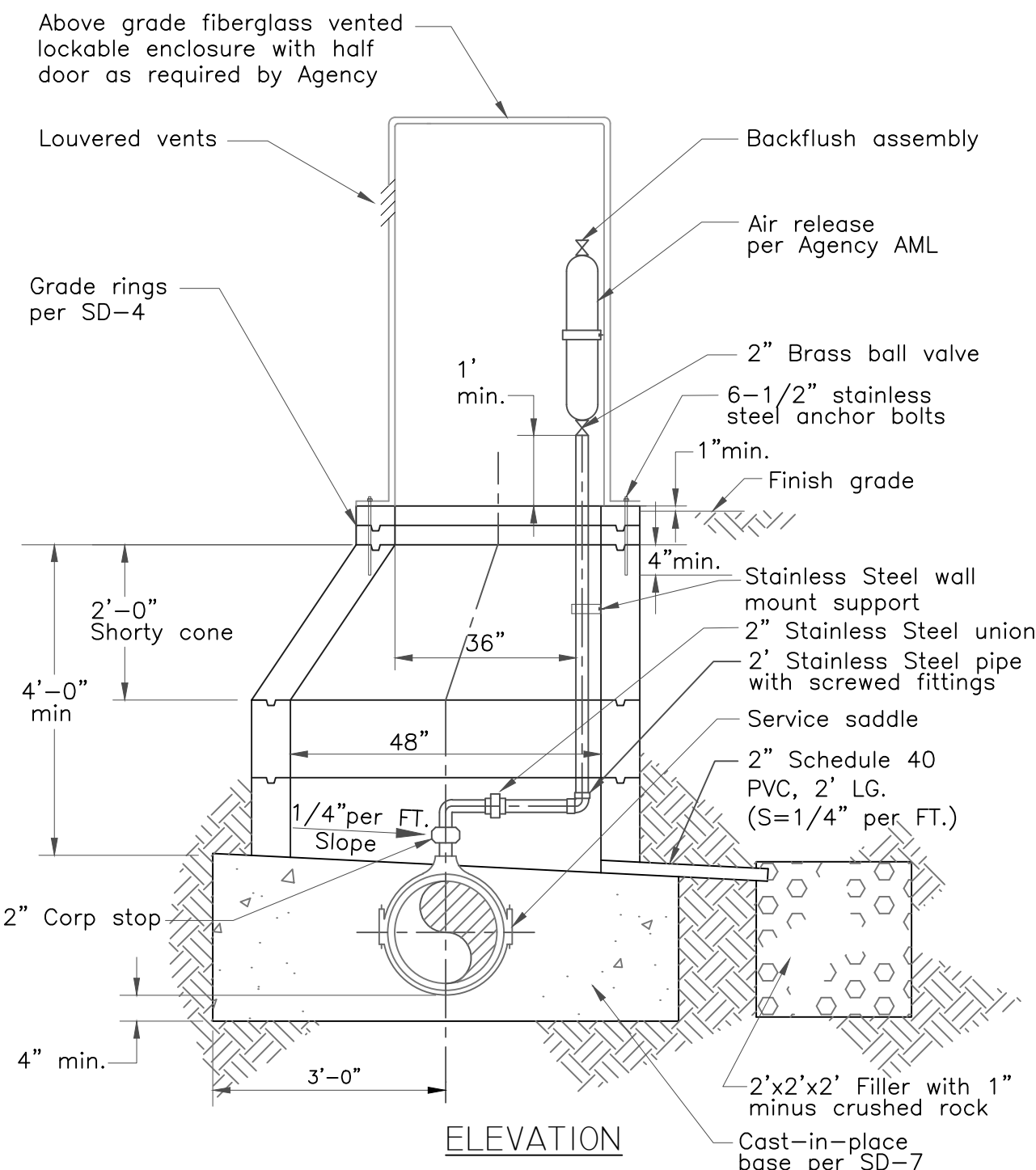
NOTES:

1. Engineer shall calculate and size necessary valves independently for each high point and long (>1/4 mile) ascending/descending stretches in a wastewater force main.
2. Provide interior corrosion protection per Agency requirements.
3. Each Agency shall have the right to determine if it shall allow high points (peaks) in a wastewater force main in its system.

BELOW GRADE AIR RELIEF VALVES

ISSUED:

NUMBER: SD-28



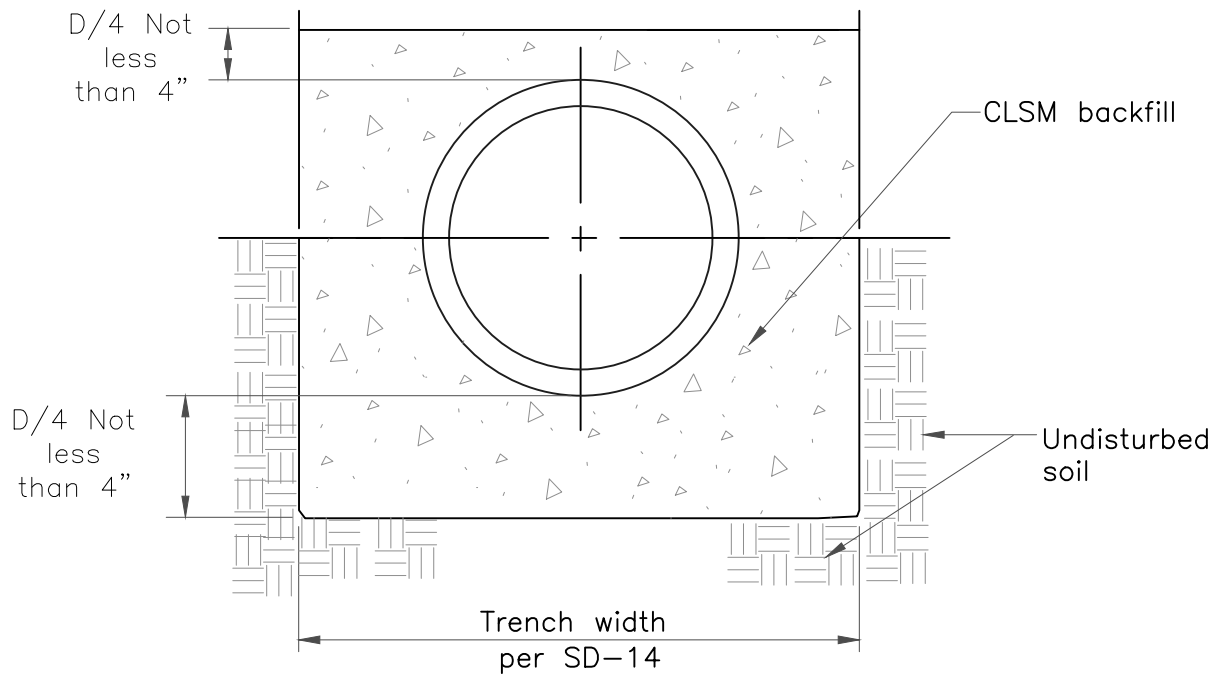
NOTES:

1. Engineer shall calculate and size necessary valves independently for each high point and long (> 1/4 mile) ascending/ descending stretches in a wastewater force main.
2. Provide interior corrosion protection per Agency requirements.
3. Each Agency shall have the right to determine if it shall allow high points in a wastewater force main in its system.

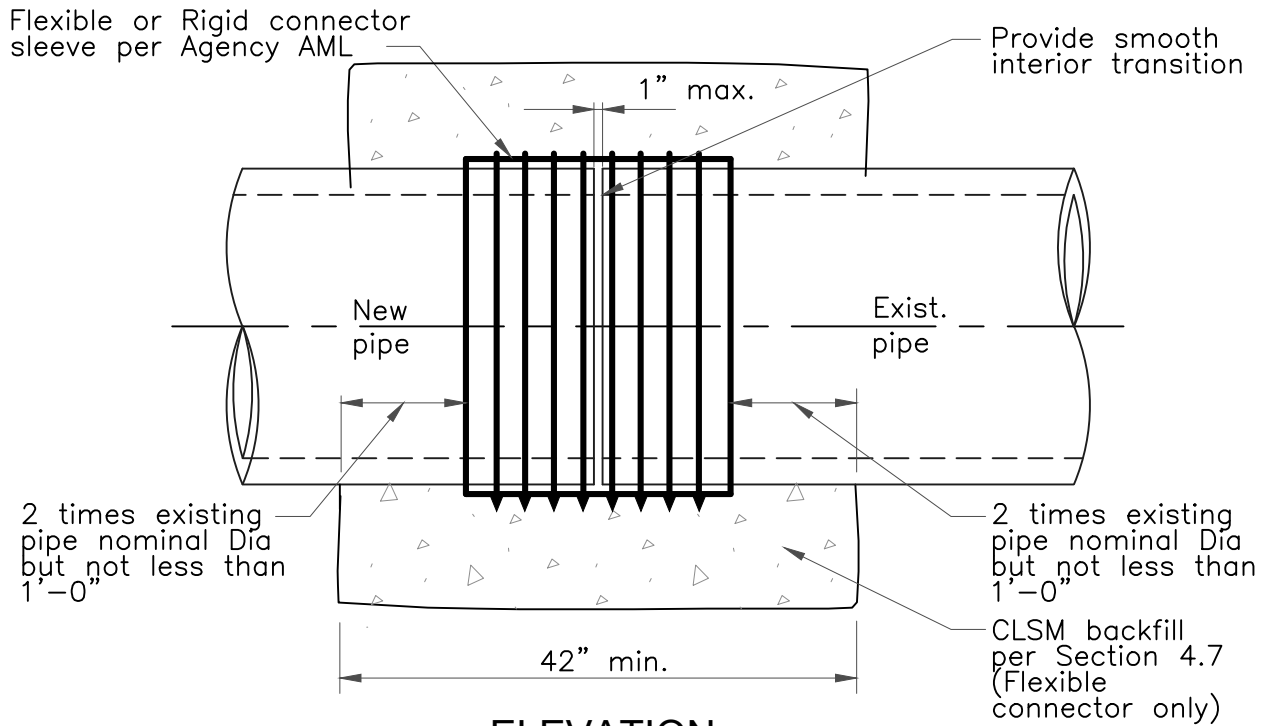
ABOVE GRADE AIR RELIEF VALVES

ISSUED:

NUMBER: SD-29



SECTION



ELEVATION

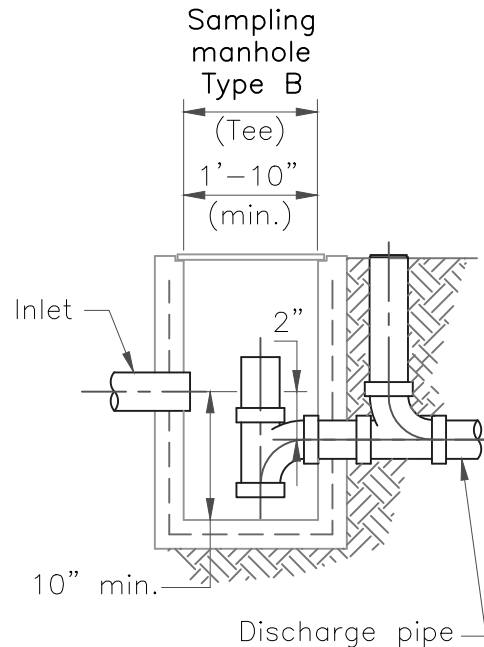
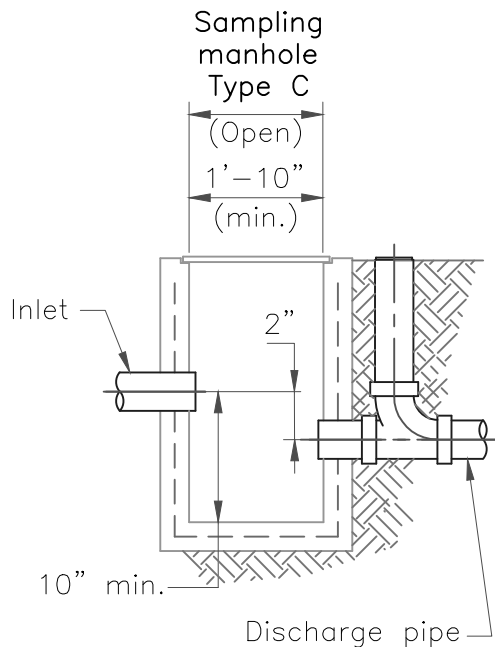
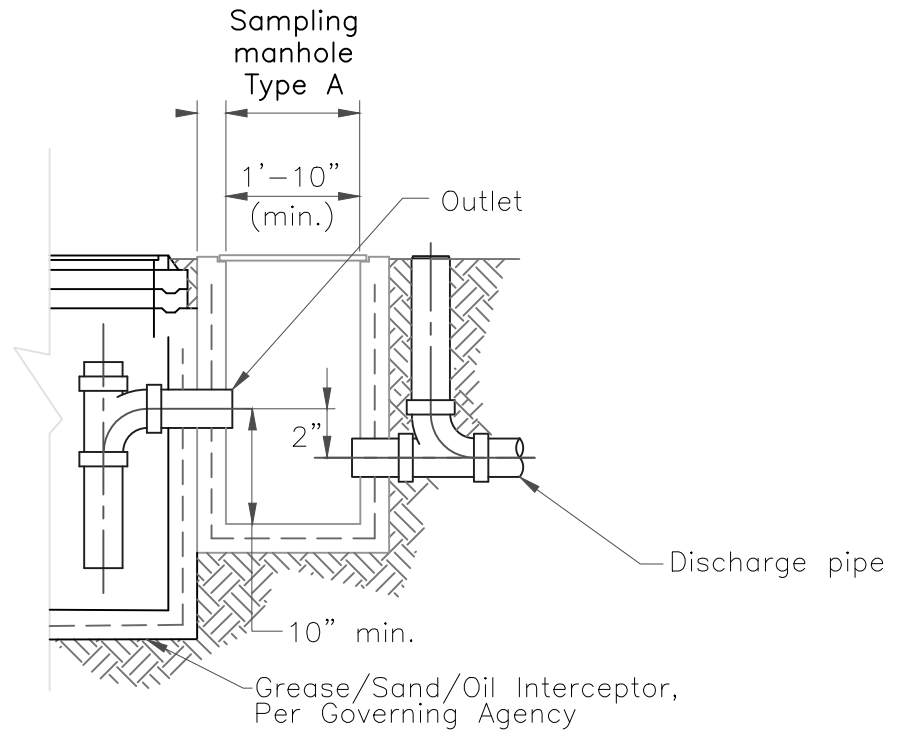
NOTE:

1. At contractors option, rigid connector may be used per Agency AML, CLSM encasement not required.

RIGID PIPE FIELD CLOSURE

ISSUED:

NUMBER: **SD-30**



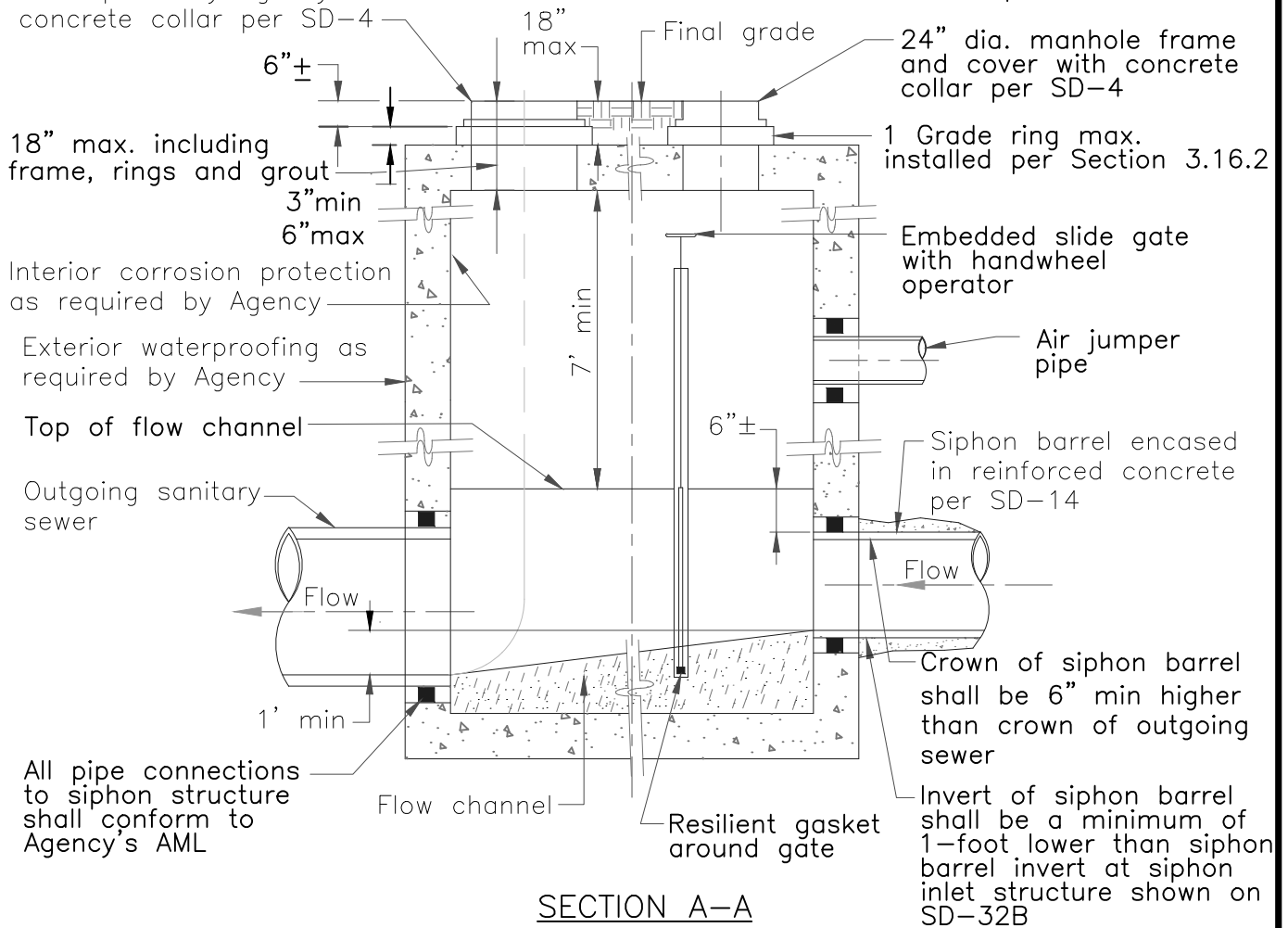
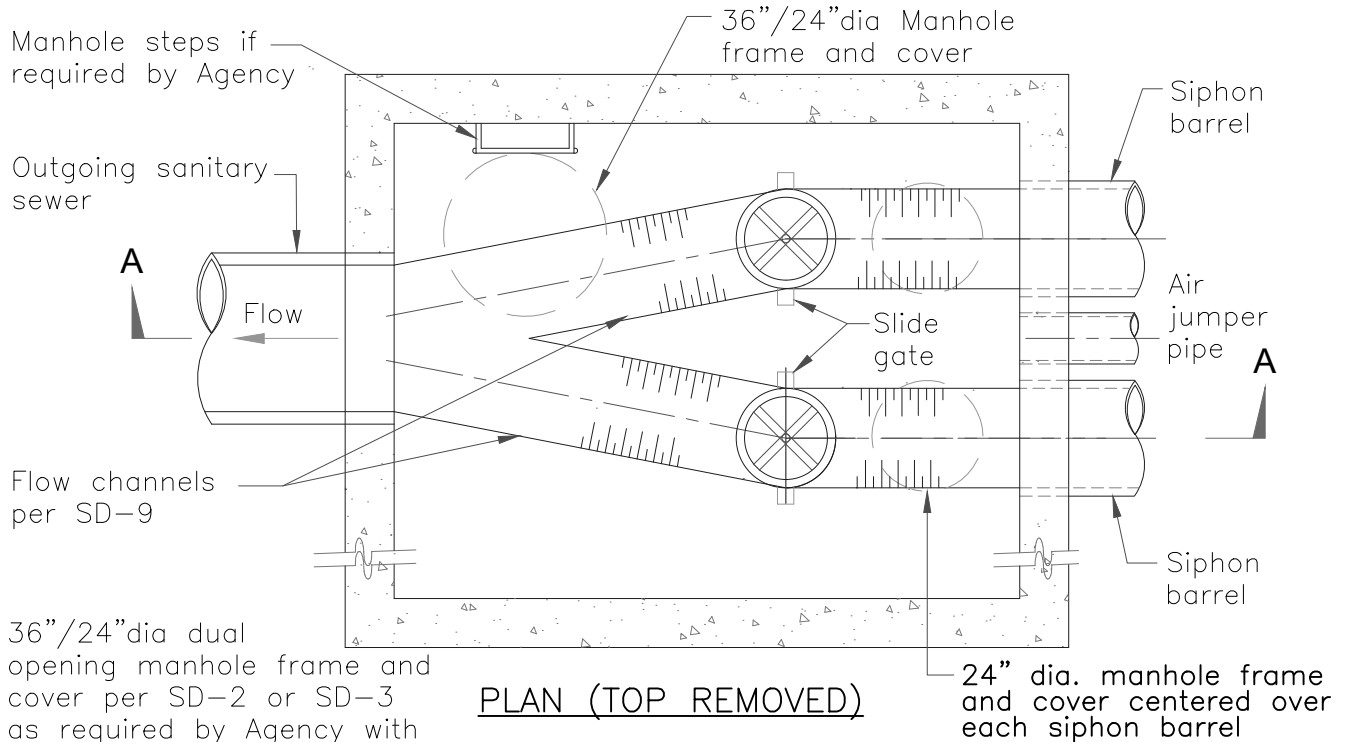
NOTES:

1. Provide 2" free fall from centerline of outlet to centerline of discharge pipe.
2. Check with each governing Agency for allowable use of type A, B or C sampling manhole within their jurisdiction.
3. Type A, B or C manholes require a minimum of 10" at the bottom of the manhole for immersion of lab sampling bottle. Type B manholes require 6" minimum tees since the sample bottle is lowered within the tee.

PRETREATMENT SAMPLING MANHOLE

ISSUED:

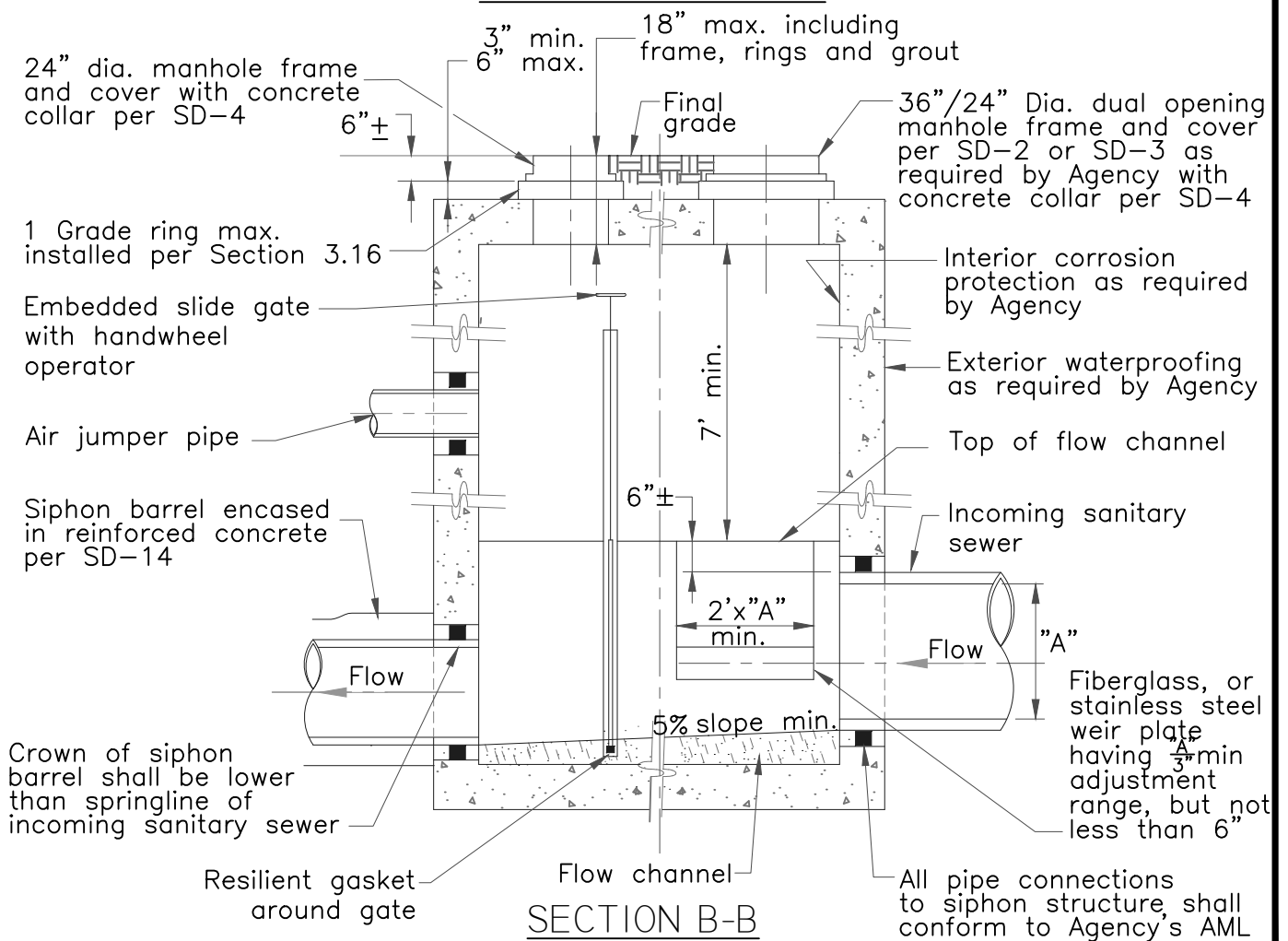
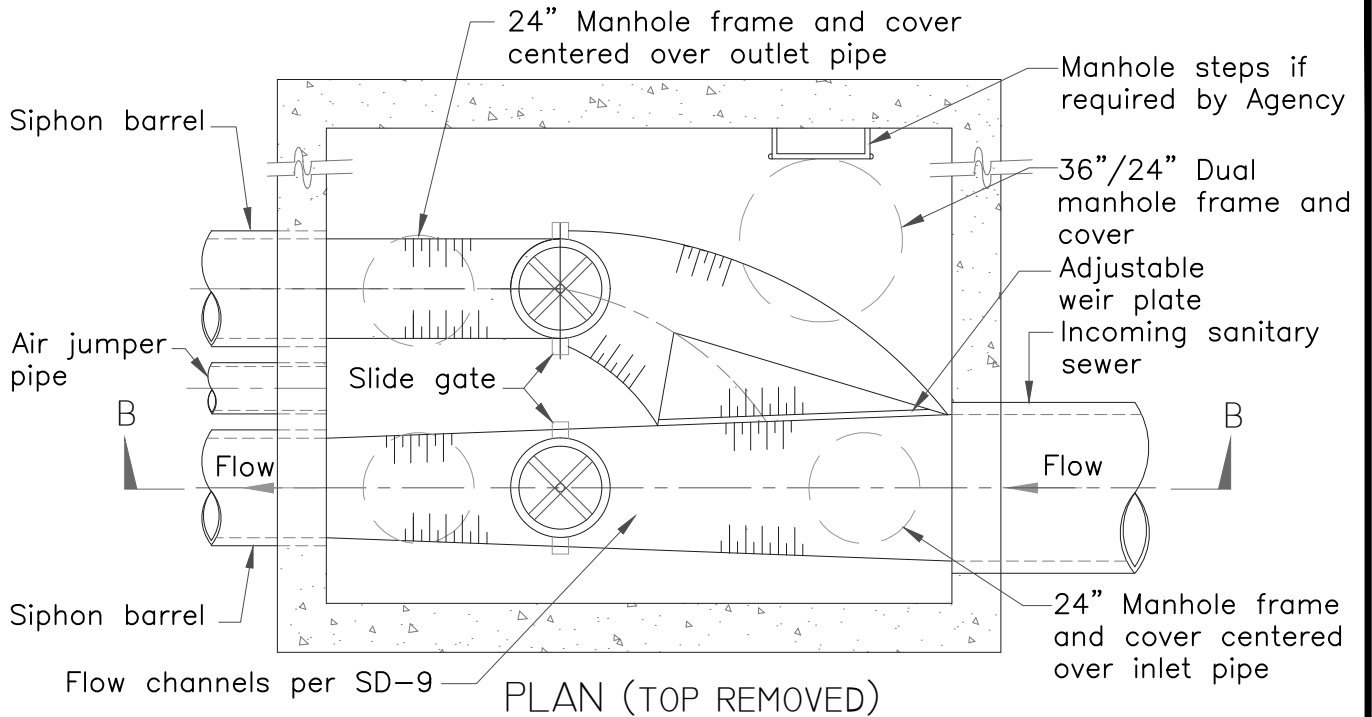
NUMBER: **SD-31**



TYPICAL SIPHON OUTLET STRUCTURE

ISSUED:

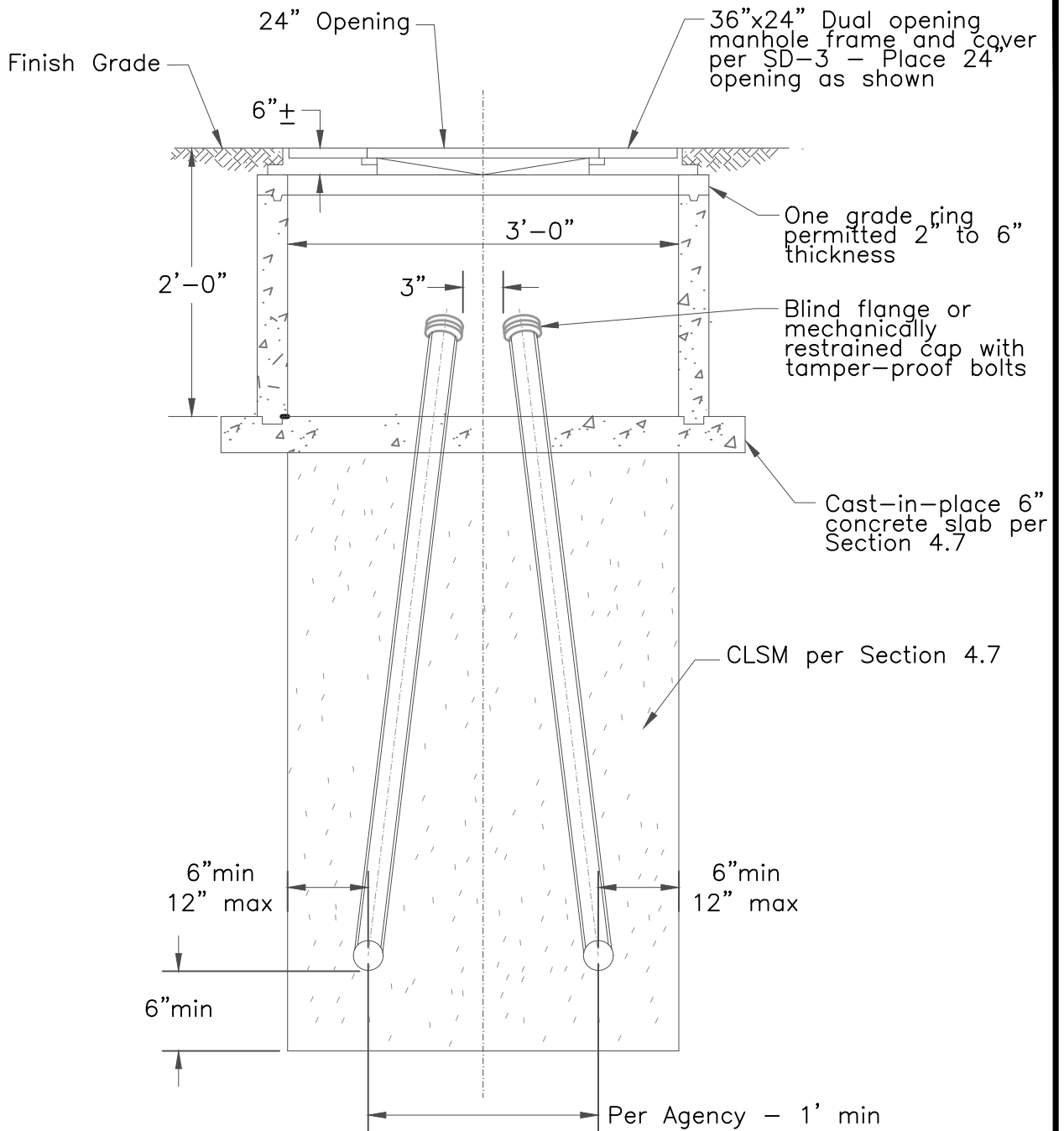
NUMBER: SD-32A



TYPICAL SIPHON INLET STRUCTURE

ISSUED:

NUMBER: SD-32B



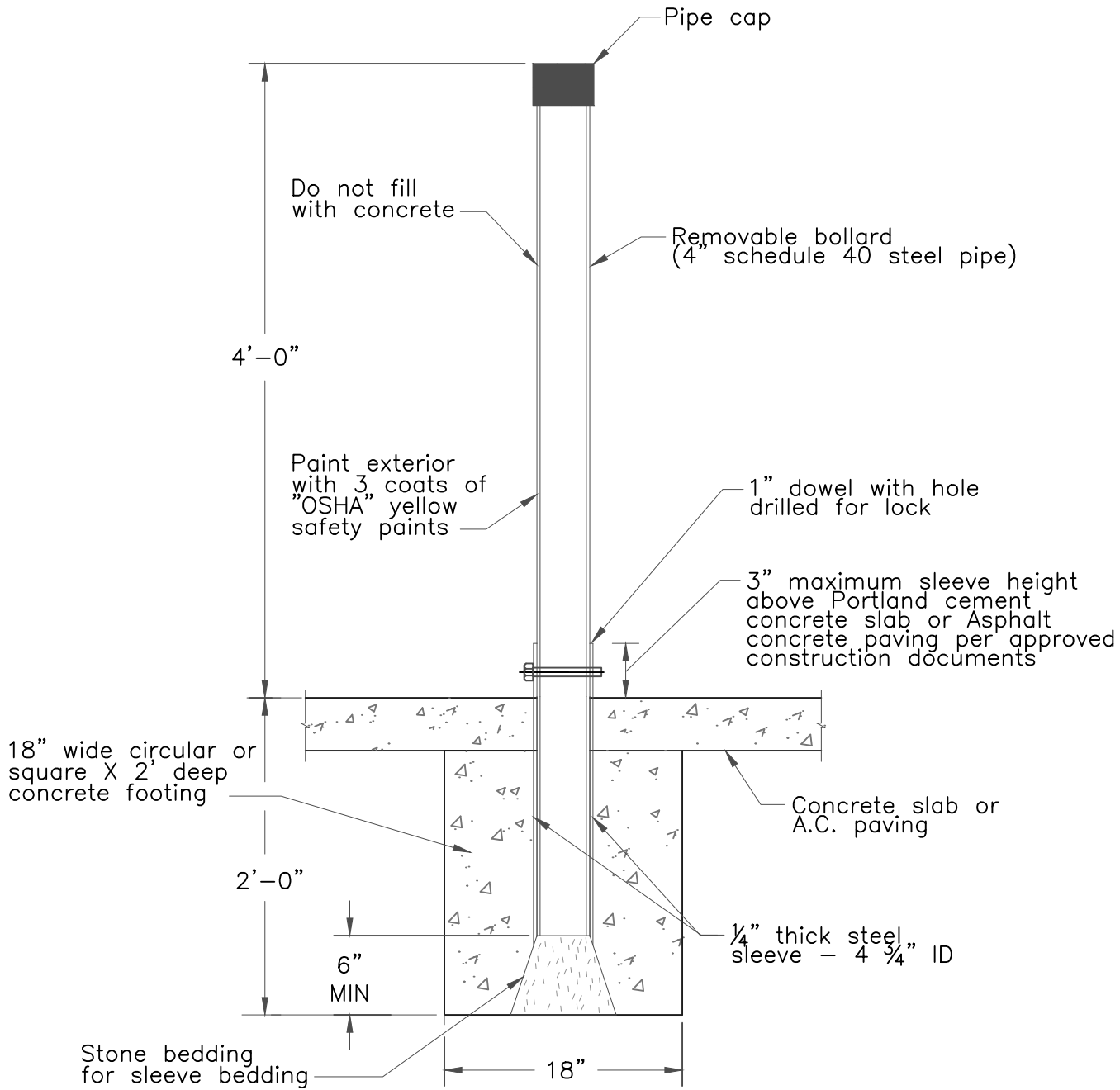
NOTES:

1. All pipes shall be PVC or DIP conforming to Section 4.6 as required by the Agency.
2. Final configuration of cleanout shall be shown in the construction documents.

TYPICAL FORCE MAIN CLEAN-OUT

ISSUED:

NUMBER: SD-33B



BOLLARD DETAIL (REMOVABLE, LOCKING)

ISSUED:

NUMBER: SD-34

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**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 6

TABLES

**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 6

LIST OF TABLES

Table	Title	Page
A	Easement Widths	T-1
B	Inspection Charge Statement of Authorization and Responsibility	T-2
C	Ratio of Peak Flow to Average Daily Flow, Clark County Nevada	T-3
D	Minimum Required and Maximum Permitted Pipe Slopes	T-4
E	Lift Station Data Sheet	T-5
F	Backfill Materials	T-6
G	Compaction Testing	T-8
H	Low Pressure Air Test for Gravity Sewer Lines	T-9
I	Force Main Allowable Leakage	T-10

TABLE "A"

EASEMENT WIDTHS

MINIMUM EASEMENT WIDTHS FOR
SEWER MAINS AND FORCE MAINS

Main Diameter	Cover Depth	Minimum Easement Width <small>(1)(2)(3)(4)(5)</small>
All Force mains	< 8 ft.	20 ft.
All Sewer Mains:		
15-inches and less	<10 ft.	20 ft.
15-inches and less	10-15 ft.	30 ft.
15-inches and less	15-20 ft.	40 ft.
15-inches and less	>20 ft.	50 ft.
16 to 30-inches	<10 ft.	30 ft.
16 to 30-inches	10-20 ft.	40 ft.
16 to 30-inches	>20 ft.	50 ft.
Greater than 30-inches	Any	Per Agency

- (1) Easements shall be increased in width by a minimum of 10-feet for each additional underground or overhead utility placed within the easement.
- (2) The center of public sewer or force mains shall be a minimum of 10-feet from the easement line for 20-foot easement widths.
- (3) The outside of public sewer or force mains shall be a minimum of 10-feet from the easement line and/or underground utilities in the easement, unless otherwise approved by Agency.
- (4) The minimum distance from public sewer or force mains to easement lines or other utilities shall be increased by 1-foot for each foot of depth to pipe invert for pipes greater than 10-foot deep.
- (5) Easement widths shall also be increased as directed by the Agency to provide sufficient clearance from walls, structures and other site improvement objects placed on property adjacent to easement.

TABLE "B"

INSPECTION CHARGE
STATEMENT OF AUTHORIZATION AND RESPONSIBILITY

Inspection Charge Authorization

(Agency Name)	Date: _____
	Sat. Sun. _____
(Street Address)	Holiday _____
	Week Day _____
(City-State-Zip Code)	

Job No.	Job Title	Overtime Worked
---------	-----------	-----------------

Permittee or Contractor _____

Type of Work Constructed During Overtime _____

Contractor's Reason for Working Overtime _____

/

Inspector's Signature	Contractor's Signature
-----------------------	------------------------

Should the Contractor desire to work outside the established normal working hours, as established by each Agency (five days a week, eight hours each day, or as established by the Agency), for which the Agency is required to pay overtime, with prior approval from the Agency, he may do so by notifying the Agency's Representative forty-eight (48) hours in advance of the additional hours to be worked, and by paying an overtime inspection fee as established by each Agency, for each hour or each portion of each hour thereof, to provide for an inspector to be present. The Contractor will be required to sign this document which constitutes approval of an overtime inspection fee. Callouts after hours will be charged a minimum of three (3) hours overtime. The Contractor will also be required to pay overtime charges for any Agency approved holidays.

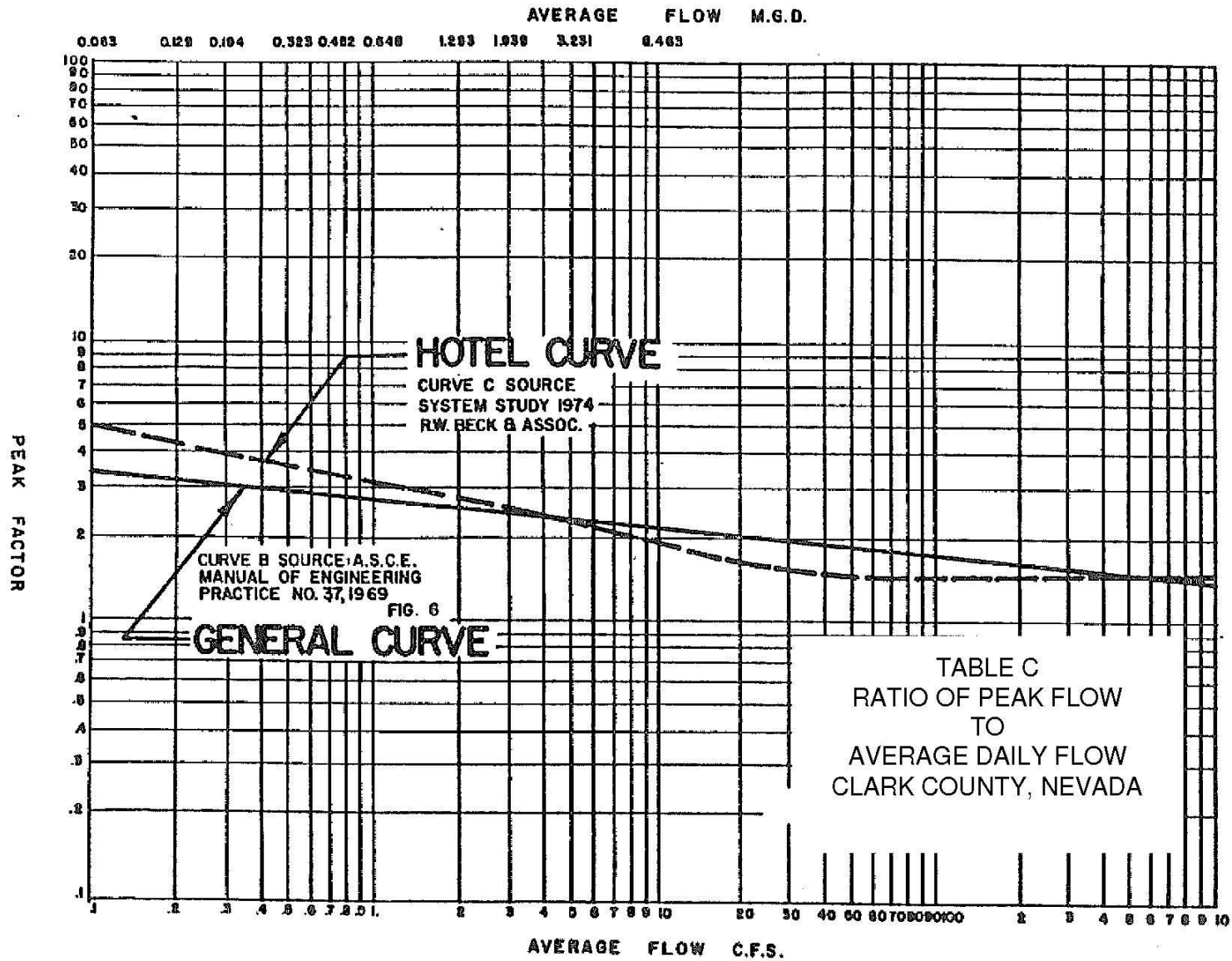


TABLE "D"

MINIMUM REQUIRED AND MAXIMUM PERMITTED PIPE SLOPES

Pipe Diameter (Inches)	Minimum Flow Rate (Cu Ft Per Sec) To Achieve a 50% Full Pipe at Min Slope	Minimum Slope (Feet per Foot) to Achieve a Velocity of 2 FPS at Pipe 50% full	Maximum Flow Rate (Cu Ft Per Sec) to Limit Depth to 75% Full Pipe at Max Slope	Maximum Slope (Feet per Foot) To Limit Velocity to 10 FPS at Pipe 75% Full
Laterals – Range of Pipe Slopes Permitted (flow rates and velocities not considered)				
4	Refer to Uniform Plumbing Code			
6	Refer to Uniform Plumbing Code			
8	Refer to Uniform Plumbing Code			
Public and Private Collector Sewers – having insufficient tributary flow to achieve half-full flow depth at peak dry weather flow rate from the tributary area				
≥ 8	(Not Applicable)	0.0060	(Not Applicable)	(Not Applicable)
Public Interceptors, Public Collector Sewers and Private Collector Sewers in a cul-de-sac, or where public sewer will not be extended (See Section 2.3.3)				
≥ 8	(Not Applicable)	0.010	(Not Applicable)	(Not Applicable)
Public Interceptors, Public Collector Sewers and Private Collector Sewers having sufficient tributary flow to achieve at least a half-full flow depth at the peak dry weather flow rate from the tributary area				
8	0.40	0.0040	3.21	0.0646
10	0.55	0.0025	5.02	0.0479
12	0.79	0.0020	7.23	0.0376
15	1.23	0.0015	11.29	0.0279
18	1.77	0.0012	16.26	0.0219
21	2.40	0.0010	22.13	0.0178
24	3.14	0.0010	28.90	0.0149
>24	Per Agency requirements			

The Agency will review the proposed slopes for larger pipes and pipes that will exceed the above maximum slope values on a case-by-case basis. Sewers at slopes less than the minimum slopes listed in Table "D" will not be permitted.

Table "E"

_____	(Agency Name)
_____	(Street Address)
_____	(City/State/Zip)
_____	(Telephone No.)

LIFT STATION DATA SHEET

GENERAL:

- 1. Owner's Name : _____
- 2. Plant Location : _____
- 3. Elevation Above Sea Level : _____
- 4. Type of Service : _____

LIFT STATION:

- 1. Manufactured By : _____
- 2. Manufacturer's Designation : _____
- 3. Manufacturer's Serial Number : _____
- 4. Size Suction: Nominal : _____ in.
- Actual : _____ in.
- 5. Size Discharge: Nominal : _____ in.
- Actual : _____ in.

INTERMEDIATE :

- 1. Manufactured By : _____
- 2. Type : _____
- 3. Serial Number : _____
- 4. Speed Ratio : _____
- 5. Efficiency : _____

DRIVER:

- 1. Manufactured By : _____
- 2. Serial Number : _____
- 3. Rated Horsepower : _____
- 4. Rated Speed : _____
- 5. Characteristics : _____
(voltage, frequency, etc.)

RATED CONDITIONS:

- 1. Capacity : _____ gpm.
- 2. Total Suction Lift (h_s) : _____ ft.
- Head (h_s) : _____ ft.
- 3. Net Positive Suction Head (NPSH) : _____ ft.
- 4. Total Discharge Head (H_d) : _____ ft.
- 5. Total Head (H) : _____ ft.
- 6. Liquid Horsepower (whp) : _____ hp.
- 7. Efficiency (E_p) : _____ percent
- 8. Brake Horsepower (bhp) : _____ hp.
- 9. Speed : _____ rpm.

ATTACHMENTS:

- 1. Pump Curves
- 2. Shop Drawings of Station Before Approval for Construction
- 3. Manufacturer's Specifications
- 4. Electrical Diagrams

Table "F"

BACKFILL MATERIALS

Backfill Materials shall conform to the requirements of Sections 207, 208 and 704 of the Uniform Standard Specifications for Public Works Construction Off-Site Improvements latest edition as referenced below.

TYPE II MATERIAL: Type II material shall conform to Section 704.03.04 and to the following requirements:

<u>Gradation:</u>	<u>Sieve Sizes</u>	<u>Percentage by Dry Weight Passing Sieve</u>
	1 inch	100
	¾ inch	90 – 100
	No. 4	35 – 65
	No. 16	15 – 40
	No. 200	2 – 10
<u>Plastic Limits:</u>	<u>Percentage by Weight Passing No. 200 Sieve</u>	<u>Plasticity Index Maximum</u>
	0.1 to 3.0	15
	3.1 to 4.0	12
	4.1 to 5.0	9
	5.1 to 8.0	6
	8.1 to 11.0	4
	11.1 to 15.0	3

GRANULAR BACKFILL: Granular material shall conform to Section 207.02.02 and the following requirements:

<u>Gradation:</u>	<u>Sieve Sizes</u>	<u>Percentage of Weight Passing</u>
	3 inch	100
	No. 4	35 – 100
	No. 16	25 – 100
	No. 200	5 – 15

Plastic Limits: As specified for Type II material above.

Table "F" (Continued)

BACKFILL MATERIALS

SELECTED BACKFILL: Selected backfill shall conform to Section 207.02.01 and the following requirements:

<u>Gradation:</u>	<u>Sieve Sizes</u>	<u>Percentage of Weight Passing</u>
	6 inch	100 *
	3 inch	80 – 100
	No. 4	35 – 100

* Stones or lumps greater than 3 inches in diameter shall not be used within the zone 12 inches from the pipe, structure or finished subgrade.

<u>Plastic Limits:</u>	<u>Percentage by Weight Passing No. 200 Sieve</u>	<u>Plasticity Index Maximum</u>
	0 – 10.0	15
	10.0 – 20.0	12
	20.1 – 50.0	10
	50.1 – 80.0	8
	80.1 – 100.0	6

Liquid Limit: LL = Maximum 50

CRUSHED ROCK: Crushed rock is material that conforms to Section 704.03.06 and the following gradation:

63% fracture one side. 30% fractured two sides.

<u>Screen or Sieve Sizes</u>	<u>Percent Passing</u>
3/8 inch	0 – 100
No. 4	20 – 80
No. 200	0 – 15

SAND: Sand is material that conforms to Section 208.02.04 and the following gradation:

<u>Sieve Sizes</u>	<u>Percent Passing</u>
3/8	100
#4	80 – 100
#200	5 – 20

TABLE "G"

COMPACTION TESTING

QUALITY CONTROL FOR TRENCH BACKFILL COMPACTION

TEST AREA	MINIMUM TEST FREQUENCY
Pipe bedding materials	1 per 200 L.F. of trench (and each branch or section of trench less than 450 feet in length) for each 2-feet of vertical depth of backfill at the location(s) as directed by the Agency.
Pipe haunching materials	
Pipe trench backfill from haunching to subgrade	
Subgrade	As required by controlling Agency at the location(s) as directed by the Agency.
Subgrade of all Agency structures (manholes, catch basins, valves, vaults, etc.)	1 per each 2 foot vertical depth of backfill around structure perimeter at the location(s) as directed by the Agency.
Backfill of all structures (manholes, catch basins, valves, vaults, siphon structures, pump stations, and other sanitary system facilities installed by the Contractor.)	

TABLE "H"

LOW PRESSURE AIR TEST FOR GRAVITY SEWER LINES

MINIMUM TEST TIMES FOR PLASTIC PIPE

Pipe Dia, in.	Min Time, min's	Length for Min Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s								
				100	150	200	250	300	350	400	450	
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	230:46

Table data from ASTM F 1417-92

MINIMUM TEST TIMES FOR VITRIFIED CLAY OR OTHER PIPE

Nominal Pipe Size, in.	T (time), min/100 ft.	Nominal Pipe Size, in.	T (time), min/100 ft.
48	8.50	21	3.00
4	0.30	24	3.60
6	0.70	27	4.20
8	1.20	30	4.80
10	1.50	33	5.40

Table data from ASTM C 828-03

TABLE "I"

FORCE MAIN ALLOWABLE LEAKAGE DURING TESTING

ALLOWABLE LEAKAGE PER 1000 FT. OF PIPELINE DUCTILE IRON (gph)

Ave Test Press, psi	Nominal Pipe Diameter, in.																
	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	0.57	0.86	1.15	1.43	1.72	2.01	2.29	2.58	2.87	3.44	4.30	5.16	6.02	6.88	7.74	8.60	9.17
400	0.54	0.81	1.08	1.35	1.62	1.89	2.16	2.43	2.70	3.24	4.05	4.86	5.68	6.49	7.30	8.11	8.65
350	0.51	0.76	1.01	1.26	1.52	1.77	2.02	2.28	2.53	3.03	3.79	4.55	5.31	6.07	6.83	7.58	8.09
300	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62	6.32	7.02	7.49
275	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38	6.05	6.72	7.17
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13	5.77	6.41	6.84
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86	5.47	6.08	6.49
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59	5.16	5.73	6.12
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22	3.75	4.29	4.83	5.36	5.72
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98	3.48	3.97	4.47	4.97	5.30
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72	3.17	3.63	4.08	4.53	4.83
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43	2.84	3.24	3.65	4.05	4.32

Table data from AWWA C600-05

ALLOWABLE LEAKAGE PER 1000 FT. OF PIPELINE PVC (gph)

Average Test Pressure, psi	Nominal Pipe Diameter, in.													
	4	6	8	10	12	14	16	18	20	24	30	36	42	48
300	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62
275	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22	3.75	4.29
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98	3.48	3.97
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72	3.17	3.63
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43	2.84	3.24
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40	1.76	2.11	2.46	2.81
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15	1.43	1.72	2.01	2.29

Table data from AWWA C605-05

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**DESIGN AND CONSTRUCTION
STANDARDS**

SECTION 7

INDEX

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INDEX TO DESIGN AND CONSTRUCTION STANDARDS

A

- Abandonment of Existing Facilities, (3-34)
 - Main Lines and Laterals, (3-34)
 - Method b (Excavate and Remove Line), (3-34)
 - Method c (Pressure Grout Line), (3-35)
 - Method d (Cured In Place Sectional Liner), (3-36)
 - Manholes, (3-36)
 - Method a (Existing Sewer to be Abandoned), (3-36)
 - Method b (Existing Sewer to be Abandoned case by case), (3-37)
 - Method c (Existing Sewer to Remain), (3-37)
 - Method d (Existing Sewer to Remain case by case), (3-37)
- Abbreviations, (1-5)
- Additional Requirements for Manhole Bases, (Manholes and Manhole Appurtenances), (2-24)
- Additional Requirements for Pre-Cast Concrete Grade Rings, (Manholes and Manhole Appurtenances), (2-25)
- Additional Requirements for Pre-Cast Concrete Section and Grade Ring Joints, (Manholes and Manhole Appurtenances), (2-26)
- Additional Services Areas (Definitions), (1-2)
- Aerial Crossings, (Design Criteria for Force Mains), (2-31)
- Aerial Crossings of Sanitary Sewers and Air Jumper Pipes, (Other Utility Crossings and Clearances and Separations), (2-15)
- Agency Notice of Operation, (Bypass Pumping), (3-8)
- Agency Pipeline Encroachment – Blasting, (3-9)
 - Agency Representation, (3-10)
 - Blaster Qualifications, (3-10)
 - Blasting Monitoring, (3-10)
 - Blasting Plan, (3-9)
 - Blasting Plan Modifications, (3-10)
 - Contractor Responsibility for Blasting, (3-9)
 - Existing Facility Inspection, (3-9)
 - Independent Blasting Consultant, (3-10)
- Agency Representation, (Agency Pipeline Encroachment – Blasting), (3-10)
- Agency's Representative, (Definitions), (1-2)
- Air Relief Valves, (Design Criteria for Force Mains), (2-30)
- All Other Provisions, (Pipe Bedding), (3-15)
- Approval of New Materials, (4-1)
- Approved Materials, (1-10)
- Assembling Pre-Cast Concrete Manhole Components, (Manhole and Cast-in-Place Structure Installation), (3-25)

B

- Backwater Valves (Design Criteria for Gravity Sewers), (2-29)
- Blasting Monitoring, (Agency Pipeline Encroachment – Blasting), (3-10)
- Blasting Plan, (Agency Pipeline Encroachment – Blasting), (3-9)
- Blasting Plan Modifications, (Agency Pipeline Encroachment – Blasting), (3-10)
- Blaster Qualifications, (Agency Pipeline Encroachment – Blasting), (3-10)
- Bond Release, (3-43)
- Boring or Jacking Sewer Pipe, (Design Criteria for Gravity Sewers), (2-18)
- Bypass Pumping Capacity, (Bypass Pumping System), (3-6)
- Bypass Pumping Plan, (Bypass Pumping System), (3-5)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

- Bypass Pumping System, (Bypass Pumping System), (3-6)
- Bypass Pumping System, (3-5)
 - Agency Notice of Operation, (3-8)
 - Bypass Pumping Plan, (3-5)
 - Bypass Pumping System, (3-6)
 - Bypass Pumping Capacity, (3-6)
 - Odor Control Requirements, (3-6)
 - Pumping Equipement, (3-6)
 - Bypass System Maintenance and Operation, (3-8)
 - Bypass System Power Source, (3-8)
 - Bypass System Traffic Protection, (3-8)
 - Noise Attenuation, (3-7)
 - Prohibition Against Sanitary System Overflows, (3-7)
 - Use of New Sanitary Sewers, (3-7)
- Bypass System Maintenance and Operation, (Bypass Pumping System), (3-8)
- Bypass System Power Source, (Bypass Pumping System), (3-8)
- Bypass System Traffic Protection, (Bypass Pumping System), (3-8)

C

- Calculation of Peak Wastewater Flow, (Design Criteria for Gravity Sewers), (2-4)
- Cast-in-Place Concrete Structures, (Manhole and Cast-in-Place Structure Installation), (3-26)
- Cement / Concrete, (4-3)
 - Concrete, (4-3)
 - Controlled Low Strength Material (CLSM), (4-3)
- Certificate of Occupancy, (3-43)
- Certifications of Installation Procedures, (3-3)
- Changes of Flow Direction Within Manholes, (Manholes and Manhole Appurtenances), (2-25)
- CIP & DIP, (Tapping Requirements), (3-33)
- Complete, Bound, Signed / Sealed Document Sets Required, (Construction Document Requirements), (2-32)
- Concrete, (Cement / Concrete), (4-3)
- Conditions Requiring a Standard Manhole, (Design Criteria for Gravity Sewers), (2-21)
- Connections to Manholes, (Manholes and Manhole Appurtenances), (2-26)
- Construction Document Requirements, (2-32)
 - Complete, Bound, Signed / Sealed Document Sets Required, (2-32)
 - Data Sheet Required, (2-33)
 - Final Document Submittal, (2-33)
 - Full Civil Improvement Drawings Required, (2-33)
 - Minimum Drawing Guidelines, (2-33)
 - Project Description Required, (2-32)
 - Sanitary Sewer Capacity Analysis, (2-32)
- Construction/Contract Document, (Definitions), (1-2)
- Construction Drawings, (Definitions), (1-2)
- Construction Staking, (3-4)
- Contractor, (Definitions), (1-2)
- Contractor's License, (3-1)
- Contractor's Responsibility, (3-1)
- Contractor Responsibility for Blasting, (Agency Pipeline Encroachment – Blasting), (3-9)
- Corrosion Protection, (Manholes and Manhole Appurtenances), (2-26)
- Controlled Low Strength Material (CLSM), (Cement / Concrete), (4-3)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

Corrosion Protection (as Required by Agency), (Manhole and Cast-in-Place Structure Installation), (3-29)
Curved Sewers, (Design Criteria for Gravity Sewers), (2-8)
Curvilinear Sewers, (Pipe Installation), (3-21)
Cut Sheets, (3-3)

D

Data Sheet Required, (Construction Document Requirements), (2-33)
Damage to Existing Sewers During Lateral Connection Installation, (Lateral Sewer Connections), (3-32)
Debris Trap, (Pipe Installation), (3-22)
Debris Trap, (Manhole and Cast-in-Place Structure Installation), (3-31)
Deep Manholes (Manholes), (2-20)
Definitions, (1-2)
 Additional Service Areas, (1-2)
 Agency's Representative, (1-2)
 Construction/Contract Document, (1-2)
 Construction Drawings, (1-2)
 Contractor, (1-2)
 Design and Construction Standards, (1-2)
 Developer, (1-2)
 Director/General Manager, (1-3)
 Engineer, (1-3)
 Equivalent Residential Unit (ERU), (1-3)
 Lateral, (1-3)
 Participating Agency or Agency, (1-3)
 Peak Dry Weather Flow, (1-4)
 Peak Wet Weather Flow, (1-4)
 Private Collector Sewer, (1-4)
 Project, (1-4)
 Public Interceptor Sewer and Public Collector Sewer, (1-4)
 Pump Station / Lift Station, (1-5)
Deflection Testing, (Testing), (3-40)
Depth, (Design Criteria for Force Mains), (2-30)
Design and Construction Standards, (Definitions), (1-2)
Design Criteria for Gravity Sewers, (2-4)
 Backwater Valves, (2-29)
 Boring or Jacking Sewer Pipe, (2-18)
 Calculation of Peak Wastewater Flow, (2-4)
 Conditions Requiring a Standard Manhole, (2-21)
 Curved Sewers, (2-8)
 Lateral Connections Into Collector Sewers and Manholes, (2-13)
 Lateral Connection General Requirements, (2-13)
 Lateral Connections to Main Greater than 21-inch Diameter, (2-14)
 Lateral Connection to Manholes, (2-14)
Main Sewer Stub-Outs, (2-9)
Manholes, (2-19)
 Standard Manholes, (2-19)
 Shallow Manholes, (2-20)
 Deep Manholes, (2-20)
 Drop Manholes, (2-20)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

- Monitoring, Pretreatment Sampling and Debris Screen Manholes, (2-21)
- Manhole and Main Line Locations, (2-28)
 - Main Line Locations, (2-28)
 - Manhole Locations, (2-28)
- Manholes and Manhole Appurtenances, (2-23)
 - Additional Requirements for Manhole Bases, (2-24)
 - Additional Requirements for Pre-Cast Concrete Grade Rings, (2-25)
 - Additional Requirements for Pre-Cast Concrete Section and Grade Ring Joints, (2-26)
 - Changes of Flow Direction Within Manholes, (2-25)
 - Connections to Manholes, (2-26)
 - Corrosion Protection, (2-26)
 - Frames and Covers, (2-26)
 - Odor Control Equipment, (2-27)
 - Pre-Cast Manhole Sections, (2-23)
- Manhole Diameters, (2-22)
- Maximum Distance Between Manholes, (2-22)
- Other Utility Crossings and Separations, (2-15)
 - Aerial Crossings of Sanitary Sewers and Air Jumper Pipes, (2-15)
 - Parallel Installation of Sanitary Sewers and Other Utilities, (2-16)
 - Vertical Crossings, (2-15)
- Pipe Size Requirements, (2-4)
 - Public Interceptors, Public Collectors & Private Collector Sewers, (2-4)
 - Laterals, (2-4)
 - Private Collector Sewers & Laterals, (2-5)
 - Public Force Mains, (2-5)
- Pipe Slope Requirements, (2-6)
 - Public Interceptors, Public Collectors & Private Collector Sewers, (2-6)
 - Terminal Main Sewers in Cul-de-Sacs (less than 450 feet), (2-7)
 - Terminal Main Sewers (multiple segments totaling more than 450 feet), (2-7)
 - Laterals, (2-7)
- Sewer Line Depths and Alignments, (2-9)
 - General, (2-10)
 - Sewer Main (Greater than 20 feet deep), (2-10)
- Sewer Main Connections, (2-12)
- Sewer Trenches, (2-12)
- Shallow Mains and Laterals, (2-11)
- Siphons, (2-16)
- Water and Sewer Utility Crossings and Clearances, (2-14)
- Design Criteria for Force Mains, (2-29)
 - Aerial Crossings, (2-31)
 - Air Relief Valves, (2-30)
 - Depth, (2-30)
 - Design Pressure, (2-31)
 - Discharge Pipe, (2-30)
 - Effluent Reuse Pipe Lines, (2-31)
 - Flow Velocity Requirements, (2-29)
 - Hydraulic Losses, (2-31)
 - Slope, (2-30)
 - Termination, (2-30)
 - Thrust Blocks, (2-31)
- Design Criteria for Pumping Stations, (2-29)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

Design Pressure, (Design Criteria for Force Mains), (2-31)
Developer, (Definitions), (1-2)
Development Requirements, (2-2)
 Point of Connection, (2-2)
 Full Frontage Extension, (2-2)
 Right of Ways and Easements, (2-2)
 Right of Ways, (2-2)
 Easements, (2-2)
Dewatering, (Earthwork), (3-13)
Director/General Manager, (Definitions), (1-3)
Discharge Pipe, (Design Criteria for Force Mains), (2-30)
Drop Manholes, (Manholes), (2-20)
Ductile Iron Pipe, (Pipe Installation), (3-21)
Duties of Agency's Representative, (Inspection), (1-6)

E

Earthwork, (3-11)
 Dewatering, (3-11)
 Excavation, (3-11)
 Pipe Bedding, (3-14)
 Pipe Bedding (Flexible Pipe), (3-14)
 Pipe Bedding (Rigid Pipe), (3-14)
 All Other Provision, (3-15)
 Pipe Zone Backfill, (3-15)
 Pipe Zone Backfill (Flexible Pipe), (3-15)
 Pipe Zone Backfill (Rigid Pipe), (3-16)
 Trench Backfill, (3-17)
 Granular Backfill, (3-17)
 Selected Backfill Material, (3-18)
 Paved Areas(See Standard Drawing No. SD-17 & SD-18), (3-18)
 Unpaved Areas (See Standard Drawing No. SD-16), (3-18)
 Nevada State Right-of-Ways, (3-19)
Easements, (Right of Ways and Easements), (2-2)
Effluent Reuse Pipe Lines, (Design Criteria for Force Mains), (2-31)
Engineer, (Definitions), (1-3)
Equivalent Residential Unit (ERU), (Definitions), (1-3)
Excavation, (Earthwork), (3-11)
Excavation and Backfilling, (Manhole and Cast-in-Place Structure Installation), (3-29)
Existing Facility Inspection, (Agency Pipeline Encroachment – Blasting), (3-9)
Exterior Waterproofing, (Manhole and Cast-in-Place Structure Installation), (3-29)

F

Final Acceptance, (3-42)
Final Document Submittal, (Construction Document Requirements), (2-33)
Final Manhole/Structure Adjustment, (Assembling Pre-Cast Concrete Manhole Components) (3-26)
Flow Velocity Requirements, (Design Criteria for Force Mains), (2-29)
Frame and Cover Installation, (Manhole and Cast-in-Place Structure Installation), (3-28)
Frames and Covers, (Manholes and Manhole Appurtenances), (2-26)
Full Civil Improvement Drawings Required, (Construction Document Requirements), (2-33)
Full Frontage Extension, (Development Requirements), (2-2)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

G

Gas Phase and Liquid Phase Odor Control Equipment, (Odor Control Equipment), (4-3)
General, (Pipe Installation), (3-20)
General, (Sewer Line Depths and Alignments), (2-10)
General Information, (2-1)
General Statement, (1-1)
Grade Lines, (3-4)
Grade Ring Joints, (Assembling Pre-Cast Concrete Manhole Components) (3-26)
Granular Backfill, (Trench Backfill), (3-17)
Gravity Sewers & Appurtenances – Initial Acceptance, (Testing), (3-38)
Groundwater, (Pipe Installation), (3-21)
Guarantee, (1-9)

H

Handling Materials, (4-2)
Hydraulic Losses, (Design Criteria for Force Mains), (2-31)

I

Indemnity, (1-8)
Independent Blasting Consultant, (Agency Pipeline Encroachment – Blasting), (3-10)
Inspection, (1-6)
 Duties of Agency's Representative, (1-9)
 Inspection of Work, (1-7)
 Scheduling of Inspection, (1-8)
Inspection of Work, (Inspection), (1-7)

J

Job Start Check List, (3-2)

L

Lateral, (Definitions), (1-3)
Laterals, (Pipe Size Requirements), (2-5)
Laterals, (Pipe Slope Requirements), (2-7)
Lateral Connections Into Collector Sewers and Manholes, (Design Criteria for Gravity Sewers), (2-13)
Lateral Connection General Requirements, (Lateral Connections Into Collector Sewers and Manholes), (2-13)
Lateral Connections to Existing Sewers, (Lateral Sewer Connections), (3-32)
Lateral Connection to Main Greater than 21-inch Diameter, (Lateral Connections Into Collector Sewers and Manholes), (2-14)
Lateral Connection to Manholes, (Lateral Connections Into Collector Sewers and Manholes), (2-14)
Lateral Connections to New Sewers, (Lateral Sewer Connections), (3-32)
Lateral Sewer Connections, (3-31)
 Damage to Existing Sewers During Lateral Connection Installation, (3-32)
 Lateral Connections to Existing Sewers, (3-32)
 Lateral Connections to New Sewers, (3-32)
 Tapping Requirements, (3-33)
 CIP & DIP, (3-33)
 NRCP & ACP, (3-33)
 PVC, FRP & HDPE, (3-34)
 RCP, (3-34)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

VCP, (3-33)
Locations of Existing Utilities and Site Objects, (1-6)
Low-Pressure Air Testing, (Gravity Sewers & Appurtenances – Initial Acceptance), (3-38)

M

Main Lines and Laterals, (Abandonment of Existing Facilities), (3-34)
Main Line Locations, (Manhole and Main Line Locations), (2-28)
Main Sewer Stub-Outs, (Design Criteria for Gravity Sewers), (2-9)
Manhole and Cast-in-Place Structure Installation, (3-24)
 Assembling Pre-Cast Concrete Manhole Components, (3-25)
 Grade Ring Joints, (3-26)
 Final Manhole/Structure Adjustment, (3-26)
 Pre-Cast Manhole Sections, (3-26)
 Cast-in-Place Concrete Structures, (3-26)
 Corrosion Protection (as Required by Agency), (3-29)
 Manhole and Cast-in-Place Structure Corrosion Protection – Field-Applied Coating Systems, (3-30)
 Manhole Corrosion Protection – Factory-Installed Coatings, (3-29)
 Manhole Corrosion Protection – Polymer Manholes, (3-31)
 Debris Trap, (3-31)
 Excavation and Backfilling, (3-29)
 Exterior Waterproofing, (3-29)
 Frame and Cover Installation, (3-28)
 Manhole Base Construction, (3-24)
 Odor Control Equipment, (3-31)
 Pipe Connection Installation, (3-27)
Manhole Base Construction, (Manhole and Cast-in-Place Structure Installation), (3-24)
Manhole and Cast-in-Place Structure Corrosion Protection – Field-Applied Coating Systems, (Corrosion Protection (as required by Agency), (3-30)
Manhole Corrosion Protection – Factory-Installed Coatings, (Corrosion Protection (as required by Agency), (3-29)
Manhole Corrosion Protection – Polymer Manholes, (Corrosion Protection (as required by Agency), (3-31)
Manhole Diameters, (Design Criteria for Gravity Sewers), (2-22)
Manholes, (Abandonment of Existing Facilities), (3-36)
Manholes, ((Design Criteria for Gravity Sewers), (2-19)
Manholes and Manhole Appurtenances, (Design Criteria for Gravity Sewers), (2-23)
Manhole and Main Line Locations, (Design Criteria for Gravity Sewers), (2-28)
Manhole Locations, (Manhole and Main Line Locations), (2-28)
Manhole Visual Inspection & Corrosion Protection - Holiday Testing, (Testing), (3-39)
Marker Balls, (Pipe Installation), (3-23)
Maximum Distance Between Manholes, (Design Criteria for Gravity Sewers), (2-22)
Method a (Existing Sewer to be Abandoned), (Manholes), (3-36)
Method b (Excavate and Remove Line), (Main Lines and Laterals), (3-34)
Method b (Existing Sewer to be Abandoned case by case), (Manholes), (3-37)
Method c (Existing Sewer to Remain), (Manholes), (3-37)
Method c (Pressure Grout Line), (Main Lines and Laterals), (3-35)
Method d (Cured In Place Sectional Liner), (3-36)
Method d (Existing Sewer to Remain case by case), (Manholes), (3-37)
Minimum Drawing Guidelines, (Construction Document Requirements), (2-33)
Monitoring, Pretreatment Sampling, and Debris Screen Manholes, (Manholes), (2-21)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

N

Nevada State Right-of-Ways, (Trench Backfill), (3-19)
Noise Attenuation, (Bypass Pumping System), (3-7)
NRCP & ACP, (Tapping Requirements), (3-33)

O

Odor Control Equipment, (4-3)
 Gas Phase and Liquid Phase Odor Control Equipment, (4-3)
 Odor Control Manhole Inserts, (4-3)
Odor Control Equipment, (Manholes and Manhole Appurtenances), (2-27)
Odor Control Equipment, (Manhole and Cast-in-Place Structure Installation), (3-31)
Odor Control Manhole Inserts, (Odor Control Equipment), (4-3)
Odor Control Requirements, (Bypass Pumping System), (3-6)
Other Utility Crossings and Separations, (Design Criteria for Gravity Sewers), (2-15)

P

Parallel Installation of Sanitary Sewers and Other Utilities, (Other Utility Crossings and Separations), (2-16)
Participating Agency or Agency, (Definitions), (1-3)
Paved Areas (See Standard Drawings No. SD-17 & SD-18), (Trench Backfill), (3-18)
Peak Dry Weather Flow, (Definitions), (1-4)
Peak Wet Weather Flow, (Definitions), (1-4)
Pipe Bedding, (Earthwork), (3-14)
Pipe Bedding (Flexible Pipe), (Pipe Bedding), (3-14)
Pipe Bedding (Rigid Pipe), (Pipe Bedding), (3-14)
Pipe Connection Installation, (Manhole and Cast-in-Place Structure Installation), (3-27)
Pipe Installation, (3-19)
 Curvilinear Sewers, (3-21)
 Debris Traps, (3-22)
 Ductile Iron Pipe, (3-21)
 General, (3-20)
 Groundwater, (3-21)
 Marker Balls, (3-23)
 Pipe Locator Ribbon, (3-22)
 Plugs, (3-23)
Pipe Locator Ribbon, (Pipe Installation), (3-22)
Pipe Locator Ribbon and Marker Balls, (4-3)
 Locator Ribbon for All Buried Sanitary System Pipes, (4-3)
 Metallic Locator Ribbon for Force Mains and Reuse Pipes, (4-3)
Pipe Size Requirements, (Design Criteria for Gravity Sewers), (2-4)
Pipe Slope Requirements, (Design Criteria for Gravity Sewers), (2-6)
Pipe Zone Backfill, (Earthwork), (3-15)
Pipe Zone Backfill Operations (Flexible Pipe), (Pipe Zone Backfill), (3-16)
Pipe Zone Backfill (Rigid Pipe), (Pipe Zone Backfill), (3-15)
Plugs, (Pipe Installation), (3-23)
Point of Connection, (Development Requirements), (2-2)
Pre-Cast Manhole Sections, (Manholes and Manhole Appurtenances), (2-23)
Pre-Cast Manhole Sections, (Assembling Pre-Cast Concrete Manhole Components) (3-26)
Pretreatment Requirements, (1-10)
Private Collector Sewer, (Definitions), (1-4)
Private Collector Sewers & Laterals, (Pipe Size Requirements), (2-5)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

Prohibition Against Sanitary System Overflows, (Bypass Pumping), (3-7)
Project, (Definitions), (1-2)
Project Description Required, (Construction Document Requirements), (2-32)
Public Force Mains, (Pipe Size Requirements), (2-5)
Public Interceptor Sewer and Public Collector Sewer, (Definitions), (1-4)
Public Interceptors, Public Collectors & Private Collector Sewers, (Pipe Size Requirements), (2-4)
Public Interceptors, Public Collectors & Private Collector Sewers, (Pipe Slope Requirements), (2-6)
Sewer and Public Collector Sewer, (Definitions), (1-4)
Pump Station / Lift Station, (Definitions), (1-5)
Pumping Equipment, (Bypass Pumping System), (3-6)
PVC, FRP & HDPE, (Tapping Requirements), (3-34)

R

RCP, (Tapping Requirements), (3-34)
Record Drawings, (3-4)
Reference to Standards and Publications, (1-5)
Reinforcing Steel, (4-4)
Right-of-Ways and Easements, (Development Requirements), (2-2)
Right of Ways, (Right of Ways and Easements), (2-2)
Right-of-Way Encroachments, (3-2)
Rules and Regulations, (1-9)

S

Sanitary Sewer Capacity Analysis, (Construction Document Requirements), (2-32)
Sanitary System Construction – Initial Acceptance, (Testing), (3-37)
Schedule of Inspection, (Inspection), (1-8)
Selected Backfill Material, (Trench Backfill), (3-18)
Sewer Cleaning, (Testing), (3-40)
Sewer Line Depths and Alignments, (Design Criteria for Gravity Sewers), (2-9)
Sewer Main (Greater than 20 feet deep), (Sewer Line Depths and Alignments), (2-10)
Sewer Main Connections, (Design Criteria for Gravity Sewers), (2-12)
Sewer Televising, (Testing), (3-41)
Sewer Trenches, (Design Criteria for Gravity Sewers), (2-12)
Shallow Mains and Laterals, (Design Criteria for Gravity Sewers), (2-11)
Shallow Manholes, (Manholes), (2-20)
Siphons, (Design Criteria for Gravity Sewers), (2-16)
Slope, (Design Criteria for Force Mains), (2-30)
Soil Testing, (3-23)
Source of Materials and Quality, (4-1)
Standard Drawings, (1-34)
 Above Grade Air Relief Valves, **SD-29**, (Section 5)
 Approved Trap for Sewer Line Construction, **SD-27**, (Section 5)
 Below Grade Air Relief Valves, **SD-28**, (Section 5)
 Bollard Detail (Removable, Locking), **SD-34**, (Section 5)
 Cast-in-Place Manhole Base Installed in Existing Sewer, **SD-7**, (Section 5)
 Deep Lateral Connection, **SD-25**, (Section 5)
 Force Main Connections to Sewer Manhole, **SD-10**, (Section 5)
 Force Main Connections to Public Sewer Manhole, **SD-11**, (Section 5)
 Grade Ring Sequence, **SD-5**, (Section 5)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

Lateral Cleanout, **SD-24**, (Section 5)
Lateral Connection to Sewer Main 21" Dia and Smaller, **SD-20**, (Section 5)
Lateral Connections to Sewer Mains 21" Dia and Smaller Around Obstructions, **SD-21**, (Section 5)
Lateral Connections to Sewer Mains 21" and Larger, **SD-22**, (Section 5)
Manhole Concrete Collar, **SD-4**, (Section 5)
Manhole Cover-Securing Device, **SD-6**, (Section 5)
Pipe Bedding Methods, **SD-14**, (Section 5)
Pipe Bedding, Haunch Support and Initial Cover, **SD-15**, (Section 5)
Pretreatment Sampling Manhole, **SD-31**, (Section 5)
Protection of Sanitary Sewer Under a Utility, **SD-19**, (Section 5)
Protection of Sanitary Sewer or Lateral Over a Utility, **SD-18**, (Section 5)
Removal of Existing Manhole, **SD-8**, (Section 5)
Rigid Pipe Field Closure, **SD-30**, (Section 5)
Sewer Lateral Marker, **SD-23**, (Section 5)
Special Manholes-Agency Authorization Required, **SD-12**, (Section 5)
Special Shallow Manholes, **SD-13**, (Section 5)
Standard Concentric Dual Manhole Cover and Frame, **SD-2**, (Section 5)
Standard Manhole Cover and Ring, **SD-3**, (Section 5)
Standard Pre-Cast Manhole, **SD-1**, (Section 5)
Trench Section for Sewer Mains Within Subdivision and Unpaved Areas, **SD-16**, (Section 5)
Typical Flow Channel Details, **SD-9**, (Section 5)
Typical Force Main Clean-Out, **SD-33A**, (Section 5)
Typical Force Main Clean-Out, **SD-33B**, (Section 5)
Typical Sewer Easement Requiring Block Walls, **SD-26A**, (Section 5)
Typical Sewer Easements Requiring Block Walls, **SD-26B**, (Section 5)
Typical Siphon Inlet Structure, **SD-32B**, (Section 5)
Typical Siphon Outlet Structure, **SD-32A**, (Section 5)
Typical Trench Section for Paved Areas, **SD-17**, (Section 5)
Standard Manholes, (Manholes), (2-19)
Standard Specifications, (3-1)
Storage of Materials, (4-1)
 Testing Re-Certification, (4-1)

I

Tables

Backfill Materials, **Table G**, (T-7)
Compaction Testing, **Table H**, (T-9)
Easement Widths, **Table A**, (T-1)
Force Main Allowable Leakage, **Table J**, (T-11)
Inspection Charge Statement of Authorization and Responsibility, **Table B**, (T-2)
Lift Station Data Sheet, **Table F**, (T-5)
Low Pressure Air Test for Gravity Sewer Lines, **Table I**, (T-10)
Minimum Required and Maximum Permitted Pipe Slopes, **Table D**, (T-4)
Ratio of Peak Flow to Average Daily Flow, Clark County Nevada, **Table C**, (T-3)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

Tapping Requirements, (Lateral Sewer Connections), (3-33)
Televising Sewers, (Occupancy Permit Guidelines/Major Requirements), (3-43)
Terminal Main Sewers (multiple segments totaling more than 450 feet), (Pipe Slope Requirements), (2-7)
Terminal Main Sewers in Cul-de-Sacs (less than 450 feet), (Pipe Slope Requirements), (2-7)
Termination, (Design Criteria for Force Mains), (2-30)
Testing Re-Certification, (Storage of Materials), (4-1)
Testing, (3-37)
 Gravity Sewers & Appurtenances – Initial Acceptance, (3-38)
 Deflection Testing, (3-40)
 Low Pressure Air Test, (3-38)
 Manhole Visual Inspection & Corrosion Protection – Holiday Testing, (3-39)
 Sewer Cleaning, (3-40)
 Sewer Televising, (3-41)
 Sanitary System Construction – Initial Acceptance, (3-37)
Thrust Blocks, (Design Criteria for Force Mains), (2-31)
Time Limitation, (1-9)
Trench Backfill, (Earthwork), (3-17)
Trench Backfill (Paved Areas) (See Standard Drawing No. SD-17), (3-18)
Trench Backfill (Unpaved Areas) (See Standard Drawing No. SD-16), (3-18)
Trench Backfill Within State Right-of-Ways, (3-19)

U

Unacceptable Materials, (4-2)
Unpaved Areas (See Standard Drawing No. SD-16), (Trench Backfill), (3-18)
Use of New Sanitary Sewers, (Bypass Pumping), (3-7)

V

Vertical Crossings, (Other Utility Crossings and Clearances), (2-15)
Violations, (1-9)
VCP, (Tapping Requirements), (3-33)

W

Warranty, (3-43)
Water and Sewer Utility Crossings and Clearances, (Design Criteria for Gravity Sewers), (2-14)
Working Hours, (1-6)

INDEX TO DESIGN AND CONSTRUCTION STANDARDS

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