CITY OF BOULDER
CITY COUNCIL AGENDA ITEM

MEETING DATE: December 5, 2024

AGENDA TITLE

Second reading and consideration of a motion to adopt Ordinance 8672, amending the introduction and Chapters 8, 9 and 11 of the City of Boulder Design and Construction Standards (DCS), originally adopted pursuant to Ordinance 5986, adding standards for narrow trenching related to installation of telecommunications infrastructure; and setting forth related details.

PRESENTERS

Nuria Rivera-Vandermyde, City Manager
Teresa Taylor Tate, City Attorney
Mark Woulf, Assistant City Manager
Brad Mueller, Director of Planning & Development Services Director
Mark Garcia, Civil Engineering Senior Manager
Gerrit Slatter, Principal Transportation Projects Engineer
Mike Giansanti, Innovation and Technology Deputy Director
Dan Nelson, IT Senior Project Manager
Christy Fitch, Assistant City Attorney III

EXECUTIVE SUMMARY

Staff is requesting City Council's consideration of an ordinance on second reading amending the city's Design and Construction Standards (DCS) that will allow narrow trenching for the construction of telecommunications infrastructure. This memo provides a summary of the revisions and additions to transportation and utilities related portions of the City of Boulder proposed in Ordinance 8672. The DCS provides a set of common design and engineering

standards by which all public infrastructure must be built, whether by private development or city funded capital infrastructure and maintenance projects.

Narrow trenching, also known as "micro-trenching" or "shallow trenching," is a newer but mature method of trenching used throughout the state and country to increase the speed of telecom construction and reduce cost compared to traditional trenching or boring. By creating a narrow trenching standard, the city will minimize the impact to the community and create an incentive for increased telecommunications investment within city limits.

The development of the narrow trenching standard began in November 2023, with a preliminary study conducted by consulting group RMS, then a survey of peer cities, the creation of a cross-department working group, and a site visit to Salt Lake City, where several different approaches have been used over time. It was then followed by community engagement in August 2024. Staff have considered the feedback provided and integrated additional changes, which are included in this final document of proposed changes.

STAFF RECOMMENDATION

Suggested Motion Language:

Staff requests council consideration of this matter and action in the form of the following motion:

Motion to adopt Ordinance 8672, amending the introduction and Chapters 8, 9 and 11 of the City of Boulder Design and Construction Standards (D.C.S.), originally adopted pursuant to Ordinance 5986, adding standards for narrow trenching related to installation of telecommunications infrastructure; and setting forth related details.

BACKGROUND

The DCS exists to prescribe minimum standards to be used in the design and construction of infrastructure located in public right-of-way/easements of the City of Boulder. The DCS is enacted through the BRC, and changes are adopted by City Council with recommendations from appropriate boards, such as Transportation Advisory Board (TAB) and Planning Board.

The following introduction comes from the *Micro-Trenching Best Management Practices* study, completed for the city by RMS in January 2024. Narrow trenching and micro-trenching should be considered interchangeable in this context.

> Micro-trenched installation of telecommunications infrastructure is the practice of cutting narrow trenches between 1 to 3 inches wide and 4 to 24 inches deep into roadways and surfaces in the public right-of-way. After conduit or direct bury cable is placed in the trench, it is backfilled with a suitable filler material. The first city to adopt the technique

of micro-trenching was New York City in 2013, and now requires it unless there is a good reason to use another technique (Dawson 2017). According to the Fiber Broadband Association (FBA), a single micro-trench can accommodate up to 2,000 strands of fiber and have been used in major cities including Chicago, Los Angeles, and Nashville (Goovaerts 2022). According to Ting Internet, micro-trenching teams can lay as much as 3,000 feet of conduit per day, compared to 500 feet using traditional construction methods (Goovaerts 2022). In July of 2022, John Geoge of FBA's Technology Committee stated that "most below grade fiber installations are by directional boring or direct trenching" but micro-trenching is "sometimes used when those methods are cost prohibitive. It can be used where pole attachments are difficult or unavailable, or the subsurface is rocky or rock" (Goovaerts 2022).

The following is a list of the advantages and disadvantages of micro-trenching (Vermeer BC 2023, Dawson 2017, & Goovaerts 2022):

Advantages of micro-trenching (Per RMS Analysis)

- Cost effective based on the following factors:
    - With reduced roadway or ground impacts, it is possible to cover more area with smaller crews, which reduces labor costs.
    - The excavation produces less spoils and less material and effort is required to restore the worksite, which reduces overall restoration costs.
- Less disruption and increased accessibility
    - The minimal disruption to traffic around the worksite is one of the biggest advantages. With the trench width only being a few inches wide, it does not pose much of a safety hazard to vehicles, which greatly reduces the number of street and access closures and impacts to the traveling public during installation.
    - Provides minimal disruption to the local ecosystem and is a sensible technique for sensitive areas.
    - The shallow depth of installation reduces impacts to tree roots, existing utilities, and rock, making the overall installation easier, efficient, and safer.

Disadvantages of micro-trenching (Per RMS Analysis)

- Shallow installation creates a higher burden on future ROW construction
    - Can cause problems in the future when roadways have full depth reconstruction if construction crews are unaware of how shallow they are installed.
    - Installation of future utility facilities that must cross microtrenched facilities. Requires adjustment of expected installation depths and locations within the roadway section.
    - Increased long-term maintenance of street surfaces and fiber access
        - More and higher long-term maintenance related to shallow installation and road deterioration than conventional methods.
- Safety concern for bicyclists

- Uneven finished asphalt sealant installation, which is not typically noticed by vehicles, can be a hazard for bicyclists.
- Narrow micro-trenches left open during construction are not an issue for vehicles or pedestrians, but they can be a hazard for bicyclists and should be adequately protected when adjacent to bicycle facilities.

Many of the disadvantages listed above, including concerns with on-street cyclist lanes, can be addressed through various best-management practices and technical requirements deployed by other municipalities. The city has included best-management practices and technical requirements in the proposed edits to the DCS to reduce potential negative impacts of narrow trenching.

COMMUNITY ENGAGEMENT

Community engagement has included targeted outreach to groups that would use the narrow trenching standard or potentially be impacted by its use, e.g., regional retail internet service providers (ISPs) and local cycling and disability advocacy groups, including Coalition 4 Cyclists, Community Cycles, It Could Be Me, and Center for People with Disabilities. Two remote meetings were held via Zoom, one with the community advocacy groups on September 27, and another for ISPs September 28. The drafted DCS updates were provided before each session, and additional feedback and materials were received afterwards by email. All feedback and materials were then shared with the cross-department working group for consideration.

Feedback from local advocacy groups consisted of:

- General concern about surface remediation and cuts parallel to the direction of travel, e.g., bumps, divots, trip hazards.
- Positive statements about shorter construction and road closure timelines the standard requires.
- Questions about community communication, notice, and marking plans.
- A preference of center line trench placement to minimize impact to cyclists. Site-by-site placement focused on safety. Counter concerns for center line placement, e.g., increased lateral cuts and additional vaults/handholes on both sides of street.
- A preference to minimize or forbid narrow trenching in bike paths.

Feedback from Regional ISPs consisted of:

- Calls for clarifications in the technical drawing regarding utility separations.
- Success of curb lip-adjacent runs and recommendation to allow in standard.
- Requests to add additional allowable conduit materials and widths.
- Calls to allow pneumatic underground piercing missiles, also known as “missile” or “mole” boring.
- Adjustments that allow for graduated depth requirements.

- Expectations vs reality for sealant reservoir approach versus over-banding on top of flowable filled trench.
- Call to consider allowing 24-inch depths for directional boring and its benefits.
- Call to consider allowing field approved variations in some circumstances versus traditional memo submission for variance.
- Recommendations on additional flowable fill allowances that are a different mix design than current city standards. And an alternative water-to-cement ratios for flowable fill remediation.

The following table demonstrates how feedback informed the proposed standards changes.

Topic	Feedback	Updates
Allowable Depth	Preferred 8” depth for residential streets or a graduated approach based on street type	Depth of cover to be 10’’- 24’’ for narrow trenching allowing different depths by pavement thickness. If pavement is 6’’ thick or greater, minimum conduit depth must be additional 4’’ from bottom of pavement.
Horizontal Location Preference	Preferred centerline versus within travel lanes. Approved of 10-day restoration requirements. Technical feedback preference to allow trenching directly adjacent to lip of curb. Claim it’s less intrusive to the overall street infrastructure given the trench is at an existing joint.	City to allow narrow trench at lip line of curb with exception that min. Depth of conduit shall be 12" to ensure future curb/gutter concrete work does not come in close contact with the narrow trench conduits.
Backfill and Pavement Restoration Requirements	Provided example mix designs for review that have better outcomes Asked to consider Flowfill to top and allow overbanding. Practical issues with sealant reservoir approach.	Keep existing City of Boulder flowable fill standards, add material alternative for use of Flashfill. Mastic One material for narrow trench roadway restorations with 1’’- 6’’ reservoir depths.

Bike Lane Considerations	Full mill and overlay of bike paths significantly increase cost per linear foot. Preference to stay out of bike lanes.	Technical drawing note that allows for trenching at lip of bike lanes wider than 3'. This is a workable compromise between the two groups' interests. If bike lane is less that 3' wide, full mill and overlay will be required.
Conduit materials	Request to allow different materials as current standards state PVC or Schedule 40 pipe.	Addition to allow SDR 9 and 11 HDPE conduit materials to meet current application methods.
Lateral Tie-In Method	Request to allow Missile method, a pneumatic piercing tool, used for penetrating under curbs and sidewalks. Traditional bore method has greater impacts and is a higher cost.	Addition to allow use Missile method for lateral tie-ins.
Locate & Warning Tape Requirements	Difficult installing tape at right depth and is disruptive to smooth and fast installation process. Adds too much cost and has logistical impacts to a project.	Removed requirement for warning tape placement associated to narrow trenching only.

SCOPE OF CHANGES WITHIN ORDINANCE 8672

The scope of the narrow trenching recommendations is focused on utilities and transportation standards and a new technical drawing as detailed below.

Chapter 8 Transportation Standards

Section	Additions
Section 408, Joint and Crack Sealant (N**ew Subsection 408.02)**	Allows the use of Mastic One material for narrow trenching roadway restorations.

Section 703, Aggregates **(New Subsection 703.05)**	Allows use of Cover Coat material for the purpose of adding on top of Mastic One while temperature is still hot, during narrow trench roadway restoration, with the purpose of creating a non-slip surface. Material would be black in color, made of crushed stone, crushed slag, crushed gravel, expanding shale, clay, or slate in a rotary fired kiln or natural gravel, that meets the purpose of use.

Chapter 9 Utility Standards

Section	Additions
9.21 Telecommunication or Cable System Standards	
(A) General **(2) Construction Plans Required** **(a)**	Requires directional boring or narrow trenching construction plans to meet subsurface engineering (SUE) level B design standards. The city can request full engineered plans and profile drawings.
(B) Underground Facilities **(1) Cable Protection** **(a)**	Changed conduit material from PVC to SDR 9 or 11 HDPE pipe to meet current application methods.
(2) Depth of Cover **(a)**	Narrow Trenching Exception: For existing pavements 6 inches or less, distance from top of pavement to top of conduit is 10 inch minimum, 24 inch maximum. For Existing pavements greater than 6 inches thick, distance from top of pavement to top of conduit equals the pavement thickness plus 4 inches minimum, 24 inch maximum.
(i)	If Narrow Trench abuts lip of curb & gutter, minimum depth of conduit is 12".
9.21 Telecommunication or Cable System Standards - Continued	

(B) Underground Facilities **(3) Trench Specifications – Roadway and Other Paved Surfaces** **(b)**	Narrow Trench minimum width of 1'', maximum of 3'', but no greater than 1'' max of conduit size. This is to ensure flowable fill surrounds conduit and does not leave any voids for future subsurface failures. Example: 1'' conduit cannot be placed in a 1'' trench. Proposed 1'' conduit would require a 2'' trench minimum, to allow .5'' gap on each side for flowable fill.
(d)	Allow narrow trench to abut the concrete lip line of curb and gutter with a 12'' minimum conduit depth. This is to prevent future curb/gutter projects from potential fiber conduit damages.
9.21 Telecommunication or Cable System Standards - Continued	
(B) Underground Facilities **(3) Trench Specifications – Roadway and Other Paved Surfaces** **(e)** **(f)**	Wheel path alignment with trench. Written to keep narrow trenches a minimum of 2' away from common wheel paths on roadways, including streets signed or marked as shared roadways for bicyclists and vehicular traffic.
(B) Underground Facilities **(4) Trench Specifications – Landscape Areas** **(b)**	Wording requires the contractor to layout the trench running line so they follow a straight path and not be allowed to eyeball or "freehand" the machine's path. This is to create clean and straight trench paths with greater final product aesthetics.
(5) Alternative Installation Methods **(a)**	Exception to the 10'' width current standard and placed a minimum of 1'' and 3'' max for Narrow Trench applications.

	Added to allow use of Missile method for lateral tie-in tunneling associated to narrow trenching. Staff researched and found this to be less of a public impact compared to traditional boring where large rigs are used and block sidewalks, bike lanes and paths, whereas Missile method is mostly limited to a setup on private property. Wording added to require use of flowable fill.
(B) Underground Facilities **(7) Warning Tape** **(a)**	Warning tape, typically required for open trench pipe installations, is only a recommendation for Narrow Trenching and not required. Based on technical feedback, staff determined that it's not financial practical to partially flow fill a trench, place warning tape, and then walk a concrete truck backwards to continue filling the open trench. Locates will be marked upon 811 request prior to anyone excavating in the future.

Chapter 11 Technical Drawings

New Technical Drawing, numbered 4.05A, Titled: Telecommunications Conduit and Cable – Narrow Trench **Update to Chapter 11 table of contents adding the new drawing.**	Created to demonstrate the expectations for trench dimensions, utility separation, placement, and remediation. Includes specific information regarding impacts to bike lanes and associated remediation.

ANALYSIS

The revised DCS would specify the requirements for Narrow Trenching within the City of Boulder.

The DCS updates include additions or revisions to standards for Narrow Trench width, depth, restoration requirements, placement locations, materials allowed and utility potholing. Information from the RMS analysis and our own research with other municipalities were used to resolve any potential disadvantages using best management practices by strengthening the construction and remediation requirements.

NEXT STEPS

Should the City Council adopt the proposed changes during the second reading on December 5th, 2024, staff will update the published version of the Design and Construction Standards, and the changes will go into effect 30 days after their adoption.

ATTACHMENT

Attachment A - Proposed Ordinance 8672

ORDINANCE 8672

AN ORDINANCE AMENDING THE INTRODUCTION AND CHAPTERS 8, 9 AND 11 OF THE CITY OF BOULDER DESIGN AND CONSTRUCTION STANDARDS (D.C.S.), ORIGINALLY ADOPTED PURSUANT TO ORDINANCE 5986, ADDING STANDARDS FOR NARROW TRENCHING RELATED TO INSTALLATION OF TELECOMMUNICATIONS INFRASTRUCTURE; AND SETTING FORTH RELATED DETAILS.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF BOULDER, COLORADO:

Section 1. The city council herby repeals and re-enacts the following sections and chapters of the *City of Boulder Design and Construction Standards,* originally adopted pursuant to Ordinance 5986 (and amended by Ordinance 7088, 7400, 7688, 8006, 8324,8370, 8561 and 8608), to read as shown in **Exhibit A** attached to and hereby incorporated into this ordinance:

- Introduction;
- Chapter 8, Transportation Standards;
- Chapter 9, Utilities Standards; and

Section 2. Chapter 11 of the *City of Boulder Design and Construction Standards* is further amended by the addition of technical drawings, as shown in **Exhibit B** attached hereto and incorporated into this ordinance.

Section 3. This ordinance is prospective in nature and shall apply to all technical document review and permit applications submitted to the city on or after the effective date of this ordinance. Technical document review applications are administrative in nature and the application date shall be the date that the fee required by Section 4-20-43, "Development Application Fees," B.R.C. 1981, has been paid. Complete site review and form-based code

review applications that have been submitted to the city prior to the effective date of this ordinance will be permitted to continue through the process under the standards in effect at the time such application is made. Such applicants shall be required to pursue such approvals and meet all requirements and deadlines set by the city manager and the Boulder Revised Code. Technical document review applications and permits applied for prior to the effective date of this ordinance may proceed under the standards in effect at the time of application. The city council intends that any project approved under the standards of the *City of Boulder Design and Construction Standards* effective prior to the effective date of this ordinance be built and otherwise constructed and maintained in accordance with those standards.

Section 4. The city council orders and directs the city manager to make any additional citation, reference, and formatting changes to the *City of Boulder Design and Construction Standards* not included in this ordinance that are necessary to properly implement these amendments to the *City of Boulder Design and Construction Standards*.

Section 5. This ordinance is necessary to protect the public health, safety, and welfare of the residents of the city and covers matters of local concern.

Section 6. The city council deems it appropriate that this ordinance be published by title only and orders that copies of this ordinance be made available in the office of the city clerk for public inspection and acquisition.

INTRODUCED, READ ON FIRST READING, AND ORDERED PUBLISHED BY TITLE ONLY this 21st day of November 2024.

_____
Aaron Brockett,
Mayor

Attest:

_____
Elesha Johnson,
City Clerk

READ ON SECOND READING AND ADOPTED this 5th day of December 2024.

_____
Aaron Brockett,
Mayor

Attest:

_____
Elesha Johnson,
City Clerk

CITY OF BOULDER
DESIGN AND CONSTRUCTION STANDARDS

INTRODUCTION

(A) INTRODUCTION

The City of Boulder Design and Construction Standards (DCS) were developed to regulate the design and construction of public infrastructure, improvements and landscaping in the city's public rights-of-way and public easements. The DCS was originally adopted on July 2, 1998 to replace the Design Criteria and Standard Specifications adopted in July 1982. The November 16, 2000 update replaced the July 2, 1998 manual and addressed changes in engineering practices, construction technology, and city review processes. The update also attempts to clarify sections that have been identified as unclear or in error by users of the manual. Updates to chapters 1, 4, 5, 6, 7, 9 and 11 and the Glossary and References were adopted on May 21, 2019. These updates were related to utilities infrastructure and to comply with requirements of the city's State of Colorado Municipal Separate Storm Sewer System (MS4) permit. Updates to chapters 2 and 4 and the Glossary and References were adopted on January 7, 2020. These updates were related to transportation standards and drawings and a correction to the minimum utility separations table in Chapter 4. Updates to chapters 2, 3, 10, and 11 and the Glossary were adopted on January 2, 2023. These updates were related to transportation standards and drawings and landscape standards. Updates to the traffic study format for hazard assessment were adopted on December 18, 2023. Updates to chapter 2 for street lighting design were adopted on May 2, 2024. Updates to chapters 8, 9, and 11 ~~chapter 11 technical drawing table of contents and chapter 11 detail drawing 9.05A~~ were adopted on _____. These updates were related to narrow trenching and utility potholing requirements and associated transportation restoration requirements.

The DCS prescribe minimum standards to be used in the design and construction of public infrastructure located in public rights-of-way and public easements in the City of Boulder, and the design of private transportation and utility improvements, such as driveway cuts, utility services and onsite drainage systems, which are connected to or impact public infrastructure. The standards in the DCS are intended to provide for the public health, safety and welfare by ensuring the comprehensive design and construction of adequate and functional public improvements associated with developing, redeveloping and subdividing lands and providing necessary right-of-way, transportation and utility services. The DCS requirements reflect accepted and well-founded civil engineering practices, construction industry specifications and conformance with national safety standards and are consistent with current city ordinances, standards, policies and practices.

(B) DCS ADOPTION

The updated DCS was adopted at second reading by City Council on October 17, 2000, with the passage of City of Boulder Ordinance No. 7088. The May 2019 updated DCS was adopted at second reading by City Council on May 21, 2019, with the passage of City of Boulder Ordinance No. 8324.

Information regarding the adoption of Ordinance No. 7088 can be reviewed at the City of Boulder Central Records Office as part of the Planning Board agenda materials for September 7, 2000 and the City Council agenda materials for October 3, 2000 and October 17, 2000.

Information regarding the adoption of Ordinance No. 8324 can be reviewed at the City of Boulder Central Records Office as part of the Planning Board agenda materials for April 18, 2019 and the City Council agenda materials for May 7, 2019 and May 21, 2019.

Information regarding the adoption of Ordinance No. 8370 can be reviewed at the City of Boulder Central Records

Office as part of the Planning Board agenda materials for November 7, 2019 and the City Council agenda materials for December 3, 2019, December 17, 2019 and January 7, 2020.

Information regarding the adoption of Ordinance No. 8608 can be reviewed at the City of Boulder Central Records Office as part of the City Council agenda materials for November 2, 2023and November 16, 2023.

Information regarding the adoption of Ordinance No. 8631 can be reviewed at the City of Boulder Central Records Office as part of City Council agenda materials for April 11, 2024, and May 2, 2024.

Information regarding the adoption of Ordinance 8672 can be reviewed at the City of Boulder Central Records Office as part of City Council agenda materials for _____, 2024, and _____, 2024.

CITY OF BOULDER

DESIGN AND CONSTRUCTION STANDARDS

CHAPTER 8
TRANSPORTATION STANDARDS

TABLE OF CONTENTS

LIST OF TABLES

8.01 Adoption of the Colorado Department of Transportation (CDOT) Specifications with Modifications

The current edition of the "Colorado Department of Transportation Standard Specifications for Road and Bridge Construction" is hereby adopted by reference in these Standards as the City of Boulder transportation construction standards, except as specifically amended by the provisions of this chapter.

(A) Section 401, Plant Mix Pavements - General

(1) **Subsection 401.02, "Composition of Mixtures,"** is amended to incorporate the following additions:

(a) A job-mix formula shall be submitted to the Director of Public Works for approval prior to placing any hot bituminous pavement. The formula shall indicate the aggregate gradation, asphalt cement content, hydrated lime content, and optimum density. If requested by the Director, a sample of the aggregate and asphalt cement shall be submitted for approval (for test purposes) prior to placing any hot bituminous pavement.

(b) The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, and a single temperature for the mixture at the discharge point of the plant.

(c) When submitting the job-mix formula, the contractor shall supply certified test results on all asphalt cements, aggregates, and mixes used for hot bituminous pavement, and certify that all materials meet or exceed all required specifications and tests.

(d) The Director reserves the right to sample materials and mixtures throughout project construction to determine whether specifications and requirements have been met and to confirm the certified test results. The contractor is responsible for providing a bituminous mixture that meets the job formula and specifications.

(e) The contractor shall be responsible for providing adequate field testing of materials used on the project and providing copies of the test results to the City to assure compliance with these specifications.

(f) The top layer of hot bituminous pavement shall not contain any reclaimed asphalt material, unless approved by the Director.

(2) **Subsection 401.11, "Tack Coat,"** is amended to incorporate the following additions:

(a) A tack coat shall be evenly applied to all existing asphalt or concrete surfaces that will be in contact with asphalt prior to hot bituminous pavement placement. A slow-setting, diluted emulsion shall be used, diluted with one part water to one part asphalt emulsion. The rate of application shall be 0.1 gallons per square yard of diluted asphalt emulsion. Before dilution, the emulsified asphalt shall comply with AASHTO M140 or M208.

(b) Only the amount of tack coat necessary for the day's operation is to be placed on the surface. All traffic not essential to the work shall be kept off the tack coat.

(3) **Subsection 401.12, "Surface Conditioning,"** is amended to incorporate the following addition: All vegetation shall be removed from any existing surface to be overlaid.

(4) **Subsection 401.16, "Spreading and Finishing,"** is amended to incorporate the following additions:

(a) The bituminous mixture shall be placed with an asphalt paver if possible. The contractor shall receive permission from the Director to use placement methods other than a paver. The lift thickness shall be at least twice the maximum particle size for the hot bituminous pavement mix. The maximum lift thickness for the final lift shall be 2 inches, unless otherwise approved by the Director.

(b) Areas to be patched shall be excavated and squared to a neat line, leaving the sides of the excavation vertical. Prior to placement of the patch, the exposed sides of the existing pavement shall be thoroughly coated with slow-setting Emulsified Asphalt. Hot bituminous pavement shall then be placed and compacted in succeeding layers; no layer shall be more than 3 inches deep.

(B) Section 403, Hot Bituminous Pavement

(1) **Subsection 403.02, "Materials,"** is amended to incorporate the following additions:

(a) Design mixes shall be established using the Marshall Method of compaction. The method will be applied based on street classification according to Table 8-1, "Marshall Method by Street Classification."

Table 8-1: Marshall Method by Street Classification

Design Method	Laboratory Compaction	Street Classification
Marshall Method, ASTM D 1559 Asphalt Institute MS-2	50 blows per side	Local, Collector, and Minor Arterial (ESAL < 1 million)
Marshall Method, ASTM D 1559 Asphalt Institute MS-2	75 blows per side	Major Arterial (ESAL < 1 million)

(b) The design mix for hot bituminous pavement shall conform to Table 8-2, "Hot Bituminous Pavement Design Mix," and Table 8-3, "Minimum Voids in the Mineral Aggregate (VMA)."

(c) The addition of any recycled material is subject to approval by the Director prior to use in any asphalt mix. All mixes including recycled material shall meet all standard specifications and contain no more than 10% recycled material.

(d) Hot bituminous pavement for patching shall be Grading C with AC-10 asphalt cement.

(e) A minimum of one percent hydrated lime by weight of the combined aggregate shall be added to all aggregate for hot bituminous pavement.

Table 8-2: Hot Bituminous Pavement Design Mix

Property	Test Method	Value
Voids, Percent	MS-2; AASHTO T269	3-5
Stability, Minimum	MS-2; AASHTO T245	1800
Flow (0.01")	MS-2: AASHTO T245	8-16
Aggregate retained on the No. 4 Sieve with at least two Fractured Faces % Min.	CP-45	70
Accelerated Moisture Susceptibility Tensile Strength Ratio (Lottman) Min.	AASHTO T283	80
Minimum Dry Split Tensile Strength, PSI	AASHTO T283	30
Voids in Mineral Aggregate, VMA, % Min.	MS-2	See Table 8.01-3
Grade of Asphalt Cement		AC-10

Table 8-3: Minimum Voids in the Mineral Aggregate (VMA)

Nominal Maximum Size*, Inches (mm)**	Design Air Voids **		
	3.0%	4.0%	5.0%
1 ½ (37.5)	11	12	13
1 (25.0)	12	13	14
¾ (19.0)	13	14	15
½ (12.5)	14	15	16
3/8 (9.5)	15	16	17

* The Nominal Maximum Size is defined as one sieve larger than the first sieve to retain more than 10%.
** Interpolate specified VMA values for design air voids between those listed.

(C) Section 608, Sidewalks and Multi-Use Paths

(1) Subsection 608.03(e), "Joints," is amended to incorporate the following additions:

All jointing of bikepath, bikeway, and bike trail concrete pavement shall be saw cut at the nearest contraction joint and shall be removed and replaced full width. No partial removal and replacement will be allowed. No longitudinal joints will be allowed in either sidewalk or bikepath concrete pavements.

(D) Section 610, Median Cover Material

(1) **Subsection 610.02, "Materials,"** is amended to incorporate the following additions:
Patterned concrete shall be colored concrete and meet the requirements of Section 601

with the following exceptions:

Field Compressive Strength (28 days), psi (Not a specification requirement)	4500
Cement Content, lbs./cu. Yd., minimum	610
Max. Water/cement ratio lbs. Water/lbs. Cement	0.44
Entrained and Entrapped Air, percent	4 - 8
Slump, AASHTO T 119, inches	2 – 5
Coarse Aggregate, AASHTO M43	Size No. 8
Fine Aggregate, AASHTO M6, percent of total aggregate	50 - 78

(2) An approved water reducing admixture shall be used in the mix.

(a) The coloring agent shall be integral to the concrete mixture.

(b) The color and pattern shall be as defined in the plans as approved by the City.

(c) Colored wax curing membrane shall be as recommended by the supplier of the coloring agent.

(3) **Subsection 610.03, "Construction Requirements,"** is amended to incorporate the following additions: Patterned concrete may be used for median cover material. Construction shall conform to the requirements of CDOT Subsection 608.03 with the following exceptions:

(a) While the concrete is still plastic, a special pattern forming tool shall be applied to the concrete surface to form the specified pattern. All tears and voids resulting from the pattern forming shall be repaired.

(b) Curing shall include application of two coats of colored wax curing membrane. The first coat shall be applied within 2 hours of finishing. The second coat shall be applied between 10 and 20 days following the first application.

(E) Section 703, Aggregates

Subsection 703.04, "Aggregate for Hot Plant Mix Bituminous Pavement," paragraph 3 is deleted and replaced with the following revision:

(1) The aggregate from individual sources shall have a percentage of wear of not more than 40 when tested in accordance with AASHTO T96 after 500 revolutions. The aggregate from individual sources shall contain no more than a 1 percent deleterious material including clay lumps, vegetable matter, friable particles, and other deleterious substances tested in accordance with AASHTO T112.

(2) For quarries or sources which contain minerals which are not of similar composition, the abrasion and friable particle requirements shall be applied to each mineral composition.

(3) All aggregate shall meet the sodium or magnesium sulfate test in accordance with AASHTO M29.

Subsection 703.05, "Aggregate for Cover Coat Material", is incorporated for the purpose of Narrow Trenching, and any other uses determined by the Director.

(F) Section 612, Delineators and Reflectors

Subsection 612.02, "Materials," is amended to incorporate the following additions: All delineators shall be "safe hit" reflective delineators and shall be anchored according to manufacturer's recommendations.

(G) Section 614, Traffic Control Devices

(1) **Subsection 614.02, "Sign Posts and Sign Structures,"** is amended to incorporate the following additions:

(a) All signs must be mounted on "TELESPAR" posts or approved equal. These installations shall be per manufacturer's recommendations and be constructed in two sections including the base and the post.

(b) The post size shall conform to manufacturers recommendations according to the total sign area square footage and wind loading, but in no instance shall post size be less than 2" square, 12 gauge material, affixed to base by means of two (each) drive rivets with washers on the back side of post and right or left side of post, at a length to accommodate the proper mounting height of sign to be affixed per the MUTCD.

(c) The "TELESPAR" sign base shall be 2 ¼ x 36 inches in length and shall be driven into the ground 33 to 34 inches with 2 to 3 inches exposed above final grade.

(d) Sign Bolts: Sign shall be affixed to post with a minimum of two (each) 5/16 x 2-¾ inch bolts with locking nut and vandal proof (Gator Lock or approved equal) hardware on each side (front/back) with nylon washer or equivalent behind the Gator lock on the sheeting side.

(e) Banded Sign Mount: All banding material shall be ¾ inch wide stainless Steel banding. Hardware for installation of signs less than 30" attached to a signal/light pole shall consist of a buckle bracket. For 30"or greater signs, Sign Fix is required to be mounted on the sign and a slider bracket to affix sign to the banding.

(f) Other Sign Mounts: Utility wood poles can be used when the location is appropriate for signs with prior approval from the Director. The mounting hardware shall be lag bolts with washers, with nylon washer or equivalent against the sheeting side.

(g) Cantilever Mount: Cantilever mounts shall be approved by the Director prior to being used.

(h) CDOT Breakaway Post System: Signs placed in rights-of-way under the jurisdiction of CDOT shall provide a breakaway system in accordance with CDOT standards (M & S Standards section S-614-5).

(2) **Subsection 614.04, "Sign Panels,"** is amended to incorporate the following additions:

(a) All reflective sheeting shall be ASTM D 4956-04 Type XI Diamond Grade

Cubed (DG3) or equivalent approved by the Director.

(b) All sign blanks shall be constructed using 0.100 gauge aluminum material.

(c) All public street name signs shall be constructed using extruded aluminum alloy 6063-T6, or approved equal, with 0.091 inch thick web, 0.250 inch thick edges, and square corners. All non-extruded signs shall be mounted on 0.100 gage aluminum with rounded radius corners. All public street name signs shall be constructed using reflective sheeting stated above and have a blue background with white lettering.

(H) Section 627, Pavement Marking

Subsection 627.03, "General," is amended to incorporate the following additions:

(1) White and yellow skip markings shall be 4 inches wide and 10 feet long with a 30 foot gap between.

(2) All crosswalk lines shall be applied longitudinally, and shall be 24 inches wide by 10 feet long.

(3) On concrete surfaces all curing compound shall be removed prior to the installation of any pavement marking.

(4) Maintenance Striping

(a) All lane, center, and channelizing lines shall be striped with epoxy pavement markings at 15 mm thickness with glass beads.

(b) All crosswalk lines installed on asphalt surfaces shall be provided using pre-formed plastic pavement markings 3M A270 E/S series tape. On concrete surfaces, an equivalent pre-form thermoplastic marking can be used if approved by the Director.

(b) All lane use arrows on concrete surfaces shall be Premark Brand Elongated Series Contrast Arrows.

(c) All lane use arrows on Asphalt Surfaces shall be pre-formed plastic pavement markings, 3M Elongated L270 ES Series.

(d) Adherence to manufacturer's installation recommendations (method) is required.

(5) New Striping

(a) Approval of final lay-out is required prior to placement of pavement markings

(b) On concrete surfaces all curing compound shall be removed prior to the installation of any pavement markings.

(c) Adherence to manufacturer's installation recommendations is required.

(d) All lane use arrows on concrete surfaces shall be Premark Brand Elongated

Series Contrast Arrows.

(e) All lane use arrows on Asphalt Surfaces shall be pre-formed plastic pavement markings, 3M Elongated L270 ES Series.

(I) Section 713, Traffic Control Materials

(1) **Subsection 713.04, "Sign Panel Backgrounds,"** is amended to incorporate the following addition: Aluminum sign panels may also have a Class II (A-1) anodic coating clear finish as defined in the "Aluminum Association Standards for Anodically Coated Aluminum Alloys for Architectural Applications."

(2) **Subsection 713.06, "Messages,"** is amended to incorporate the following additions:

(a) All street name signs on non-signalized intersections shall be 9 inches wide with 6 inch, upper-case, series D capital letters, together with 4 ¾ inch, lower-case, series D letters for the name of the street, and a 3 inch, upper-case, series D capital letter together with 2 ¼ inch, lower- case, series D letters for "Avenue," "Street," 3 inch block numbers below the abbreviation of "Ave.," "St.," etc. The "Ave" etc. and block numbers shall be centered on the sign with a 1 inch separation between them. When block numbers are not used, "Ave", "St", "Rd", etc. shall be 6 inch upper case with 4 /4 inch lower case letters series D. On numbered streets, a 6 inch, series D number shall be used with 4 ¾ inch, lower-case, series D letters for "th", "st" and "nd" to be held in line with the number that it follows.

(b) All reflective sheeting for street name sign faces shall be Type XI 3M - Diamond Grade Cubed sheeting or approved equal.

(3) **Subsection 713.08, "Glass Beads for Traffic Markings,"** is amended to incorporate the following addition: Glass beads shall be applied on Epoxy Pavement Markings Lane Lines at a rate of 15 to 18 pounds per gallon.

(4) **Subsection 713.13**, "Preformed Plastic Materials," is amended to incorporate the following additions:

(a) Preformed Plastic: material shall be 3M Stamark Series A270 ES for all transverse & longitudinal lines. All lane use symbols shall be 3M Stamark Series L270 ES.

(b) Preformed Plastic: (New Concrete Application) "white only" material shall be 3M Stamark Series A380I-5 ES (contrast) for all longitudinal skip lines or channelizing lines.

(5) **Subsection 713.14**, "Preformed Thermoplastic Material," is amended to incorporate the following additions:

(a) Preformed Thermoplastic; Materials shall be alkyd based materials for transverse & longitudinal lines, or approved equivalent.

(b) All materials shall be 90 mm thick with beads. Only preformed thermoplastic marking material listed on CDOT's approved products list may be used.

(6) **Subsection 713.19,** Methyl Methacrylate Pavement Marking,"
Methyl Methacrylate material shall be approved by the Director prior to being used on transportation facilities in the public right-of-way.

(J) Section 408, Joint and Crack Sealant

(1) **Subsection 408.02, "Materials,"** is amended to incorporate the following addition: Use of Mastic One or equivalent materials, for Narrow Trenching restoration, shall be listed on the CDOT approved products list. The contractor shall provide to the city, material certifications and manufacturer's instructions for heating and application prior to use.

8.02 Traffic Signals

All traffic signal design and construction shall be performed in accordance with the Section 2-2-11, "Traffic Engineering," B.R.C. 1981 and these Standards.

8.03 Traffic Signs and Markings

(A) Required

The applicant shall be responsible for the installation of all traffic control devices, street name signs, and pavement markings prior to opening or reopening any public transportation facility.

(B) Signing and Striping Plan

A complete signing and striping plan shall be submitted as part of project or development construction plans, to be approved by the Director prior to installation. The plan shall specify the locations, types, and combinations of approved signs, pavement markings, and barricades required for each project or development.

(C) Conformance with MUTCD

All signs, sign materials, and barricade warning lights shall conform to the standards set forth in the current edition of the "Manual on Uniform Traffic Control Devices (MUTCD)", and these Standards.

(D) Materials

The quality of material used in traffic signs, type and quality of all vandal-proof sign hardware, and quality of all metal square sign posts shall be in conformance with these Standards, subject to approval by the Director.

(E) Private Street Signs

Private streets shall be signed as such and shall include the message "NO CITY MAINTENANCE", and be installed on the same support as the street name sign. Any private street name signs should be fabricated and installed according to the specifications for a public right-of-way street name sign except that the sign shall have white lettering on a green

background.

8.04 Temporary Traffic Control Plan

(A) Required

The Director of Public Works may require a Temporary Traffic Control (TTC) Plan for any work that impacts a public right-of-way or easement.

(B) Intent

The purpose of this section is to establish standards and methods for handling traffic to be applied when work or work activity in the public right-of-way or public easements impedes or obstructs any mode of transportation, including but not limited to pedestrian, bicycle, transit, or vehicular traffic. These standards are intended to ensure safe and effective work areas, and warn, control, protect, and accommodate all modes of transportation.

(C) Transportation Master Plan

All temporary traffic control plans shall comply with the goals, policies, and standards adopted in the Transportation Master Plan (TMP).

(D) Objectives

Primary objectives of a TTC plan are as follows:

(1) Prevent accidents and injury for both the public and for workers, by providing a safe work area;
(2) Prevent damage to public and private property, including damage to vehicles and construction equipment;
(3) Ensure well defined and safe traffic movements through work areas and temporary traffic control zones;
(4) Efficiently and equitably accommodate pedestrian, bicycle, transit, and vehicular traffic;
(5) Support mode prioritization goals established in the TMP;
(6) Provide effective communication with the public; and
(7) Ensure conformity with these standards for work zone temporary traffic control.

(E) Certification Requirements

(1) Traffic Control Plans shall be prepared by or under the direct supervision of a person certified as a Traffic Control Supervisor (TCS) by the American Traffic Safety Services Association (ATSSA) or with equivalent certification as approved by the Director.
(2) Traffic Control Plans shall be implemented under the direct supervision of a TCS, certified Traffic Control Technician (TCT), or person with equivalent certification as approved by the Director.

(F) Conformance with MUTCD

All traffic control plans, signs, sign materials, barricade warning lights, and other temporary traffic control measures shall conform to the "Manual on Uniform Traffic Control Devices" (current edition), except as specifically amended or supplemented by the provisions of these Standards.

(G) General Requirements

All proposed Traffic Control Plans shall include the following:

(1) The location of work
(2) A description of work to be performed
(3) A construction schedule identifying duration and extent of impacts
(4) A delineation of the proposed work area including any staging, storage, and delivery areas.
(5) Proposed measures to address impacts to vehicles, bicycles, pedestrians, multi-use path facilities, transit facilities, and persons with disabilities.

(H) Non Standard Closures

Traffic control plans which due to their location, duration, extent, hours of operation, or impact will result in more significant impacts to the traveling public require additional information to demonstrate that impacts have been avoided, minimized, and mitigated. The Director may approve the following Non Standard closures upon finding that the applicable criteria have been met:

(1) **Work Hours:** Plans which propose to close a vehicular travel lane on any weekday prior to 9 a.m. or later than 4 p.m., or on any weekend shall demonstrate that such impacts cannot be reasonably avoided or that the proposed schedule reduces impacts to the public compared to closure during normal work hours.

(2) **Multiple Vehicle Lanes:** Plans which propose to close all or multiple vehicle lanes in a single direction of travel shall demonstrate that such impacts cannot be reasonably avoided through alternative scheduling or phasing of work.

(3) **Vehicular Detours:** Plans which propose to detour traffic to another roadway shall demonstrate that such impacts cannot be reasonably avoided and that impacts to the detour route have been mitigated to the extent practicable. Impacts to the detour route shall be evaluated including, without limitation, intersection level of service, traffic speed and volume in residential neighborhoods and school zones, and impacts to all modes of transportation.

(4) **Flagging:** Plans which propose use of flaggers shall demonstrate that the duration or scope of work is such that more permanent control measures are not practical.

(5) **Transit Facilities:** Plans which propose impacts to a transit facility or transit stop must demonstrate that such impacts cannot be avoided and provide for appropriate detours and alternative stop locations.

(6) **Sidewalks:** The following special considerations shall be given to proposed closures of sidewalks:

a) Adjacent to streets not classified as “Local” in the Transportation Master Plan;
b) Located in the CAGID or UHGID boundary areas;
c) Impacted for more than seven days;
d) Where no other sidewalk exists adjacent to the roadway;
e) Serving a school zone or transit stop, or
f) Requiring pedestrians to detour to a facility on a separate parallel roadway. Such proposed closures must demonstrate that impacts cannot be avoided through

alternative construction methods, that the duration and extent of impacts has been minimized, and that an adequate detour has been provided.

(7) **Bicycle Lanes:** Special consideration shall be given to proposed closures of on street bike lanes along roadways with a posted speed limit of 40 mph or greater; or bike lanes that involve contra-flow lanes. Such proposed closures shall demonstrate that impacts cannot be avoided through alternative construction methods, that the facility cannot be reasonably relocated through reassignment of vehicle lanes or other existing facilities, that the duration and extent of impacts has been minimized, and that an adequate detour has been provided.

(8) **Multi-Use Paths:** Special consideration shall be given to proposed closures of sidewalk facilities which have been designated as multi-use paths. Such proposals shall demonstrate that impacts cannot be avoided through alternative construction methods, that the facility cannot be reasonably relocated through reassignment of vehicle lanes or other existing facilities, that the duration and extent of impacts has been minimized, and that an adequate detour has been provided. Detours routes must be of similar width and surface type to the permanent facility.

(9) **Signage:** Where detours or closures impact pedestrian, bicycle, or multi-use path facilities, additional signage as required by Director shall be utilized to supplement the requirements of the MUTCD.

8.05 Fire Lane Sign Specifications

(A) Size
Fire lane signs shall be 12 inches by 18 inches.

(B) Material
Fire lane sign material shall be 0.100-inch thick aluminum alloy 6061-T6 with 3M Diamond Grade Cubed (DG3) sheeting Type XI.

(C) Colors
Fire lane sign colors shall be red letters on a white background. The letter on the symbol shall be black.

(D) Wording
Fire lane signs shall including the wording “FIRE LANE” with an appropriate arrow and a no parking symbol (“P” with a slash).

8.06 Signing for Accessible Parking

Accessible parking signs required for accessible parking spaces shall meet the following standards:

(A) Materials

Sign materials shall conform to the standards set forth in the MUTCD and these Standards.

(B) Required Signs

Three signs shall be required for accessible parking spaces as follows:

(1) **Sign #1:** Sign #1 (R7-8) shall be 12 inches by 18 inches with green lettering on a white background. This sign shall read, "RESERVED PARKING", followed by a blue accessible symbol and a green arrow indicating the stalls restricted to accessible parking.

(2) **Sign #2:** Sign #2 shall be 24 inches by 18 inches with white lettering on a blue background. This sign shall read, "VEHICLES NOT DISPLAYING THE STATE AUTHORIZATION MAY BE TOWED AT OWNER'S EXPENSE. FOR PERMIT INFORMATION CONTACT THE LOCAL MOTOR VEHICLE OFFICE," and shall display a symbol of accessibility.

(3) **Sign #3:** Sign #3 shall be 12 inches by 6 inches with white numerical numbering on a blue background. This sign shall read in numerical value, "$112.00," centered with a white border.

(C) Sign Placement

The accessible parking signs shall be placed as shown on Technical Drawing 2.86, "Accessible Parking Sign Details," in Chapter 11 of these Standards, and are to be set directly facing or no more than 45 degrees from the line of travel of a vehicle entering the stall. These signs may be mounted on a post or may be mounted permanently on an adjacent wall using anchor bolts. Such signs shall be placed at the center of the end stalls of each accessible parking area and at every second stall in-between.

8.07 Signing for Parking Restrictions

(A) Size

Parking restriction signs shall be 12" x 18".

(B) Material

Sign material shall be 0.100-inch thick aluminum alloy 6061-T6 with 3M DG3 (Diamond Grade Cubed) sheeting Type XI.

CITY OF BOULDER

DESIGN AND CONSTRUCTION STANDARDS

CHAPTER 9
UTILITIES STANDARDS

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9.01 General

(A) Intent

The Utilities Standards are intended to complement the design standards specified in Chapter 4, "General Utilities Design," Chapter 5, "Water Design," Chapter 6, "Wastewater Design," Chapter 7, "Storm Water Design," and Chapter 11, "Technical Drawings," of these Standards, and provide minimum standards for the construction of public utilities improvements in public rights-of-way and public easements.

(B) Scope

These Standards apply to all city-operated public utility improvements within the City of Boulder service area. This chapter describes the construction of public utilities and other work within the public right-of-way and public easements including, but not limited to, work activities involved, materials used, installation methods, and required testing. The utilities construction requirements of this chapter are in addition to those set forth in Chapter 4, "General Utilities Design," Chapter 5, "Water Design," Chapter 6, "Wastewater Design," Chapter 7, "Storm Water Design," and Chapter 11, "Technical Drawings," of these Standards and the B.R.C. 1981.

(C) Reference Standards

Where not specified in these Standards or the B.R.C. 1981, in order to protect the public health, safety, and welfare, the Director of Public Works will specify the standards to be applied to the design and construction of utilities and may refer to one or more of the references listed in the References Section of these Standards.

(D) City Approval Required

All work associated with the construction of public utilities within or upon any City of Boulder public right-of-way or public easement is subject to City of Boulder approval or permit issuance as set forth in Chapter 8-5, "Work in the Public Right Of Way and Public Easements," B.R.C. 1981.

9.02 Excavation and Trenching

(A) General

(1) **Scope:** This section describes excavation and trenching, which includes the following:

(a) Necessary clearing, grubbing, and preparation of the site;

(b) Removal and disposal of debris;

(c) Excavation and trenching as required;

(d) The handling, storage, transportation, and disposal of all excavated material;

(e) Necessary sheeting, shoring, and protection work;

(f) Preparation of subgrades;

(g) Pumping and dewatering as necessary or required;

(h) Protection of adjacent property

(i) Backfilling;

(j) Pipe embedment;

(k) Placement of fills;

(l) Surfacing and grading; and

(m) Other relevant work.

(2) **Quality Assurance:** All tests required for the preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of the contractor. Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material. The contractor shall pay for all in-place field density tests, Proctor moisture-density tests, and relative density tests on the materials as required.

(B) Materials

(1) **General:** All bedding and backfill material shall be free of frozen material, organic material, and debris.

(2) **Pipe Bedding:** Bedding materials shall conform to the following requirements:

(a) Bedding Materials: Bedding materials shall not contain cinders or other material that may cause pipe corrosion.

(b) Concrete Arch Encasement: A concrete arch encasement is not required unless improper trenching or unexpected trench conditions require its use, as determined by the Director.

(c) Granular Bedding Material: Granular bedding material shall consist of well graded sand or squeegee meeting a fine aggregate standard shown in Table 9-1, "Granular Bedding Material." Instead of a material meeting the requirements in Table 9-1, the Director may approve 3/8-inch chips conforming to the grading and composition requirements of Course Aggregate No. 8 in Table 703-1, "Concrete Aggregate Gradation Table," of the CDOT Standard Specifications for Road and Bridge Construction, 2017, due to lack of availability of the materials meeting Table 9-1 requirements.

Table 9-1: Granular Bedding Material

Sieve Size	Percent Passing by Weight
3/8-inch	100%
No. 4	60-100%
No. 8	0-45%
No. 16	0-30%
No. 50	0-6%
No. 200	0-2%

(d) Compaction: All granular bedding material shall be compacted by vibrating or

slicing with a shovel and placed in layers no more than 6 inches thick.

(3) **Stabilization Material:** Stabilization material shall be placed on suitably prepared subgrades and compacted by vibration. Stabilization material shall be crushed rock or gravel; free from dust, clay, or trash; and graded 1 ½ inch to No. 4 as defined in ASTM C33 and shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254.

(4) **Trench Backfill:** Trench backfill is material placed above the pipe bedding and shall meet specifications for Class 1 structural backfill material of Subsection 703.08 "Structural Backfill Material," of the CDOT Standard Specifications for Road and Bridge Construction (2017), or shall be flowable fill as specified in Subsection 9.02(B)(6) of these Standards.

(5) **Groundwater Barrier Material:** Groundwater barrier material shall be flowable fill or meet AASHTO soil classification SC or CL, free from stones, organic material or debris.

(6) **Flowable Fill:** Flowable fill, meeting the standards outlined in Table 9-2, "Flowable Fill Requirements," shall be used for trench backfill or for groundwater barriers.

(7) **Flashfill:** Use of Flashfill is permitted as an alternative material for trench backfilling, consistent with Subsection 206.03 of the CDOT Standard Specifications for Road and Bridge Construction (2023), as may be amended from time to time.

Table 9-2: Flowable Fill Requirements

Ingredients	Lbs./C.Y.	Kg/m^3
Cement	50	30
Coarse Aggregate (AASHTO No. 57 or 67)	1,700	1,009
Fine Aggregate (AASHTO M 6)	1,845	1,095
Water (39 gallons) (147L)	325 (or as needed)	193 (or as needed)

(a) Enough water shall be used so that the flowable fill flows into place properly without excessive segregation. Approximately 39 gallons of water per cubic yard (193 liters per cubic meter) of flowable fill is normally needed. Additional water shall not be added to the mixture at the project site.

(b) The contractor may use aggregate that does not meet the specifications in Table 9-2, "Flowable Fill Requirements," if the cement is increased to 100 pounds per cubic yard (60 kilograms per cubic meter) and the aggregate conforms to following gradation:

Sieve Size or Designation	Percent Passing
1 inch (25.0 mm)	100%
No. 200	0-10%

(c) The contractor may make the following substitutions in the flowable fill mix:

(i) Thirty pounds per cubic yard (18 kilograms per cubic meter) of cement and 30 pounds per cubic yard (18 kilograms per cubic meter) of fly ash for 50 pounds per cubic yard (30 kilograms per cubic meter) of cement, or

(ii) Sixty pounds per cubic yard (36 kilograms per cubic meter) of cement and 60 pounds per cubic yard (36 kilograms per cubic meter) of fly ash for 100 pounds per cubic yard (60 kilograms per cubic meter) of cement.

(d) The City reserves the right to review the use of recycled broken glass (glass cullet) as part or all of the aggregate.

(e) Compaction of flowable fill shall not be required

(f) The maximum layer thickness for flowable fill shall be 3-feet. Additional layers shall not be placed until the flowable fill has lost sufficient moisture to be walked on without indenting more than 2-inches. Any damage resulting from placing flowable fill in layers that are too thick or from not allowing sufficient time between placement of layers shall be repaired at the Contractor's expense.

(~~7~~8) **Rock Backfill Material:** Rock backfill material shall be an imported graded material that meets either the 57/67 size requirements of ASTM C33 or the requirements for stabilization material specified in Subsection 9.02(B)(3) of these Standards.

(C) Execution

(1) **Site Preparation**

(a) All sites to be occupied by permanent construction shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. All waste materials shall be removed from the site and properly disposed.

(b) In natural areas where excavation will occur all topsoil shall be stripped or, in the absence of topsoil, the top 6 inches of surface material shall be stripped and stored separately from other excavated materials.

(c) For concrete walks, roadways, parking areas, and road crossings existing pavement shall be cut full depth to a true line before excavation. For Portland Cement pavements, cuts shall be made at existing joints.

(2) **Classification of Excavated Materials:** Excavated materials shall not be classified. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

(3) **Unauthorized Excavation:** Undermining or tunneling under walls, footings, slabs on grade, foundations, sidewalks, concrete or bituminous asphalt pavements, or any other surface or subsurface facilities or structures shall not be permitted unless authorized by the Director. If unauthorized tunneling or undermining occurs, the contractor shall pay for all repairs and restorations the Director deems necessary. The repairs and restorations may include removing and replacing part or all of the affected facility or structure.

(4) **Stabilization of Subgrades**

(a) Subgrades for concrete structures and trench bottoms shall be firm, dense, thoroughly compacted and consolidated, and free from mud and muck.

(b) Subgrades for concrete structures or trench bottoms that are otherwise solid, but become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel meeting the requirements for stabilization material, described in Subsection 9.02(B)(3) of these Standards and approved by the

Director.

(c) Stabilization material shall be spread and compacted to a depth of not more than 4 inches. However, if the required depth exceeds 4 inches, the subgrade for concrete structures or trench bottom shall be re-excavated and all mud and muck removed and replaced with stabilization material, as required by Subsection 9.02(B)(3) of these Standards and approved by the Director.

(d) This material shall be placed, and compacted, as prescribed in these Standards. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the drawings.

(5) **Blasting:** Blasting or other use of explosives for excavation will not be permitted.

(6) **Shoring**

(a) All excavations shall be properly shored and braced to meet federal, state and local laws governing safe working conditions. The shoring shall be arranged so that no stress is placed on any portion of the completed work until the general construction thereof has proceeded far enough to provide ample strength.

(b) Shoring shall be removed as the work progresses. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling.

(c) Where trench sheeting is left in place, such sheeting shall not be braced against the pipe but shall be supported in a manner that will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

(d) The contractor shall pay to repair any damage to pipes or structures resulting from missing, failed or improper shoring, sheeting, or bracing or any negligence on the part of the contractor.

(7) **Water Control and Dewatering**

(a) Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

(b) All excavations for concrete structures or trenches that extend down to or below the groundwater table shall be dewatered by lowering and keeping the groundwater level 12 inches or more below the bottom of the excavation.

(c) Surface water shall be diverted or otherwise prevented from entering the excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

(d) The contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes. All such pipe or conduit shall be left clean and free of sediment.

(8) **Trench Excavation:** Trenches shall be excavated so that pipes can be laid according to the profiles, grades, elevations, and minimum cover shown on the drawings or specified in these Standards. Trench subgrades shall be clean and free of loose material of any

kind.

(a) Excavation in Streets and Other Paved Surfaces: Excavations in streets with asphalt paving must be confined to the minimum width required to maintain a safe trench condition. The contractor shall pay for replacing any pavement damage resulting from their construction work. The Director will determine the limits of the damaged pavement needing replacement.

(b) Minimum Cover: Where pipe grades or elevations are not definitely fixed by the approved plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe as follows:

(i) Water lines require at least 4.5 feet of cover;

(ii) Sanitary sewers require at least 3 feet of cover; and

(iii) Storm sewers require at least 1.5 feet of cover.

(c) Trench Widths

(i) Trench widths shall be as shown below where the maximum trench width is measured at the top of the pipe barrel:

Pipe Diameter Inches	Maximum Trench Inches	Pipe Diameter Inches	Maximum Trench Inches
4	24	24	48
6	26	27	52
8	28	30	56
10	30	33	60
12	34	36	68
14	36	39	72
15	37	42	76
16	38	48	82
18	40	54	90
20	42	72	110
21	44		

(ii) If the stated maximum trench widths are exceeded, and if the Director determines that the combined dead- and live-loads will exceed the design loadings on the pipe, the Director may require the contractor to either cradle the pipe in concrete or use a pipe of a stronger class. Remedial measures shall be entirely at the contractor's expense.

(iii) As illustrated on Drawing No. 4.03 in Chapter 11, "Technical Drawings," of these Standards, the pipe trench shall be excavated to a depth below the bottom of the pipe, backfilled with the specified granular bedding material, and compacted to the requirements of these Standards.

(iv) Narrow Trenching Widths shall be 1 to 3 inches but no more than 1 inch greater than conduit size.

(d) Trench Walls

(i) The contractor may slope or bench trench sidewalls in areas where an increased trench width will not interfere with surface features or other utilities. Such sloping or benching shall terminate at least 1 foot above the top of the pipe barrel; from that point down, the trench wall shall be vertical.

(ii) The trenching operation, including the spoil bank and the sloping of trench sidewalls, shall be confined to the width of any permanent and temporary rights-of-way or easements.

(iii) A sufficient clear area shall be maintained away from the top edge of the excavation to avoid overloading that may cause slides or caving of the trench walls. The excavated material shall be kept trimmed to avoid inconveniencing the public and adjoining property owners. Unless otherwise authorized by the Director, all public thoroughfares and crossroads shall be kept open to traffic. When required by the Director, the contractor shall, at their own expense, provide open-cut bridging at street crossings, sidewalks, and other necessary points to prevent serious travel interruptions and to provide access to fire hydrants and public and private premises.

(e) Trench Preparation

(i) The trench shall be excavated only so far in advance of pipe laying as permitted by the Director. Trench preparation shall also conform to the details shown on the drawings in Chapter 11, "Technical Drawings," of these Standards.

(ii) Bell holes in the trench bottom shall be provided at each joint to permit the jointing to be made properly and to prevent the pipe from bearing on the pipe bells.

(iii) After excavation, the trench bottom shall be uniformly graded and hand-shaped so that the pipe barrel (exclusive of the joint) will have uniform and continuous bearing on thoroughly compacted pipe bedding material throughout the length of the pipe.

(iv) The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade and without exceeding the permissible joint deflection. If raising the pipe subgrade is necessary, and approved by the Director, compacted bedding material may be used at the contractor's expense.

(f) Excavation Material: Excess excavated material shall be removed from the construction site and disposed of by the contractor.

(g) Rock Excavation: In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material. During its placement, the bedding material shall be shaped to provide support along the full length of pipe.

(9) **Installation of Pipe Bedding**

(a) Pipe bedding material shall consist of the material as specified in Subsection

9.02(B)(2) of these Standards. Bedding material shall be placed to provide the grade and elevation specified on the approved plans.

(b) After bedding material has been placed and approved, and after the pipe has been installed and approved, the additional granular bedding material shall be installed to an elevation 12 inches above the top of the pipe.

(10) **Installation of Trench Backfill**

(a) Backfilling during freezing weather shall not be performed, except by permission of the Director. No backfill shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill.

(b) Unless accurate results cannot be obtained, the compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture- Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.

(c) When required by the Director, the contractor shall excavate backfilled trenches for purposes of performing compaction tests at locations and depths determined by the Director. The contractor shall be responsible for reinstalling and recompacting the test excavations.

(d) All backfill above the bedding material shall be carefully placed and compacted. Except for the backfill requirements as set forth under Section 8-5-12, "Standards for Repairs and Restoration of Pavement or Sidewalks," B.R.C. 1981, approved backfill material shall be placed in loose lifts, not exceeding 8 inches thick, and shall be compacted by equipment and means approved by the Director. If the contractor wishes to use equipment and means other than what was approved for the project by the Director, the contractor shall submit, in writing, a request for approval of the proposed equipment and means to the Director for review and approval. Any approval by the Director, of an alternate method of compaction shall not relieve the contractor from providing a finished product that meets or exceeds all the intents and requirements of the approved plans and these Standards.

(e) All backfill shall be compacted to 95 percent of maximum laboratory dry density or 70 percent relative density. The material shall be within 2 percent of optimum moisture content.

(f) A loose layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.

(g) Backfill material for Narrow Trenching shall be flowable fill per subsection (B) or Table 9-2 of this section.

(11) **Structural Excavation and Backfill**

(a) All structural excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

(b) The quality and moisture content of materials for backfill around and outside of

structures shall conform to the requirements for materials used for earthfills and embankments. Backfill materials shall be placed in loose lifts, not to exceed 8 inches in thickness, and shall be compacted to at least 95 percent of maximum dry density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.

(c) No backfill shall be deposited or compacted in water.

(d) Particular care shall be taken to compact structure backfill that will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less that 12 inches above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

(12) **Restoration**

(a) Streets and Roadways: Any pavements disturbed during construction shall be repaired in accordance with the requirements as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement or Sidewalks," B.R.C. 1981. All dirt and debris, including dust shall be removed from streets and paved surfaces within 3 days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.

(i) Restoration associated with Narrow Trenching in roadways: Narrow trenching within asphalt roadway shall backfill using flowable fill and allow for 1'' minimum to 6'' maximum depth of Mastic One material to restore surface, where patch must be cleaned, material flush with existing asphalt pavement grade and top coated with black colored surface aggregate material per CDOT specs 703.05 – Aggregate for Cover Coat Material, for the purpose of surface grip. Narrow trenching within concrete paved roadways shall not be permitted unless otherwise approved by the director. Mastic One, or equivalent material, shall be listed on the CDOT approved products list.

(ii) Restoration associated with Narrow Trenching in Bike Lanes: Asphalt pavement within a designated bike lane shall be completed within 10 calendar days of backfilling and include, flowable fill, Mastic One, mill & overlay the full width of the bike lane, or from center of roadway to edge of concrete lip line. If trench abuts curb & gutter concrete lip line and the bike lane is greater than 3 feet wide, measured from edge of striping to edge of concrete lip edge, mill & overlay is not required, unless otherwise directed by the city. Pavement cuts for lateral tie-in's that extend beyond the width of the parallel trench require full width restoration of the bike lane.

(iii) Restorations associated with Underground Utility Potholing: All potholes must be filled with flowable-fill within 10 calendar days per mix design outlined in Table 9-2 of these standards and use of a concrete vibrator is required at time of flowable-fill backfilling operations. All surface

restorations within concrete must be restored with approved concrete mix. All surface restorations within asphalt must be restored using hot-mix asphalt. Temporary and Final restored surfaces must remain flush with adjacent roadway grade at all times. Any utility potholes that are found failing, and are still within the warranty period, must be restored by the contractor within the timeline the city determines necessary for the safety & security of the public.

(iv) Any street markings or striping removed, damaged or impacted, must be restored within 14 days, 10 for bike lanes, using approved materials.

(b) Fencing and Culverts: Restore all existing structures to conditions equal to or exceeding existing structures.

(c) Landscape

(i) After other outside work has been finished, and backfilling and embankments completed and settled, all areas that are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas that have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

(ii) Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

(iii) Final grading and surfacing shall be smooth, even, and free from clods and stones larger than 1 inch in greatest dimension, weeds, brush, and other debris.

(iv) The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

(v) The Director will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

(13) **Cleanup:** The contractor shall maintain a clean site at all times. Prior to final inspection and acceptance, the contractor shall remove all rubbish and excess materials and leave the area in a neat, satisfactory condition.

(14) **Maintenance of Backfill:** All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained for a period of 2 years following the date of final acceptance of all work. When the contractor discovers or is notified by the City that any backfill is not in compliance with City standards, the contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the contractor to the satisfaction of the City. In addition, the contractor shall be responsible for the cost of all claims for damages due to settlement of backfilled areas.

9.03 Ductile Iron Pipe (DIP)

(A) General

(1) **Scope:** This section describes the furnishing and installation of ductile iron pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4 inches to 30 inches.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Ductile Iron Pipe**

(a) Unless revised on the approved drawings, the ductile-iron pipe shall conform to ANSI A21.51, AWWA C151, Class 52 thickness. The interior of each length of pipe shall have a cement-mortar lining, conforming to the requirements set forth in ANSI A21.4, AWWA C104, of standard thickness. The exterior of the pipe shall be coated with standard coating approximately 1 mil thick.

(b) Unless otherwise specified, the pipe joint shall be the "push-on" type, made in accordance with ANSI A21.11, AWWA C111, and the gaskets shall be standard for buried water service and as provided by the pipe manufacturer.

(2) **Polyethylene Wrap**

(a) All ductile iron pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in accordance with all recommendations and practices of the AWWA M4 l, Manual of Water Supply Practices - Ductile Iron Pipe and Fittings.

(b) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.

(c) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.

(d) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

(e) Tube Size or Sheet Width: Table 9-3, "Tube Size and Sheet Width for Pipe Diameter," shows the tube size or sheet width for each pipe diameter.

Table 9-3: Tube Size and Sheet Width for Pipe Diameter

Nominal Pipe Diameter (Inches)	Flat Tube (Inches)	Minimum Sheet Width (Inches)
4"	16"	32"
6"	20"	40"
8"	24"	48"

10”	27”	54”
12”	30”	60”
14”	34”	68”
16”	37”	74”
18”	41”	82”
20”	45”	90”
24”	54”	108”

(C) Thrust Restraint

Where designated by the Engineer with expertise in thrust restraint systems, or where existing conditions do not permit the use of concrete thrust blocks, individual joint restraint systems shall be provided as follows:

(1) **Alternative A:** Full length tie rods between joints. “Star” systems fabricated from “Cor-Ten” steel or an equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings.

(2) **Alternative B:** Pacific States Lock Mechanical Joint with Tyton Joint Core, or equivalent fittings with ductile iron joint restraint features conforming to ANSI Standard A21.10. Push-on joints for such fittings shall be in accordance with AWWA Standard A121.11. Assembly of the joint portion of the product shall be in accordance with AWWA C600-77

(3) **Alternative C**

(a) Follower gland type systems may be used for 12-inch diameter pipe and smaller. Pipe clamps shall be fabricated from “Cor-Ten” steel or an equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings. The follower gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to AWWA C111 and C153.

(b) The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as tee head bolts, shall be used to ensure proper actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain. The device shall have a working pressure of at least 200-psi with a minimum safety factor of 2:1.

(c) Follower gland joint restraint devices shall be of the type listed below:

(i) “EBAA Iron, Inc.,” Megalug 1100 Series (4 -12 inches)

(ii) “Uniflange,”1400 Series (4 -12 inches)

(D) Connections to the Existing System

(1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.

(2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved drawings.

(3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the affected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.

(4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the contractor shall advise such customer in writing 24 hours in advance of when the supply will be disconnected and reestablished.

(E) Execution

(1) **Installation of Ductile Iron Pipe:** Except as specified herein or unless specifically authorized by the Director, all installation of pipe shall conform to the recommendations contained in "Installation Guide for Ductile Iron Pipe," published by the Ductile Iron Pipe Research Association. The contractor shall assure that a copy is available at the job site.

(a) Pipe Laying

(i) Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Director. Pipe shall be laid on the bedding with support over the full length of the pipe barrel.

(ii) Table 9-4, "Ductile Iron Pipe Deflection," shows the maximum allowable pipe joint deflections.

(iii) The information in the columns referring to the deflection and the approximate radii shall be adjusted for pipe lengths different than 18-foot lengths. Shorter pipe lengths will be required if a shorter radius is called for on the approved construction plans. Double hubs may be used to lay pipelines on curved alignment.

Table 9-4: Ductile-Iron Pipe Deflection

Size of Pipe (Inches)	Approximate Radius of Curve Produced by: Bend in One Joint (%)	Deflection in One 18-Foot Length (Inches)	Succession of 18-Foot Joints (Feet)
4 -12	4	15	250
14 - 24	2	7.5	510

(iv) Vertical deflections shall not exceed any of the above values.

(v) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.

(vi) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. The pipe end shall be beveled and free of sharp edges that could damage the gasket during installation.

(b) Mechanical Joints: Mechanical joints shall be installed per the manufacturer's specifications and guidelines.

(c) Push-On Joints: For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. The proper gasket supplied with the pipe shall be placed in the bell in compliance with the manufacturer's specifications and guidelines so it will spring into its proper place inside the pipe bell. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position.

(d) Installation of Polyethylene Wrap

(i) All pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in accordance with all recommendations and practices of the AWWA M4 l, Manual of Water Supply Practices -Ductile Iron Pipe and Fittings.

(ii) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.

(iii) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.

(iv) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

(2) **Installation of Thrust Restraint**

(a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.

(b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on each side of the pipe. The tie rod nut should first be hand tightened with a 12-

inch wrench (approximately 50 to 100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.

(c) Follower gland type joint restraint systems shall be assembled according to manufacturer's instructions.

(3) **Testing:** Testing of ductile iron pipe shall be as specified in Section 9.13, "Testing of Water Pipes," of these Standards.

(4) **Backfilling and Restoring Surface Conditions:** Surface conditions shall be backfilled and restored as specified in Section 9.02, "Excavation and Trenching," of these Standards.

(5) **Disinfecting Potable Pipelines:** Ductile iron pipe shall be disinfected as specified Section 9.12, "Disinfecting Waterlines," of these Standards.

9.04 Polyvinyl Chloride (PVC) Pressure Pipe

(A) General

(1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) pressure pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4 to 12 inches.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **PVC Pressure Pipe**

(a) All PVC pipe shall meet the requirements of AWWA C-900-16, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (4 – 12 inches) and shall be Pressure Class 305 psi (DR 14), or shall meet the requirements of AWWA C-905-08, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (14 – 48 inches) and shall be Pressure Class 235 psi (DR 18).

(b) All pipe shall be suitable for use as a pressure conduit. Provisions must be made for expansion and contraction at each joint with a rubber ring. The bell shall consist of an integral wall section with a solid cross-section rubber ring which meets the requirements of AWWA C-900-07.

(c) Laying length of pipe shall be 20 feet for all sizes of pipe.

(d) Each length of pipe shall bear the date manufactured, type, grade, length, manufacturer's name, and NSF seal of approval.

(e) Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint.

(f) Solvent cement joints are prohibited.

(g) The manufacturer shall furnish a certified statement that all specified tests and inspections have been made and the results thereof comply with the AWWA standards specified in this Subsection 9.04(B). A copy of the certification shall be sent to the City upon request.

(2) **Polyethylene Encasement**

(a) All pipeline fittings and appurtenances shall be encased in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105.

(b) The finished polyethylene film shall have a minimum nominal thickness of 0.008-inch (8 mil), and the minus tolerance on thickness shall not exceed 10 percent of the nominal thickness. The film shall have at least 1200-psi tensile strength of with an elongation of 300 percent minimum. The dielectric strength shall be at least 800 volts per mil thick.

(3) **Tracer Cable:** Tracer wire shall be Type THHN, AWG size #12, UL listed with a single copper conductor, PVC insulation, and nylon jacket. Test stations at fire hydrants shall be CP Test Services, Glenn Series Glenn-4 with locking lid, 3½ x 4 inches, or approved equal.

(C) Thrust Restraint

(1) **Required:** All fittings and joints shall be restraint from movement due to hydraulic forces with concrete thrust blocks as shown in Chapter 11, "Technical Drawings," of these Standards except where existing conditions or other practical difficulties do not permit the use of concrete thrust blocks. Where the applicant demonstrates to the satisfaction of the Director that existing conditions or other practical difficulties do not permit the use of concrete thrust blocks, individual restraint systems shall be provided meeting one of the following:

(a) Alternative A - Full Length Threaded Tie Rods: Threaded rods shall be Type 316L stainless steel coated with an anti-galling compound. Connecting T-bolts and nuts shall be Type 316L stainless steel coated with an anti-galling compound or corrosion resistant fluorocarbon coating such as "NSS Industries" Cor-Blue or "Star Pipe Products" Core Blue. The number and diameter of tie rods shall be as shown on the approved plans.

(b) Alternative B - Follower Gland Type Mechanical Joint Restraint Systems: Follower gland type mechanical joint restraint systems may be used only for 16-inch diameter and smaller pipe. Restraint rings shall be manufactured of ductile iron conforming to ASTM A536, Grade 65-45-12 with a factory applied fusion epoxy coating. The mechanical joint follower gland shall be incorporated into the restraint. Connecting T-bolts and nuts shall be as required in Alternative A.

(c) Alternative C - Bolt-Through Positive Restraint Mechanisms: A bolt-through positive restraint mechanism may be used only for connecting 12-inch diameter and smaller mechanical joint valves and fittings. It shall not be used for pipe attachment or fire hydrant connections. Adaptor body shall be made of ductile iron, conforming to ASTM A536 80-55-06 with styrene butadiene rubber gaskets conforming to AWWA C111. Connecting T-bolts and nuts shall be as required in Alternative A.

(2) **Bell-And-Spigot Joints:** Restraint devices for PVC pipe bell-and-spigot joints may be used, if approved by the Director, for sizes 4 to 16 inches. Devices shall be of ductile iron conforming to ASTM A536. Connecting T-bolts and rods as required in Alternative A.

(3) **Mechanical Joint Restraint Required:** Mechanical joint restraint devices are required for the following installations:

(a) Fire hydrants;

(b) Fire line connections;

(c) Three inch and larger domestic line connections;

(d) Reducers;

(e) Vertical and horizontal offsets (all angles);

(f) Bends, line valves, and fittings;

(g) Bulkheads and plugs;

(h) Bored casing carrier pipe; and

(i) When the bearing capacity of the soil is not sufficient to provide adequate restraint, as determined by the Director.

(4) **Mechanical Joint Restraint Design Requirements:** The mechanical restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability; or a series of machined serrations designed to grip the entire pipe surface; or a system that is integral to the gasket. For twist-off nut-type designs, the nuts shall be sized the same as T- bolts and be used to insure proper actuating of restraining devices. When the nut head is sheared off, a standard hex nut shall remain. All devices shall have a working pressure of at least 200 psi with a minimum safety factor of 2:1.

(5) **Follower Gland Type Joint Restraints:** Follower gland type joint restraint devices shall be of the type listed below:

(a) "EBAA Iron"

(i) Megalug 2000 Series for PVC (4 to 16 inches)

(ii) Megalug 1600 Series for PVC (4 to 12 inches) Pipe Bell Joints

(iii) Megalug 2800 Series for PVC (14 inches and larger)

(b) "Star Pipe Products"

(i) Domestic PVC Stargrip Series 4000 (4 to 12 inches)

(ii) Domestic 1100C Bell Restrainers Series 1100 for PVC Pipe Bell Joints

(c) "U.S. Pipe": MJ FIELD LOK Gasket with MJ FIELD LOK Gland, Series for PVC (4 to 12 inches)

(d) "Romac Industries": PVC RomaGrip Series, fusion bonded polyester coating is required if using C909 PVC

(6) **Bolt-Through Mechanical Joint Restraints:** Bolt-through mechanical joint restraint devices shall be of the type listed below:

(a) "Infact Corporation": Foster Adaptor (4 to12 inches) with fusion bonded epoxy coating. Standard foster adaptor accessory pak is required for restraining C153 compact fittings and valves

(D) Connections to the Existing System

(1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.

(2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved construction plans.

(3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the effected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.

(4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the owner-developer-contractor shall advise such customer in writing 24 hours in advance of when the supply will be disconnected and when the supply will again be available.

(E) Execution

(1) **Installation of PVC Pressure Pipe:** Unless specifically authorized by the Director, all pipe shall be installed as follows:

(a) Pipe Laying

(i) Pipe shall be laid with bell ends facing in the direction of laying. No deflection in the joints shall be allowed. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or to plumb valve operators, the pipe itself may be uniformly curved as shown in Table 9-5, "Pipe Laying."

Table 9-5: Pipe Laying

Approximate Pipe Size (Inches)	Offset in 20-Foot Length (Inches)	Radius of Curve (Feet)
4"	15"	120'
6"	15"	160'
8"	15"	250'
10"	15"	300'
12"	15"	400'

(ii) Pipe deflection for curvature shall not be permitted at temperatures less than 32° F ambient temperature.

(iii) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.

(iv) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field cut pipe.

(v) Tracer wire shall be attached to the pipe as shown in Chapter 11, "Technical Drawings," of these Standards.

(b) Mechanical Joints: Mechanical joints shall be installed per the manufacturer's specifications and guidelines.

(c) Push-On Joints: For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position. Position the completed joint so that the joint mark on the pipe end is in line with the end of the bell.

(2) **Installation of Thrust Restraint**

(a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.

(b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on each side of the pipe. The tie rod nut should first be hand tightened with a 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.

(c) Follower gland type joint restraint systems shall be assembled according to manufacturer's instructions.

(3) **Installation of Tracer Cable:** Tracer wire shall be spirally wrapped around the pipe exterior, 2 wraps minimum per 20-feet of pipe, as it is installed in the trench or taped to the top of the pipe. Splices due to breaks in wire continuity shall be made by stripping insulation coating from each wire with wire stripper pliers. Wires shall be joined with a solderless connector, 3M Direct Bury Splice Kit or equivalent in suitability, strength, effectiveness, and durability as approved by the Director. The join shall be made in accordance with manufacturer instructions. The solderless connector shall be covered with Emmerson Electric Seal-A-Conn II putty or approved equal.

The wire shall form a continuous electrical circuit between any 2 contact points on the new pipeline, including branch lines and fire hydrant laterals. Wire shall be stubbed out to the point where the new pipe connects to the existing main unless otherwise directed by the Director. Where the wire terminates at a point where there is not an installed wire, the ends of the wire shall be stripped bare a minimum of 18-inches and grounded into the native soil material. Special care should be taken to avoid contact from the tracer wire to steel gas service lines.

(4) **Testing:** Testing of PVC pressure pipe shall be as specified in Section 9.13, "Testing of Water Pipes," of these Standards.

(5) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.

(6) **Disinfecting Potable Pipelines:** PVC pressure pipe shall be disinfected as specified Section 9.12, "Disinfecting Waterlines," of these Standards.

9.05 Water Services

(A) General

(1) **Scope:** This section describes the furnishing and installation of water services and fire lines in the pipe diameter size range of 3/4 to 2 inches. For water services and fire lines greater than 2 inches in diameter refer to Section 9.03, "Ductile Iron Pipe," Section 9.04, "Polyvinyl Chloride (PVC) Pressure Pipe," Section 9.06, "Gate Valves," and Section 9.08, "Tapping Sleeves and Valves," of these Standards.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Pipe:** Pipe shall be Type K copper, soft drawn, in accordance with ASTM B88.

(2) **Curb Stops:** All curb stops shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). Curb stop valves shall be ball type with a maximum working pressure of 300 psi and shall have compression fittings.

(3) **Corporation Stops**

(a) All corporation stops and threaded brass fittings shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). All corporation stops shall be tested at the factory and shall meet the following minimum physical requirements:

(i) Tensile strength 30,000 PSI minimum.

(ii) Yield Strength 14,000 PSI minimum.

(iii) Elongation in 2 inches 20 percent minimum.

(b) Corporation stops shall be ball valve type designed for a maximum working pressure of 300 psi. The inlet side shall have AWWA taper thread (CC thread) and the outlet side shall have a compression fitting.

(c) Corporation stops shall be the following type or a corporation stop approved by the Director as equivalent in design and composition to the following types:

(i) Ford – FB1000-3-NLG.

(ii) Mcdonald – 74701BQ No lead brass.

(iii) Mueller – B25008N.

(4) **Water Meters**

(a) General: All water meter installations shall be in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards for all water services:

(i) All meters shall be "Badger" meters.

(ii) No connections shall be made in the meter pit other than those related to the meter and bypass. Sprinkler system or backflow preventer connections shall be made no closer than 5 feet from the meter pit or vault on the downstream side of the meter.

(iii) The city will own and maintain the service line and fittings up to and including the meter.

(iv) Residential 3/4-inch meters with transponders shall be provided and installed by the City upon the contractor's request for a final meter inspection. All other meters and associated transponders shall be purchased by the contractor and then provided to the City for testing prior to installation.

(v) The contractor shall contact the City's Meter Shop prior to purchasing meters and transponders to verify the type of meter that will be required. The contractor shall also contact the City's Meter Shop to make an appointment for delivery of the meter(s) to the City for testing. The location of installation and manufacturer's information shall accompany the meter when delivered by the contractor to the City. The meter will be tested and a schedule set for picking up the meter within two working days by the contractor.

(b) 3/4-Inch and 1-Inch Meter Installations: 3/4-inch and 1-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

(i) The meter shall be installed within right-of-way or a public easement.

(ii) No meter shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces.

(iii) In attached sidewalk areas, the meter shall be located a minimum of 18 inches from the back of the sidewalk to the edge of the meter lid.

(iv) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back edge of the curb.

(v) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.

(vi) The dome or meter lid shall be level and 2 inches above the approved final grade.

(vii) The copper setter shall be a minimum of 15 inches and a maximum of 17 inches below the meter pit lid.

(viii) Meter pits shall be constructed of modified hi-density polyethylene. The size shall be as specified in the detail drawing in the appendix of this Chapter. Grade adjustment shall be made at the top of the pit using concrete rings. The trench floor under the concrete rings shall be compacted earth. The concrete pit shall not bear on the service pipe.

(ix) Lids shall be a 12-inch cast iron lid and bonnet and shall have a 2-inch diameter hole in the center to accommodate the transponder.

(x) Final inspections of the meter pit will be made at the time the meter is set. The permit applicant is responsible for any required adjustments to the copper setter or meter lid at that time.

(c) 1-1/2-Inch and 2-Inch Meter Installations: 1-1/2 -inch and 2-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

(i) The meter model shall be Badger E112 SS 1 ½ Model 120 or Badger E2 SS 2 Model 170.

(ii) 1-1/2-inch and 2-inch meters shall be installed in a manhole.

(iii) A meter manhole shall be installed within the right-of-way or a public utility easement.

(iv) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.

(v) In attached sidewalk areas, the meter manhole shall be located a minimum of 3 feet behind the sidewalk and in no case shall the manhole be located more than 25 feet from the back edge of curb.

(vi) Where no sidewalk exists, the meter manhole shall be located a maximum of 6 feet behind the back of curb.

(vii) In detached sidewalk areas, the meter manhole shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.

(viii) Meter manhole lids shall be a maximum of 2 inches above the approved final grade.

(ix) A curb stop is required on the service line behind the back of curb and outside of the manhole.

(x) Meter manholes shall use a 24-inch aluminum ring and cover, and the outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch-thick concrete collar shall be placed around the manhole ring.

(xi) The manhole cover shall have a 2-inch diameter recessed hole in the center of the cover for the transponder, and the cover shall have the lettering "Water Meter" cast into the lid.

(d) 3-Inch and Larger Meter Installations: 3-inch and larger meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

(i) 3-inch and larger meters shall be installed in a vault.

(ii) The entry hole through the roof of the vault shall be aligned perpendicular to the service line and adjacent to the water meter.

(iii) Vaults shall be sealed at all joints and made watertight.

(iv) Meter vault lids shall be a maximum of 2 inches above the approved final grade.

(v) In attached sidewalk areas, the meter vault shall be located a minimum of 5 feet behind sidewalk or back of curb and no more than 25 feet from the back of curb.

(vi) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back of curb.

(vii) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.

(viii) A curb stop is required on the service line behind the back of curb and outside of the vault.

(ix) The meter vault shall be installed within the right-of-way or a public utility easement.

(x) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.

(xi) Meter vaults shall use a 24-inch aluminum cover and shall have the lettering "Water Meter" cast into the lid.

(xii) A 24-inch x 36-inch aluminum cover adaptor and ring shall be used to enlarge the access opening, and the adaptor shall have a 2-inch diameter hole for the transponder. The outside of the aluminum ring shall have 8

mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch-thick concrete collar shall be placed around the manhole ring.

(xiii) PVC pressure pipe shall be used on the service line outside the vault except where the PVC pipe stubs through the vault walls. Ductile iron pipe shall be used inside the vault.

(xiv) For all 3-inch and 4-inch meter settings, 4-inch service pipe will be required on the city side of the meter. A reducer will be required before the meter and on the bypass for 3-inch settings. Insulators shall be provided between connections of dissimilar metals. Meter installations larger than 4 inches shall require submittal of drawings for approval by the Director.

(xv) A minimum of distance 5 times the pipe diameter of straight, unobstructed pipe is required upstream of the meter.

(xvi) Final inspections of the meter vault will be made at the time the meter is set.

(5) **Service Saddles:** Corporation stops require the installation of a bronze or brass bodied service saddle with 304L stainless steel double straps and studs, equivalent in design and composition to “Mueller” BR 2 S series or “McDonald" 3855 series for cast iron or PVC. All saddles require an AWWA tapered thread (CC) outlet. No direct taps to PVC pipe are allowed.

(6) **Insulators (Ferrous Pipes only):** Insulators shall be installed at the inlet end of the corporation stop and shall be Ford Service Insulators or an approved equivalent for service lines.

(C) Execution

(1) **General**

(a) Size as shown, lay to grades and lines in accordance with pipe manufacturer’s specifications. Thoroughly clean pipe interiors of foreign matter before placing into trench. Replace with new pipe any laid section of pipe found damaged or defective. All pipe fittings, valves, and appurtenances shall be installed according to manufacturer’s instructions. Corporation stops shall be installed with the appropriate tapping machine in the presence of the Director after the waterline has been pressure tested.

(b) All bedding, pipe zone backfill, compaction, polyethylene sheathing and other details of the water pipeline construction shall be returned to original condition after service connections are completed.

(c) Service connections to all ferrous mains shall be electrically insulated by means of a City approved insulating fitting.

(2) **Pipe Cutting:** Cutting shall be done neatly by methods that will not damage pipe.

(3) **Testing:** Testing of water service pipe shall be as specified in Section 9.13, “Testing of Water Pipes,” of these Standards.

(4) **Backfilling and Restoring Surface Conditions:** Backfilling and Restoring surface conditions shall be as specified in Section 9.02, “Excavation and Trenching,” of these Standards.

(5) **Disinfecting Potable Pipelines:** Water service pipe shall be disinfected as specified Section 9.12, "Disinfecting Waterlines," of these Standards.

9.06 Gate Valves

(A) General

(1) **Scope:** This section describes the furnishing and installation of gate valves and appurtenances for potable water service in the pipe diameter size range of 4 to 12 inches.

(2) **Quality Assurance**

(a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(b) All valves shall be tested in accordance with AWWA C500 or C509. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

(B) Materials

(1) **Gate Valves**

(a) Gate valves are required for 4-inch through 12-inch valve sizes. The Director may approve a different valve type where practical installation of a gate valve is not feasible.

(b) Gate valves shall be iron body, resilient-seated gate valves with non-rising bronze stems with design, construction, and pressure ratings conforming to AWWA Specifications C-509-01, Resilient Seated Gate Valves, or C515-01, Reduced Wall Resilient Seated Gate Valves, and with modifications specified herein.

(c) Stem seals shall be triple "O" ring seals designed so that the seals above the stem collar can be replaced with the valve under pressure and in full open position.

(d) Gate valves shall be one of the following types:

(i) American Flow Control, Series 2500 (C515 only).

(ii) Mueller, Series 2360 (C509 only).

(iii) American AVK.

(iv) Series 45 CLOW Valves, Models 2639 and 2640.

(e) With the exception of tapping valves and valves in vaults, gate valves shall have mechanical joint ends.

(f) All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall

have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.

(g) The resilient seat gate valve stem shall have external break-off capabilities for over-torquing and positive stop to prevent over compression.

(h) All external bolts, nuts, and washers used in conjunction with valves shall be stainless steel, and tee-bolts shall be "Cor-blu".

(i) Valves shall be delivered complete with bolts, glands, and rubber gaskets in conformance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

(2) **Valve Boxes**

(a) All buried valves shall be provided with valve boxes. Valve boxes shall be of cast iron, 3-piece screw type, suitable for the depth of cover required by the drawings. Valve boxes shall be 5 ½ inches in diameter, shall have a minimum thickness at any point of 1/16 inch, and shall be provided with suitable cast iron bases and stay-put covers. Covers shall have cast thereon “water” on the top. They shall be Tyler 6860 series or approved equal.

(b) The valve box shall have at least 6 inches adjustment above and below specified depth of cover over pipe.

(c) All parts of valve boxes, bases, and covers shall be coated by dipping in bituminous varnish.

(d) Valves and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

(3) **Special Wrenches and Keys:** All tools needed to operate valve and to open valve box lid. At least one of each type as required for each style and size of box and lid shall be furnished by the contractor. Provide 1 key for each valve. Key lengths shall be as approved by the Director.

(C) Execution

(1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.

(2) **Installation:** Install valves as indicated in Chapter 11, “Technical Drawings,” of these Standards, and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation.

(3) **Valve Boxes:** Install a valve box over the gate valve with the base section centered over the operating nut and resting on well-compacted backfill. The top section shall be so set as to allow equal movement above and below finished grade, with the final elevation to be 1/4 inch below finished grade in roadways and 1 to 2 inches above grade outside of roadways. The top of base section shall be placed approximately on line with the operating nut at the top of the valve stem, and the entire assembly shall be plumb.

(4) **Tests:** Gate valve tests shall be with and part of the general tests on the companion water lines.

(5) **Disinfection:** Gate valve disinfection shall be done with and as a part of the disinfection to the companion water lines.

9.07 Butterfly Valves

(A) General

(1) **Scope:** This section describes the furnishing and installation of butterfly valves and appurtenances for potable water service in the pipe diameter size range of 12 inches to 24 inches.

(2) **Quality Assurance:** Manufacturer's installation recommendations and certificates of compliance shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(3) **Testing:** All valves shall be tested in accordance with Section 3.8 of AWWA C504. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

(B) Materials

(1) **Butterfly Valves**

(a) Butterfly valves shall be rubber-seated conforming to the AWWA C504 and designed for buried service. The valves shall be designed to operate as open or closed with a design velocity of 8 feet per second. The valves shall have a cast-iron body with mechanical joint ends conforming to ANSI 21.11, AWWA C111 and shall be rated for a design working pressure of 150 psi. Butterfly valves shall be one of the following types: Mueller, Lineseal III and XPII (sizes up to 48 inches), Pratt, Triton XR-70 (sizes 24 inches to 72 inches), or K-Flo 500 Series (sizes up to 20 inches); unless a butterfly valve equivalent in design and composition to these types has been approved by the Director.

(b) Discs shall be cast or ductile iron with stainless steel, type 304, either stub or one-piece shafts. Discs shall be secured to shafts by means of solid, smooth sided, stainless steel or monel pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of bolts, setscrews, knurled or fluted dowel pins, expansion pins, roll pins spring pins, or other devices in lieu of the pins specified herein will not be acceptable.

(c) Shaft bearings shall be the bushing type of nylon or Teflon. Thrust bearings that are directly exposed to line liquid and that consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable. Shaft seals may be rubber ring or chevron packing.

(d) Seats shall be rubber vulcanized to the body and designed to provide bubble tight shutoff with mating surface of Type 304 or 316 stainless steel or monel mounted on the discs. Valve seat configurations that rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

(e) The valve operator shall be the traveling-nut type designed for previous stated conditions, in an enclosed body, sealed to prevent the entrance of groundwater up to the depth of 5 feet above the valve. The operator shall have travel limiting

devices to prevent over closing or opening damage to the valve. Valves shall open counterclockwise with the use of a valve key on a 2-inch square operating nut. The housing of traveling-nut type actuators shall be fitted with a removable cover that shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve.

(C) Execution

(1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.

(2) **Installation:** Install valves with the shaft horizontal according to the manufacturer's recommended installation procedures. Operate all valves from full open to full close before installation. Check all seats, seat rings, shaft sleeves, disc connections, etc. prior to installation.

(3) **Valve Boxes:** Install valve boxes over the valve operator with the base section centered over the operator nut and resting on well-compacted backfill. The top section shall be set to allow equal movement above and below finished grade, with final elevations to be 1/4 inch below finished grade in roadways and 1 inch to 2 inches above grade outside of roadways. The top of base sections shall be placed approximately on line with the operator nut at the top of the valve stem, and the entire assembly shall be plumb.

(4) **Tests:** Butterfly valve tests shall be done with and as a part of the general tests on the companion water lines.

(5) **Disinfection:** Butterfly valve disinfection shall be done with and as a part of the general disinfection to the companion water line.

9.08 Tapping Sleeves and Valves

(A) General

(1) **Scope:** This section describes the furnishing and installation of tapping sleeves and valves for potable water service in the pipe diameter size range of 4 inches to 12 inches.

(2) **Quality Assurance**

(a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(b) The manufacturer of tapping sleeves and valves shall be experienced in their design and construction, shall be regularly engaged in their manufacture, and shall have produced tapping sleeves and valves of the sizes specified herein that have given successful service for a period of at least 5 years.

(B) Materials

(1) **General**

(a) All tapping sleeves shall be constructed of stainless steel that meets or exceeds the requirements of ASTM A240 Type 304 UNS designated S30400. Tapping sleeves shall be "Romac Industries" SST, "Mueller" H-

304L, "Ford" FTSS, "JCM" 432, or a tapping sleeve of equivalent design, material, and rating approved by the Director.

(b) Extension stems, valve boxes, and special wrenches and keys shall be as specified in Section 9.06(B), "Materials," of these Standards.

(2) **Flanges:** Flanges shall be fabricated from steel plate, and all dimensions shall conform to AWWA Standard C207, Class D. Flanges shall be machined to a flat rate with finish of 250 micro inches or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207. In addition, the machined face shall also be recessed for tapping valves in accordance with the MSS Standard SP-60.

(3) **Gaskets:** Gaskets shall be compounded from new materials, and the shape and cross-section of the gasket shall provide adequate seal for the design pressure. Gaskets shall be shop glued to the groove provided in the body section.

(4) **Fasteners:** Bolts and hex nuts shall be stainless steel or an approved equivalent for corrosion control.

(5) **Testing Outlet:** A 3/4-inch NPT by welded coupling shall be attached to the outlet nozzle of each tapping sleeve assembly, complete with a 3/4-inch square head pipe plug.

(6) **Tapping Valves:** With the exception of the valve ends and other modifications necessary for tapping service, tapping valves shall be as specified in Section 9.06(B), "Materials," of these Standards. Each tapping valve shall be provided with a flanged inlet end designed, faced and drilled for attachment to the outlet flange of the tapping sleeve; an outlet end provided with a tapping flange for attachment of a standard drilling machine; and a mechanical joint bell end for connection of the branch main. The size of the waterway shall include the appropriate clearance for the diameter of the tapping machine cutter recommended by the valve manufacturer. Tapping valves shall be Mueller "No. H-667" or equal.

(7) **Painting:** All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.

(C) Execution

(1) **Tapping Valves:** Install tapping valves in the lines as indicated on the drawings and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation. Valves shall be securely bolted to the tapping sleeve in accordance with the manufacturer's instructions using the fasteners specified in Subsection 9.08(B)(4) of these Standards.

(2) **Tests:** Valve tests shall be done with and as a part of the general tests on the companion waterlines.

(3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterline.

9.09 Fire Hydrants

(A) General

(1) **Scope:** This section describes the furnishing and installation of fire hydrants for potable water service.

(2) **Quality Assurance**

(a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(b) All valves shall be tested in accordance with Section 5.1 of AWWA C502. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

(B) Materials

Fire hydrants shall be "Mueller" Super Centurion 250 A-423 or "CLOW" Medallion 395" (the "CLOW" Medallion shall be a higher-pressure rating with chain tagged "heavy duty"), with mechanical joint bottom connection and meet the following requirements:

(1) **Inlet Pipe:** 6-inch, mechanical joint inlet shoe and accessories.

(2) **Trench Depth:** 4-1/2 feet cover (Note: standard shipping depth is 5.0").

(3) **Operating Nut:** 1-1/2-inch Pentagon National Standard Threads.

(4) **Open:** Left (CCW).

(5) **Connection:** Two 2-1/2-inch hose nozzles and one 5-1/4-inch pumper nozzle.

(6) **Threads:** National Standard Hose Threads.

(7) **Pressure:** 150 psi working pressure, 300 psi pressure.

(8) **Break-Off Flange:** Hydrants shall be provided with traffic break-off flange.

(9) **Mechanical Joint Bolts and Nuts:** The mechanical joint bolts and nuts shall be anti-galling coated stainless steel, "NSS" Cor-Blue, or an equivalent in design, material, and specifications.

(10) **Shoe Nuts and Bolts:** Shoe nuts and bolts shall be corrosion resistant stainless steel, Grade 304.

(11) **Color:** Color shall be Rustoleum No. 831 "restful green" or KWAL "hydrant green" except for bonnet, weather caps and nozzle caps, which must be Rustoleum No. 2766 "reflectorized white."

(12) **Spares:** A set of spare break-off parts shall be furnished.

(C) Execution

(1) **Hydrants:** Where applicable, hydrants shall be installed with pumper outlet facing the adjacent roadway or parking area. Set hydrants at such elevations that the connecting pipe shall drain to the main with a grade of not less than 1 percent, and upon a concrete foundation not less than 6 inches thick and 18 inches square. The centerline of nozzles shall be at least 18 inches above finished grade. Firmly block the back of the hydrant

opposite the pipe connection with a concrete thrust block braced against the vertical face of the trench to prevent the hydrant from blowing off the line.

(2) **Drainage Aggregate and Backfill:** Place not less than 1/3 cubic-yard of approved clean gravel or crushed rock around the base of each hydrant and 12 inches over the top of the supply pipe to insure drainage. A layer of 30-pound asphalt-saturated felt paper or heavy vinyl sheet shall be placed over gravel to keep backfill material from sifting into gravel. Thoroughly compact the backfill around hydrants, to the grade line, in an approved manner.

(3) **Operations Check:** Clean hydrant interiors of all foreign matter before installation. Stuffing boxes shall be tightened and the hydrant inspected in opened and closed positions to see that all parts are in working condition.

(4) **General:** Hydrants shall be tagged "out-of-service" until the water system is operational. It is the responsibility of the contractor to notify Boulder Police Communications regarding the location of the tagged hydrants.

9.10 Combination Air Valve

(A) General

(1) **Scope:** This section describes the furnishing and installation of combination air valves for potable water service.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Manholes:** Refer to Section 9.16, "Manholes and Inlets," of these Standards.

(2) **Combination Air Valve:** The valve shall be a 2-inch combination air release vacuum valve, "Vent-O-Mat" Series 050 RB X 25 2 1, or approved equivalent in design, material, and specifications. The combination air valve shall be provided with a 2-inch diameter hand wheel operated gate valve.

(3) **Hose Gate Valve:** A 3/4-inch hose gate valve is to be installed in the air release valve manhole. The valve shall have a bronze body, threaded end, solid wedge, union bonnet, inside screw rising stem gate valve. These valves shall be "Powell" 375 HS. Each hose gate valve shall be equipped with a brass cap and chain.

(4) **Ball Valve:** Ball valves shall be of bronze or brass construction with two-piece end entry body, bronze or brass ball, Teflon or Viton stem seal, reinforced Teflon seats and thrust washer, a removable operating lever, and threaded ends. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be drip-tight in both directions. Valves shall be "Conbraco Industries" Apollo 70-100 Series, "Powell" Fig 4210T, or "Stockham" S-216.

(5) **Corporation Stop:** A corporation stop shall be as referenced in Subsection 9.05(B)(3), of these Standards.

(6) **Insulators:** Insulators shall be as referenced in Subsection 9.05(B)(6), of these Standards.

(C) Execution

(1) **Installation:** Install valve, manhole, and appurtenances as indicated on Drawing No. 5.22, in Chapter 11, "Technical Drawings," of these Standards, and in accordance with applicable provisions of the related sections.

(2) **Tests:** Valve tests shall done be with and as a part of the general tests on the companion waterlines.

(3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterlines.

9.11 Pipeline Fittings

(A) General

(1) **Scope:** This section describes the furnishing and installation of pipeline fittings for potable water service.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Gray or Ductile Iron:** Fittings shall be made from gray iron or ductile iron and manufactured in accordance with AWWA C110-08, Ductile Iron and Gray Iron Fittings, or AWWA C153-06, Ductile Iron Compact Fittings.

(2) **Rubber Gasket Joints:** Fittings shall be furnished with rubber gasket joints in accordance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

(3) **Design:** Fittings shall be rated for a design working pressure of 350 psi pressure rating and shall conform to the dimensions and weights shown in the tables of the AWWA standards referenced in this Section 9.11(B) of these Standards.

(4) **Certification:** The manufacturer shall prepare a certified statement that the inspection and all specified tests have been performed and the results thereof comply with the requirements of the applicable AWWA standard(s) specified in Section 9.11(B) of these Standards. The contractor shall cause a copy of the certification to be sent to the City upon request.

(5) **Ductile Iron Flanged Fittings:** Ductile iron flanged fittings shall be manufactured in accordance with the following:

(a) Integrally cast flange fittings: AWWA C110-08, Ductile Iron and Gray Iron Fittings.

(b) Threated flange fittings: AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

(c) Ductile iron flanged fittings shall be rated for 250 psi working pressure and shall be installed with special gaskets that achieve 350 psi working pressure.

(6) **4 Through 6 Inch Fittings:** 4 through 16-inch diameter fittings shall be furnished with a fusion bonded epoxy inside and out, with a standard thickness as defined in AWWA

C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings. The Director may waive the requirement for fusion bonded epoxy on fittings if the Director finds that specific fittings are not available.

(7) **Bolts and Nuts:** Fittings shall be furnished with tee-head mechanical joint bolts and hexagon nuts, fabricated from corrosion resistant high strength, low alloy steel such as "Cor-Ten" or “Blue Bolts.”

(8) **Connection fitting:** Mechanical joint anchoring fittings (swivel) shall also be used. Infact Corporation’s “Foster Adaptor” may also be used to connect between mechanical joint fittings, valves and hydrant connections.

9.12 Disinfecting Waterlines

(A) Scope

This section describes the disinfecting of all portions of the potable water system, including buried piping, valves, hydrants, and any portion of the existing connecting system that might have become contaminated during construction activities, and also any temporary water service piping used during construction.

(B) Materials

(1) **Chlorinating Material:** The chlorinating material shall either be a hypochlorite solution, tablets or granules.

(2) **Tablet Attachment:** The hypochlorite tablets shall be fastened to the top of the pipe using Permatex No. 1.

(C) Execution

(1) **Disinfection**

(a) Care shall be taken to prevent contaminating materials from entering the water mains during construction or repair. Such materials that may accidentally enter the main shall be removed by flushing. This flushing shall be done prior to disinfection unless the tablet method of disinfection is used. If, in the opinion of the Director, the contaminated material that has entered cannot be removed by flushing, the interior of the pipe shall be cleaned by mechanical means and then swabbed with a 1 percent hypochlorite solution.

(b) Upon completion of the water pipelines, all new pipe, valves, hydrants, etc. shall be thoroughly flushed and disinfected, using a continuous-feed method of hypochlorite and water mixture or hypochlorite tablets or granules in accordance with AWWA Standard C-651, latest revision.

(c) The chlorinating material shall be introduced into the water lines and distribution systems in a manner approved by the Director. After a contact period of not less than 24 hours, the treated water in the lines shall contain not less than 10 mg per liter chlorine using the continuous-feed method or 25 mg per l chlorine using the tablet or granular method throughout the length of the line. The system shall be flushed after successful completion of disinfection with clean water until the residual chlorine content is no more than 1.0 mg per liter. All valves in lines

being disinfected, except those being used as bulkheads, shall be opened and closed several times during the contact period. During flushing and disinfection the contractor shall make sure that none of the disinfection solution enters any existing water main.

(d) Flushing shall be done with a flushing velocity of at least 2 ½ feet per second. The contractor shall provide all fittings required to flush the line. Flushing will be accomplished in such a manner that no erosion will occur and there will be no damage to street, fish, animals, plants or other property.

(2) **Bacteriological Examination:** After the system has been thoroughly flushed and before the new water line is connected to the distribution system, samples shall be taken from representative points in the system, at intervals of 1200 feet, in sterile bottles treated with sodium thiosulfate. Labeled samples shall be submitted to the City Drinking Water Program staff, or designated certified laboratory, for bacteriological examination. Submitted samples shall meet all City and State bacteriological standards, showing the absence of both coliform and heterotrophic bacterial growths. If the initial disinfection fails to produce satisfactory bacteriological results, the new main shall be reflushed and resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous feed or slug method until satisfactory results are obtained.

(3) **Disposal of Solution:** Following testing, the solution and flushing water shall be disposed of by the contractor into the nearest sanitary sewer line. The solution and flushing water shall not be dumped into any lakes, streams, waterways, irrigation ditches or stormwater drainage systems. If wasted water cannot be safely discharged into a sanitary sewer system, and then a reducing agent shall be applied to the wasted water to thoroughly neutralize the chlorine residual remaining in the water.

9.13 Testing of Water Pipes

(A) General

This section describes the testing of all water pipe including water mains, fire lines and services.

(B) Materials

The contractor shall provide all necessary test equipment including test pumps, pipe, connectors, meters, gauges, instruments, and other equipment required. Pressure gauges used shall be graduated in increments no more than 5 psi and shall have a range of approximately twice the test pressure. Gauges meters and other instruments shall be calibrated prior to testing.

(C) Execution

(1) **Notification and Witness**

(a) The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.

(b) The pipe may be subjected to hydrostatic pressure and inspected and tested for leakage at any convenient time after the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director. Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least 2 days have elapsed after the concrete was installed.

(2) **Pressure Test**

(a) All new pipe shall be pressure tested prior to connection to the existing system. All pipe shall be tested at a pressure of 150 psi at the lowest point in each section or 1½ times the working pressure, whichever is greater.

(b) Prior to testing, all equipment that would be damaged by the test pressure shall be removed. This equipment shall be replaced in the system after testing is complete. All pipe and appurtenances shall be backfilled except for joints unless otherwise permitted by the Director.

(c) The contractor shall slowly fill the pipe with water prior to testing and remove all air from the piping system. Each valved section, unless otherwise directed by the Director, shall be tested prior to connection to the existing system. The duration of each pressure test shall be at least 2 continuous hours. Test time will be accrued only while full test pressure is on the system. All water used in testing the pipelines shall be provided by the contractor from a potable water source.

(d) The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Director. The contractor shall furnish all necessary labor, equipment, and connection corporation stops to the pipeline to perform the test.

(e) No testing shall be permitted against valves or fittings that are part of the existing system unless specifically approved by the Director. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the test. Any cracked or defective pipe, fittings, valves, or hydrants discovered during the pressure test shall be removed and replaced by the contractor with sound material. The test shall be repeated until the test is satisfactory to the Director.

(3) **Leakage Test**

(a) A leakage test shall be conducted after the pressure test has been completed, unless the pressure test indicates that there are no leaks. The contractor shall furnish the pump, pipe, connections, meters and all other necessary apparatus, and shall furnish all necessary assistance to conduct the test. The duration of each leakage test shall be two hours, and, during the test, the main shall be subjected to a hydrostatic pressure specified.

(b) No pipeline installation will be accepted until the leakage is less than the amount computed by the following formula:

$$L = \frac{SD(P)^{0.5}}{133{,}200}$$

Where: L = Allowable Leakage (Gallons Per Hour)

S = Tested Length of Pipe (Feet)

D = Nominal Diameter of Pipe (Inches)

P = Average Test Pressure During the Test (psi)

(c) The contractor shall, at their own expense, locate and repair the points of leakage until the leakage is within the specified allowance.

9.14 Polyvinyl Chloride (PVC) Non-pressure Pipe

(A) General

(1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) non-pressure pipe and appurtenances for storm sewer mains, sanitary sewer mains and sewer services in the pipe diameter size range of 4inches to 15inches.

(2) **Quality Assurance: Manufacturer's** certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **PVC Non-pressure Pipe**

(a) PVC non-pressure pipe shall be type PSM polyvinyl chloride (PVC) having a cell classification of 12454 or 12454 or 13364 (with a minimum tensile modules of 500,000 psi) as defined in ASTM D1784. All PVC pipe and fittings shall meet or exceed all of the material requirements of ASTM D3034 and thickness requirements of SDR 35.

(b) Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Gaskets shall conform to ASTM F477. Pipe shall be supplied in laying lengths of 19-1/2 to 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe and all fittings shall have marked on the exterior the following:

(i) Manufacturer's Name or Trademark;

(ii) Nominal Pipe Size;

(iii) PVC Cell Classification (e.g. 12454-B);

(iv) Legend - Type PSM SDR-35 Sewer Pipe; and

(v) ASTM - D3034.

(c) All fittings and plugs to be used with the PVC pipe shall be those manufactured by the manufacturer of the pipe. Each special fitting shall be a completely manufactured unit with either bells or spigots on each connection that are an exact duplication of the bells and spigots on the pipeline. Fittings with any other type of connections will not be accepted.

(2) **Plugs:** Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation.

(3) **Couplings**

(a) Couplings shall be used only where shown on the approved drawings or where approved in writing by the Director. The contractor shall provide a description of an exact location of any couplings used.

(b) Flexible couplings shall consist of a rubber gasket or boot with a stainless steel shield and tightening bands. Couplings shall be ASTM C1173 Type B couplings and shall be "Fernco Strong Back" or an approved equivalent.

(4) **Grout**

(a) Grout shall conform to the specifications defined in Section 9.16(B)(5). The contractor may substitute a two-component, 100 percent solids epoxy resin for the specified grout.

(b) Grout used for sealing service connections shall be a 2-component, waterproof epoxy grout specifically manufactured for this application. The grout shall adhere to any of the dissimilar materials.

(5) **Sealants:** Sealants used on manholes or pipe connections shall be equal to SIKAFLEX-la, a one component polyurethane base, elastomeric sealant. When required due to moisture or immersion, provide SIKAFLEX 429 or an equivalent primer for application onto the substrate according to manufacturer's recommendation.

(C) Execution

(1) **General**

(a) Each pipe length and fitting interior, interior surface of bells, and exterior surface of spigots shall be cleaned of all foreign material before placement in the trench and shall be kept clean at all times thereafter. Each item shall also be examined for cracks and other defects before installation.

(b) Pipe shall be cut, only whenever necessary, to conform to location of manholes or connections. All cuts shall be straight, true, and at right angles to the axis of the pipe. The cutting process shall leave a smooth end without damaging the pipe. All burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed. All tools used in cutting pipe will be subject to the Director's approval.

(c) Pipe laying shall proceed with the spigot ends of pipe pointing in the direction of the flow, unless otherwise approved by the Director. Each pipe length shall be laid true to line and grade in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets to the flow line. Pipe shall be laid in a dewatered trench and shall not be used for draining water from the trench. Do not lay pipe when trenches or weather conditions are unsuitable for such work.

(d) Whenever the pipe is left unattended or pipe laying is not in progress, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent debris and animals from entering the pipe. All temporary plugs will be subject to approval by the Director.

(e) The contractor shall install the materials in accordance with the manufacturer's recommendations. If there is a conflict between the methods prescribed in the approved plans and the manufacturer's instructions, the contractor shall obtain resolution from the Director, before proceeding with the work.

(2) **Pipe Installation**

(a) Pipe Laying: No deflection in the joints shall be allowed. All pipe shall be fully supported along the full length of pipe barrel without support by the bell mounding.

(b) Pipe Joints

(i) The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.

(ii) Bevel the end of cut pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

(3) **Connection of Pipe to Concrete Manhole Base**

(a) The pipe shall be encased in the concrete poured for the manhole base as detailed in Drawing No. 6.01, "Standard Sewer Manhole," in Chapter 11, "Technical Drawings," in these Standards. Special provisions shall be made for water tightness of the connection.

(b) The exterior circumference of the pipe where encased in concrete for water tightness shall be uniformly roughened or scarified by sanding with coarse sandpaper or emery cloth for at least 6 inches encased length.

(c) Additionally, gasket as specified elsewhere shall be stretched onto the pipe to form a weep ring where encased in concrete. Any alteration to the above specified methods for pipe connection to concrete shall be submitted to the Director for approval.

(4) **Grouting**

(a) Any opening between the manhole wall and pipe made during construction shall be closed and sealed with watertight grout. The opening shall be of sufficient size to accommodate the pipe, "O" rings, and grout. The grout shall extend no less than the full width of the manhole barrel.

(b) Channels that have been cut into concrete bases shall be smoothed to the specified contour with grout. The grout shall extend no less than the full width of the manhole barrel.

(5) **Temporary Plugs:** Where required on construction plans and at the end of each sewer service stub out, the pipe shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation without permanently sealing the joint.

(6) **Sewer Services:** The general location of the sewer service lines is detailed in Drawing No. 6.06, "Sewer Service Line," in Chapter 11, "Technical Drawings," in these Standards. Actual locations of the service lines shall be determined by the approved construction plans and in the field by the Director. The contractor shall notify the Director prior to constructing each sewer main so that the Director may have adequate time to determine the final location of each service tee or wye fitting to be installed in the sewer main. Failure of the contractor to properly notify the Director as noted above may result in the contractor's removal of any portion of the sewer main that is necessary to install the fittings in their proper location as determined by the Director.

(a) The contractor will be allowed to tap and install a service saddle to new sewer mains only at those locations approved by the Director. Connections onto sewer mains shall be made only by boring or drilling with equipment designed for this

purpose. Connections shall not be made by impact equipment. The contractor shall request, in writing, Director approval of methods and equipment proposed to be used for performing connections.

(b) The contractor shall remove from the sewer main all debris created by making connections before the service line is connected.

(c) Service line saddle connections shall be attached to the sewer main with an epoxy-bonding agent. Where the sewer main has been lined, the original sewer main shall be removed and the saddle shall be attached directly to the liner. The bonding agent shall be applied to a clean, dry surface. The connection shall remain dry until the bonding material has set, depending upon environmental conditions. Backfill around the connection shall not be attempted until the material has hardened and been accepted by the Director.

(d) At the end of all sewer services, the contractor shall provide plugs and furnish and set two marker posts. One marker post shall be buried at least 3 feet and shall extend at least 2 feet above the ground surface and shall have a piece of green flagging at the top or be painted green. The second marker shall extend from the end of the service to 18 inches below the existing surface. The marker posts shall be wood 2 x 4, 4 x 4 or #4 rebar.

(7) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.

(8) **Testing:** Testing of PVC non-pressure pipe shall be as specified in Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

9.15 Reinforced Concrete Pipe

(A) General

(1) **Scope:** This section describes the furnishing and installation of reinforced concrete pipe and appurtenances for culverts and storm drains in the pipe diameter size range of 12 inches to 144 inches. Reinforced concrete pipe shall not be used for sanitary sewer mains.

(2) **Quality Assurance:**

(a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(b) The pipe will be tested by the manufacturer based on the three-edge bearing test for both the 0.01-inch crack and the ultimate strength as set forth in ASTM C-497. The pipe shall be tested at the manufacturer's plant. Not more than 1 percent of the number of pipe lengths, but no fewer than two pipes, for each size of pipe, will be tested. The contractor shall provide copies of the test results to the Director for approval. The Director may select pieces to be tested.

(B) Materials

(1) **Reinforced Concrete Pipe**

(a) The reinforced concrete pipe shall comply with the requirements of ASTM C76. The pipe shall be Class III unless noted otherwise on the approved construction

plans. The cement for the pipe shall conform to the requirements set forth in ASTM 150 and shall be type II and shall have a minimum compressive strength of 4,000 psi. All wall thicknesses shall be those established in "Wall B" in table 3, of said C76 specification, and the reinforcement shall be shown in the same "Wall B." Each section, or "stick", of pipe shall be 7 feet-6 inches or greater in length.

(b) No elliptical reinforcement will be permitted except for any elliptical reinforced concrete pipe designated on the construction plans.

(c) Lifting holes will not be permitted in any of the pipe. The following shall be clearly marked on the exterior surface of the pipe:

(i) ASTM Specification;

(ii) Date of manufacture;

(iii) Class and size; and

(iv) Name or trademark of manufacturer.

(d) The joint design shall be tongue and groove, or bell and spigot. Joints for the circular reinforced concrete pipe shall be all rubber gasket conforming to ASTM C-443, latest revision. The gasket shall be attached to the spigot of the pipe and shall make the joint flexible and watertight. The contractor may use butyl mastic joint sealant in rope or trowel applied form in lieu of rubber gaskets for circular pipe if approved in writing by the Director. For all non-circular pipe and culverts, butyl mastic joint sealant may be used. The contractor shall submit test results and material specifications on the sealant to the Director before the Director gives written approval of its use. This sealant shall be made specifically for permanently sealing joints in tongue and groove concrete sewer pipe, must adhere tightly to the pipe surface, and form a tight flexible joint. The gaskets or sealants shall be installed as directed by the manufacturer of the pipe.

(e) Flared end sections, bends and tees shall comply with the requirements of ASTM C76 and shall be the same class and shall have the same joint design as the pipe described above.

(f) Visual inspections of all materials shall be made at the job site, and pipe will be rejected on account of any deficiencies covered by ASTM Specification Designation C76 or on account of the following:

(i) Porous spots, inside or outside, having a greater area than 10 square inches and a depth of more than 1/4 inch;

(ii) Patched or repair of porous spots or other defects that are not approved by the Director; or

(iii) Exposure of reinforcement that indicates the reinforcement has been replaced.

(C) Execution

(1) Laying Pipe

(a) All materials shall be carefully lowered into the trench piece-by-piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage. Under no circumstances shall materials be dropped or dumped

into the trench. All pipe shall be inspected for defects prior to installation. Any defective, damaged or unsound pipe shall be rejected.

(b) All foreign matter or dirt shall be removed from the inside of the pipe and fittings before the pipe is lowered into its position in the trench. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew is unable to place the pipe into the trench without getting foreign matter or dirt into it, the Director may require that, before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size be placed over each end and left there until the connection is to be made to the adjacent pipes.

(c) An approved snug-fitting stopper or plug shall be installed in each pipe immediately after it is laid and prior to any further excavating, or backfilling. All openings along the line of the main shall be securely closed as directed and, in the suspension of work at any time, stoppers shall be placed to prevent dirt or other substances from entering the main. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

(d) Pipes shall be laid to a true line and at uniform rates of grade between manholes as shown on the approved construction plans. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying. The grade shall be accurately established for each joint by laser beam, or other means approved in writing by the Director. The laser beam shall be checked with a level each time it is moved and each day before construction proceeds, and thereafter as required to assure that it is set at the correct alignment. If any errors of grade are observed, pipe laying shall stop until the grade is corrected.

(e) Pipe laying shall proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work. The contractor shall make all connections of pipe to the manholes that have previously been constructed. When connecting to existing sewers, the contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.

(f) Bedding shall be placed under and on both sides of the pipe as each length of sewer pipe is installed.

(2) **Joining Pipe**

(a) Use a method of joining pipe sections that ensures that ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate enough to overcome the gasket pressure involved.

(b) Just prior to joining the pipes, the ends of the pipe shall be thoroughly cleaned to remove all foreign substances that may have adhered to the pipe surface. All dust and dirt shall be removed with a clean rag. A lubricating solution that is not injurious to the gasket or concrete, such as flax soap or water glass, shall be liberally applied to the gasket groove and to the entire surface of the bell ring. Following this operation, a thin film of lubricant shall be applied to the gasket that shall then be snapped into place in the groove, after which a small diameter smooth steel rod shall be inserted between the gasket and groove and run completely around the gasket to equalize the gasket tension.

(c) In the event that any foreign matter becomes imbedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant shall be applied.

(d) The pipe being jointed shall be carefully moved into position, be line and grade checked, and as the spigot end is started into the bell of the section previously laid, the gasket position shall be checked to ensure uniform entry into the bell at all points.

(3) **Testing and Flushing Pipe**

(a) Prior to acceptance of each section of storm sewer line, the contractor shall jet clean all sewers up through 18 inches in diameter. Larger storm sewers shall be cleaned by other appropriate methods approved by the Director. All dirt and debris shall be prevented from entering the existing storm sewer system by means of watertight plugs or other suitable methods.

(b) If the Director finds it necessary to clean the mains immediately after construction by rodding, jetting, or both, the Director shall assess the contractor for the cleaning at a set per foot charge with a minimum dollar amount.

(c) The Director will televise all mains as part of public inspection, and will bill the contractor for the televising at a set per foot charge with a minimum dollar amount. Any defects found during the televising shall be repaired by the contractor, in a manner approved by the Director.

(d) Any visible infiltration, that the Director finds to be the result of poor installation of the specified materials, shall be repaired by the contractor in a manner approved by the Director before the work will be accepted.

(e) Before acceptance of the work, the Director will survey the manhole invert and surface elevations. Any inverts or surface elevations not meeting the approved design in the construction plans shall not be approved and shall be redone to the satisfaction of the Director.

(f) Upon completion of construction, the Director will carefully inspect all sewers and appurtenances. Any unsatisfactory work shall be removed and replaced by the contractor in a proper manner. The invert of sewer and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. Manhole rings and covers must be raised to finished grade before final acceptance of the sewer.

(g) For sanitary sewers, testing shall be as specified in Section 9.17, “Testing of Gravity Sewer Pipelines and Manholes,” of these Standards.

9.16 Manholes and Inlets

(A) General

(1) **Scope:** This section describes the furnishing and installation of precast concrete manholes, storm sewer inlets and appurtenances.

(2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **General**

(a) Manholes shall be constructed of precast concrete riser sections, in accordance with Drawing No. 6.01, "Standard Sewer Manhole," in Chapter 11, "Technical Drawings," of these Standards. The concrete sections shall conform to ASTM C478. The top section required for change of diameter shall be concentric cone or flat slab. Invert channel shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. The minimum internal diameter of the manhole barrel shall be in Table 9-6, "Required Manhole Diameters," for all manhole installations:

Table 9-6: Required Manhole Diameters

Pipe Size (Diameter)	Inner Manhole Section Diameter
18 Inches (and Smaller)	4 Feet
21 - 36 Inches	5 Feet
42 - 48 Inches	6 Feet
54 Inches (and Larger)	Special Detail

(b) The minimum internal diameter of the manhole barrel may also be determined by the number and size of pipes junctioning at a manhole. In such cases, the Director may modify the minimum internal diameter of the manhole barrel as required.

(c) To bring the manhole cover to the correct elevation, the adjustment section of each manhole shall be constructed of brick that is sound and true in shape and size and shall be Grade S-W from clay or shale. Precast concrete grade adjustment rings may be substituted for the brick. These rings shall be not less than 6 inches wide and furnished in heights to allow for 1-inch adjustment. Total adjustment height, with grade rings or bricks, shall not exceed 12 inches.

(2) **Joints:** Precast manhole and inlet joints shall be made watertight with RUB'R-NEK, Kent Seal No. 2, or LO-MOD GEL material, or approved equivalent. The diameter of gasket shall be as recommended by the manufacturer.

(3) **Frame and Cover:** Manhole frames and covers shall be of heavy duty traffic lids, Colorado Springs pattern, round base, 22-1/8 inch opening lids 1 inch thick, non-locking type with frame and cover weighing approximately 327 pounds. The cover and frame seat shall be machine finished to prevent any rocking of the cover in its associated frame. The cover shall have the word "SEWER" for sanitary sewer manholes, or "STORM SEWER" for storm sewer manholes clearly cast on the surface. Covers for other utility manholes shall also be marked with the appropriate utility designation. Frames and covers shall be CASTINGS, INC. MH 310 COVER B, or approved equivalent.

(4) **Manhole Steps:** Manhole steps shall be built into and thoroughly anchored to the manhole walls at time of fabrication and shall be positioned as shown on the approved construction plans, and in accordance with the technical drawings in Chapter 11, "Technical Drawings," of these Standards. The steps shall be made of polypropylene coated reinforcing steel.

(5) **Grout:** Grout shall be "non-shrink" type with aluminum filings; grout with iron filings is not acceptable. Grout shall be "Five Star Grout," "Embeco Grout" or equivalent.

(6) **Concrete:** Concrete for cast-in-place manhole bases shall have a 28-day compressive strength of not less than 3,000 psi. The maximum water content shall be 0.5 pounds of water per pound of cement. Entrained and entrapped air shall be between 4 and 9 percent. All reinforcement shall be standard deformed reinforcement conforming to the requirements set forth in ASTM, A615, Grade 60.

(7) **Inlets:** Inlets shall be constructed of reinforced concrete and shall conform to the dimensions and specifications as set forth for Type "R" Curb Inlets in Chapter 11, "Technical Drawings," of these Standards, and CDOT's M & S Standards. Inlet steps shall be built into and thoroughly anchored to the walls at the time of inlet construction. These steps shall conform to the requirements for manhole steps and shall be positioned as shown on the technical drawings.

(C) Execution

(1) **Construction of Manholes**

(a) Concrete bases shall be poured on undisturbed ground. Pipe sections shall be flush on the inside of the structural wall (except as noted below) and project outside sufficiently for proper connection to the next pipe section. All pipelines into a manhole shall have a joint located no more than 12 inches from the exterior wall. Where incoming pipes enter a storm drain manhole at an elevation 3 feet or greater above the base, the incoming pipe shall project 2 inches inside the manhole. All annular spaces around the pipe opening shall be grouted.

(b) For all precast manhole bases, the ground surface below precast concrete bases shall be excavated 6 inches below the elevation of the bottom of the base and backfilled with bedding material, meeting the requirements of Subsection 9.02(B) of these Standards. The bedding material shall be carefully leveled and smoothed as to give uniform support to the precast base over its entire area.

(c) The invert channels of manholes shall be constructed in accordance with the Drawing No. 6.03, "Manhole Invert," in Chapter 11, "Technical Drawings," of these Standards. They shall be smooth and semicircular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Where differences of 24 inches or less in invert elevations are called for, sloped flow channels shall be formed so the water does not undergo a vertical drop. A drop manhole shall be installed where the specified distance in the manhole inverts exceeds 24 inches. The inlet channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside of the channel shall be smooth and shall slope towards the channel not less than 1 inch per foot nor more than 2 inches per foot. The manhole covers shall be set with a final elevation of 1/4 inch below the finished grade in roadways and 1 to 2 inches above grade outside of roadways. When a manhole is located in the pavement area, it shall not be constructed to final grade until the pavement has been completed, unless directed otherwise by the Director.

(d) Install joint material per manufacturer's instructions so that no voids are present. Grout all joints inside and outside after manhole assembly is completed.

(e) Gaskets for connecting PVC pipe to manhole sections shall be specifically manufactured for that purpose. The gasket shall provide for at least five bearing points on the pipe surface. The interior circumference of the gasket shall be approximately 5 percent less than the exterior circumference of the pipe. The gasket shall be as manufactured by Hamilton Kent Mfg. Co. of Kent, Ohio, or approved equivalent. All annular spaces around pipe openings must be grouted.

(f) Stubs shall be provided at manholes when indicated on the construction plans. Such stubs shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation.

(2) **Adjusting Manhole Tops:** When grade adjustment of an existing structure is specified, remove frames and covers and reconstruct as required. Reset cleaned frames at the indicated elevation. Prior to final acceptance, clean structures of accumulations of silt, debris, or foreign matter.

(3) **Testing Manholes:** Refer to Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

9.17 Testing of Gravity Sewer Pipelines and Manholes

(A) General

This section describes the testing of gravity sewer pipelines and manholes including sanitary sewers and storm drains.

(B) Materials

The contractor shall provide all equipment and material specifically designed for the testing specified in this section.

(C) Execution

(1) **Notification and Witness:** The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.

(2) **When to Test:** The pipe shall be tested for leakage after the pipe has been installed and the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director.

(3) **Testing Procedures**

(a) **General:** All sanitary sewer mains and appurtenances shall be cleaned, tested, and PACP TV inspected after backfill operations have been completed. The contractor shall furnish all labor, materials, tools, and equipment necessary to clean the pipe and appurtenances, perform the tests and all work incidental thereto. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the contractor

(b) **Alignment and Grade:** Gravity sewer pipelines will be checked by the Director to determine whether any displacement of the pipe has occurred after the trench has been bedded. The maximum vertical deflection allowed for PVC pipe is five percent. The city may require the contractor to perform deflection tests of the

pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the City. To ensure accurate testing, the line shall be thoroughly cleaned prior to testing.

(4) **Air Tests**

(a) Air testing of sanitary sewer pipes shall be done on all sections of pipe between manholes. The pipe shall be cleaned and may be wetted before air testing. The section of pipeline being tested shall be plugged at each manhole with pneumatic balls.

(b) Low-pressure air shall be introduced into the plugged line until an internal pressure of 4 psig greater than the average backpressure of any ground water pressure that may submerge the pipe would cause. At least 2 minutes shall pass to allow air temperature to stabilize before the test time is started.

(c) No pipeline installation will be accepted if the pressure drops 0.5 psig or more during the time and for the length of pipe shown in Table 9-7, "Specifications for Air Testing of Sanitary Sewer Pipes," of these Standards:

(d) If the pipeline installation fails the air test, repairs shall be made and the pipe shall be retested until it passes the air test.

(5) **Deflection**

(a) All PVC non-pressure pipes shall be tested for vertical deflection after placement and compaction of backfill. The maximum deflection allowed is 5 percent.

(b) Method of testing shall be by calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the Director. Any and all pipe with vertical defection greater than the allowable shall be excavated, and removed from the pipeline, replaced, backfilled and compacted as specified, and retested at the contractor's expense.

Table 9-7: Specifications for Air Testing of Sanitary Sewer Pipes

Pipe Diameter (Inches)	Minimum Test Time for Pipe Lengths up to Lengths in Column 3 (min:sec)	Maximum Pipe Length for Minimum Time Testing in Column 2 (Feet)	Minimum Test Time for Pipe Lengths Greater than Column 3 (Seconds)
4	1:53	597	0.190 x Pipe Length (Feet)
	2:50	398	0.427 x Pipe Length (Feet)
8	3:47	298	0.760 x Pipe Length (Feet)
10	4:43	239	1.187 x Pipe Length (Feet)
12	5:40	199	1.709 x Pipe Length (Feet)
15	7:05	159	2.671 x Pipe Length (Feet)

(6) **Television**

(a) Following completion of sewer line work, the contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer. TV inspections shall be performed by a PACP certified inspector. Prior to performing the TV inspection, the sewer improvements must be complete,

accessible, and cleaned using pressurized water sufficient to allow for a detailed inspection. The city will not accept inspections for lines that have not been cleaned.

(b) Following TV inspections and any necessary repairs that the contractor may have identified, the city will review the inspection data. If the condition of the pipe is determined to be free of structural defects, deflections, debris, defects in pipe material, and other installation errors, the work will be eligible for acceptance.

(D) Sanitary Sewer Manholes

(1) **General**

(a) During the construction of the manholes, the contractor shall, in accordance with good construction practice, ensure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the sections. The Director shall check each manhole to determine whether the manhole fulfills the requirements of the construction plans and these Standards.

(b) The Director shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies that might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, any repairs deemed necessary by the Director shall be made by the contractor.

(c) Exfiltration tests as specified above shall be performed on all sanitary sewer manholes.

(2) **Vacuum Testing:** When required by the Director, sanitary sewer manholes shall be vacuum tested with the following procedure:

(a) Each manhole shall be tested immediately after assembly and prior to backfilling.

(b) All lift holes shall be plugged with an approved non-shrink grout.

(c) No grout will be placed in the horizontal joints before testing.

(d) All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole.

(e) The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation.

(f) A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for one 48-inch diameter manhole, 75 seconds for 60 inches, and 90 seconds for 72 inches.

(g) If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

9.18 Corrugated Metal Pipe

(A) General

(1) **Scope:** This section describes the furnishing and installation of corrugated metal pipe and appurtenances for drainage culverts in the pipe diameter size range of 12 to 54 inches.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Corrugated Metal Pipe**

(a) Pipe shall be fabricated from zinc-coated (galvanized) iron or steel sheets conforming to AASHTO M-218 except as modified herein. The diameter or span by rise dimensions indicated on the drawings shall mean the nominal inside dimensions of the conduit. The widths of the laps and depths or corrugations shall be as specified in AASHTO M-36. The pipe shall have the following minimum gauge (specified thickness) for the sizes shown in Table 9-8, "Corrugated Base Metal Specifications," of these Standards:

Table 9-8: Corrugated Base Metal Specifications

Diameter (Inches)	Gauge Number	Specified Galvanized Thickness (Inches)	Specified Galvanized Thickness (Inches)
21 and Smaller	16	0.064	0.0598
24	14	0.079	0.0747
30 - 54	12	0.109	0.1046

(2) **Dimpled Coupling Bands:** The dimpled coupling bands shall be the same thickness as that used for the pipe and shall be at least 12 inches wide. The dimples shall conform substantially to the shape and depth of pipe corrugations and shall be in circumferential rows. Each row shall contain dimples so spaced as to effectively engage all corrugations of the pipe ends. All bands shall have at least two zinc coated bolts per connection, conforming to ASTM A 307, grade A, electroplated in accordance with ASTM A 164, Type RS, not less than ½ inch in diameter. The bands shall have end connection angles, conforming to ASTM A 36, zinc-coated in accordance to ASTM A 153, not less than 2 inches by 2 inches by 3/16 inch by 11 inches, adequately fastened to the band.

(3) **Fittings (Including Flared End Sections) and Specials:** Fittings and specials shall be of the same material, coating, and wall thickness, including the same structural qualities, as the adjoining pipe. Steel flared end sections shall be furnished complete with field-bolted toe plates.

(4) **Repair of Damaged Spelter Coatings:** Units such as tees, angles or bends on which the spelter coating has been burned by flame cutting and gas or arc welding, or otherwise damaged in fabrication or shipping, shall be wire-brushed and painted with two coats of Haltz-Rust HR-54-53 or equal conforming to Federal Specification and Standards, TT-P-

641, or as otherwise approved by the Director. Culverts, pipes, fittings, specials, etc., on which the spelter coating has been bruised or broken either in the shop or in shipping, or that shows defective workmanship, will be rejected.

(C) Execution

Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the "Handbook of Steel Drainage and Highway Construction Projects," published by the American Iron and Steel Institute.

(1) **Bedding**

(a) All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.

(b) The bedding material shall be placed evenly on both sides of the pipe to a point 12 inches above the top of the pipe. Special care shall be taken to ensure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.

(2) **Backfilling:** After the pipe has been properly installed and bedded, the remaining trench excavation shall be restored as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement or Sidewalks," B.R.C. 1981. Pipe installed outside of public rights-of-way where no pavement is impacted may be backfilled in the following manner. The backfill shall be placed in 8-inch loose lifts and compacted to 90 percent Standard Proctor density (AASHTO T-180) with mechanical hand tampers, for the first 2 feet. At least 4 feet of cover over the top of pipe shall be provided before the use of wheel-mounted mechanical tampers (free drop hammer), hydraulic tampers, (Hydraulic ram hammers) or other heavy tamping equipment will be permitted. Puddling or jetting will not be allowed.

(3) **Removal of Trench Protection:** Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point 1 foot above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for "flexible conduits" and create excessive lateral soils pressures and pipe deflections.

(4) **Protection of Conduit During Construction:** Maximum supporting strength in flexible conduits does not develop until the fill consolidates. Therefore, excessive concentrated loads or heavy equipment on top of or alongside if the pipe shall be avoided.

9.19 Cured-in-Place Pipe (CIPP)

(A) General

(1) **Scope:** This section describes the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is inserted into the original non-pressure conduit.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Resin-Impregnated Tube**

(a) The tube shall meet the requirements of ASTM F1216 and shall have a uniform thickness that, when compressed at installation pressures, will equal the specified nominal tube thickness, with a -5 percent manufacturing tolerance. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during insertion. The minimum length shall be that deemed necessary by the contractor to effectively span the distance between respective access points unless otherwise specified. The contractor shall verify the lengths and diameters in the field before fabricating the tube. Individual insertion runs can be made over one or more manhole sections as determined in the field by the contractor. The maximum allowed insertion run is 1,200 feet. Intermediate manholes will be reopened as directed by the Director.

(b) The outside layer of the tube (before insertion) shall be translucent plastic coated with a flexible material that clearly allows inspection of the resin impregnation (wet-out) procedure. The translucent plastic coating on the tube will allow visual proof that the resin has wet-out the entire tube and that there are no dry areas. A vacuum shall be used to ensure the resin fills all dry areas. The plastic coating shall not be subject to delamination after curing of the CIPP.

(c) The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials will be allowed in the tube that is subject to delamination of the cured CIPP.

(2) **Resin:** The resin system shall meet the requirements of ASTM F1216.

(3) **Structural Requirements**

(a) The CIPP wall thickness will be measured in accordance with the applicable sections of ASTM Test Method D2122. Sufficient readings, at least eight, will be made to ensure that the minimum thickness has been determined. A cylindrical anvil tubing micrometer accurate to +0.02mm (+0.001 in) will be used. The minimum wall thickness at any cross section shall meet or exceed those shown on the proposal forms and the approved plans, with the allowable minus five (-5) percent tolerance. The wall thickness tests will be performed by a Certified Independent Laboratory, approved by the Director. All costs, for testing, shall be borne by the contractor.

(b) The layers of the CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly of the probe or knife blade moves freely between the layers, nor shall separation of any layers occur during testing performed under the requirements of this specification.

(c) The cured pipe material (CIPP) shall conform to the minimum structural standards, as follows:

(i)	Flexural Stress (ASTM D-790)	4,500 psi
(ii)	Modulus of Elasticity (ASTM D-790)	250,000 psi

(d) The liner shall be designed assuming a fully deteriorated host pipe.

(C) Execution

(1) **Cleaning**

(a) The contractor shall be required to remove all internal debris from the line by use of water jet equipment prior to inserting the CIPP tube. The cleaning operation shall remove any and all debris so that each joint of pipe can be thoroughly inspected and successfully reconstructed.

(b) All sludge, dirt, sand, rocks, grease and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole to another will not be permitted.

(c) All such debris resulting from the cleaning operations shall be removed from the site and disposed of in the proper manner. The contractor shall bear all costs associated with testing of debris and proper dumping. Dumping of the debris shall be in accordance with all local, state, and federal regulations.

(d) All debris shall be removed from the downstream manhole and the site no less often than at the end of each workday. The contractor shall leave no debris unattended at the site. Under no circumstances will the contractor be allowed to accumulate debris beyond the stated time. In the event the contractor has not removed the debris generated by the cleaning operation, the contractor will not be allowed to proceed with the work until the debris is properly removed.

(e) During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might occur by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public or private property being served by the section of sewer line being cleaned. The contractor shall bear all costs associated with any flooding or damage to basements or structures.

(2) **Bypassing Flows:** The contractor shall provide for flows around the section(s) of pipe designated for rehabilitation. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.

(3) **Inspection of Pipelines:** Inspections of pipelines shall be performed by trained personnel experienced in locating breaks, obstacles and service connections by closed circuit

television. The inspection of pipelines is also to determine active service connections and the addresses that they serve. The interior of the pipe shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the CIPP into the pipeline and it shall be noted so these conditions can be corrected. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining.

(4) **Line Obstructions:** It shall be the responsibility of the contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of the CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional cleaning equipment, then the contractor shall repair the excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Director prior to the commencement of the work.

(5) **CIPP Installation**

(a) CIPP installation shall be in accordance with ASTM F1216, Section 7, with the additional following requirements. The resin shall be cured by circulating hot water within the tube. After curing, the finished pipe (CIPP) shall be continuous and tight fitting.

(b) The contractor, and the Director, shall designate a location where the tube will be impregnated with resin prior to installation, in order that an inspection can be made to determine proper materials and procedures. A resin and catalyst system compatible with the requirements of this method shall be used.

(c) The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply. Another such gauge shall be placed at the remote manhole to determine the temperature at that location during the cure. If air pressure and steam are used with styrene-based resins, the compressed atmosphere shall be monitored with a safety gas detector to ensure that it does not reach the explosive limit.

(d) The finished CIPP shall be continuous over the entire length of an insertion run between two manholes and be free, as commercially practicable, from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. It shall also meet the leakage/pressure test requirements specified below (water tightness).

(e) Before the insertion process begins, the minimum pressure required to hold the tube tight against the existing conduit and the maximum allowable pressure so as not to damage the tube shall be provided by the tube manufacturer, and it will be the contractor's responsibility to obtain and submit this information to the Director. Once the insertion has started, the pressure shall be maintained between the minimum and maximum pressures until the operation has been completed. If air pressure is used for inversion, the equipment shall be fitted with a pressure gauge accurate to 0.01 psi. Should the pressure deviate from within the range of minimum and maximum pressures, the installed tube will be rejected, and the contractor will remove and dispose of the tube, at their expense.

(f) Before the curing process begins, the pressure required to hold the flexible tube tight against the host pipe shall be provided by the tube manufacturer and submitted to the Director prior to any inversion process. Once the cure has started and dimpling for laterals is completed, the required pressure shall be

maintained until the cure is complete. Should the pressure deviate more than 1 psi (2.3 feet of water) from the required pressure during the critical curing period, the tube will be rejected, and the contractor will be responsible for its removal and disposal and replacement with new CIPP at, at their expense. A complete log of the pressures shall be maintained on site and shall be offered to the Director after each inversion.

(6) **Sealing at Manholes:** A hydrophilic end seal shall be installed at the upstream and downstream manholes prior to installation of the CIPP liner. The end seals shall be LMK Insignia End Seals or equivalent.

(7) **Service Connections**

(a) After the curing of the CIPP is completed, the contractor shall restore the existing active service connections and branch connections. The connections shall be reopened without excavation, and in the case of non-man entry pipes, from the interior of the pipeline utilizing a remotely controlled cutting device, monitored by a closed-circuit television camera, that re-establishes them to not less than 95 percent capacity, while conforming to the shape of the existing opening. All reinstated openings shall be smoothed by brushing with a wire brush.

(b) The contractor shall verify the possession of at least two complete cutting devices in good working order before each insertion.

(c) If excavations for the purpose of re-opening connections are required, the contractor will be responsible for all costs and liability associated with such excavation and restoration work.

(d) No service connection shall remain out of service for more than 24 hours at a time unless the contractor has provided temporary facilities or other appropriate accommodations for the affected service.

(8) **Testing:** CIPP samples shall be prepared and tested in accordance with ASTM F1216, Section 8.1, using both methods 8.1.1 and 8.1.2 if so required by the Director. The test will be performed by a Certified Independent Laboratory, approved by the city. Tests results shall be submitted to the Director. Costs of the tests are considered to be incidental to the project.

(9) **Visual Inspection:** Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.4. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining.

9.20 Pipe Bursting Non-Pressure Pipe

(A) General

(1) **Scope:** This section describes the reconstruction of pipelines and conduits by which a bursting unit splits the existing pipe while simultaneously installing a new polyethylene pipe of the same size or larger where the old pipe existed.

(2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

(B) Materials

(1) **Polyethylene Plastic Pipe:** The pipe shall be high density polyethylene pipe and meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR). Sizes of the insertions to be used shall be such to renew the pipe to its original or greater flow capacity. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.

(2) **Dimension Ratios:** The polyethylene pipe shall meet or exceed the thickness requirement of SDR 17.

(C) Execution

(1) **Bypassing Flows:** The contractor shall provide for flow around the section(s) of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.

(2) **Inspection:** Inspection of work shall be in accordance with Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

(3) **Equipment:** The pipe bursting tool shall be designed and manufactured to force its way through existing pipe material by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall be pneumatic and shall generate sufficient force to burst and compact the existing pipeline. The bursting tool shall be selected in accordance with the manufacturer's recommendations to meet the project specific requirements for the type and size of pipe being burst and upsized if specified. The pipe bursting tool shall be pulled through the sewer by a winch located at the receiver pit. The bursting unit shall pull the polyethylene pipe with it as it moves forward.

9.21 Telecommunication or Cable System Standards

The installation and construction of telecommunication or cable systems shall comply with the requirements as set forth in Chapter 11-6, "Boulder Cable Code," B.R.C. 1981, and these Standards.

(A) General

(1) **Applicable National Standards:** All telecommunications and cable system construction shall conform to the requirements of the following standards:

(a) American National Standards Institute, Inc. (ANSI), Electronic Industries Association (EIA), and Telecommunications Institute of America (TIA) Standards: EIA/TIA Standards Proposal No. 2840-A, Proposed Revision of EIA/TIA-568 (if approved to be published as EIA/TIA-568-A), EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces, and TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

(b) National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.

(c) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).

(d) Federal Communications Commission.

(e) Colorado Public Utilities Commission.

(f) Williams-Steiger Occupational Safety and Health Act (OSHA).

(2) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific underground and/or aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director's office for review and approval.

(a) Construction plans for Directional Boring or Narrow Trenching operations shall meet design standards of Subsurface Engineering (SUE) Level B or above. At the City's request, the applicant shall provide full engineered plan & profile drawings.

(3) **Protection of Systems:** All systems shall be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

(B) Underground Facilities

(1) **Cable Protection**

(a) All buried telecommunications cable shall be installed in conduit, ~~PVC Schedule 40~~SDR 9 or 11 HDPE pipe, or equivalent. Cable placement by means of direct plow-in will not be allowed within the City's rights-of-way.

(b) Major conduit duct banks (more than 4 conduits) and those comprising a portion of the City's telecommunications conduit backbone infrastructure shall be encased in concrete with a minimum strength of 2000 psi. When encased in concrete, conduit may be PVC Type EB, DB, or equivalent. The concrete encasement shall have a minimum thickness of 4 inches around the entire conduit or duct bank.

(c) Multiple duct systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.

(d) Conduit placed by directional bore method will be allowed subject to approval by the Director.

(2) **Depth of Cover:** The minimum depth of cover over the conduit shall be 30 inches.

(a) Narrow Trenching Exception: For existing pavements 6 inches or less, distance from top of pavement to top of conduit is 10 inch minimum, 24 inch maximum. For Existing pavements greater than 6 inches thick, distance from top of pavement to top of conduit equals the pavement thickness plus 4 inches minimum, 24 inch maximum.

(i) If Narrow Trench abuts lip of curb & gutter, minimum depth of conduit is 12".

(3) **Trench Specifications - Roadway and Other Paved Surfaces**

(a) All trenches shall be open cut unless otherwise permitted by the city.

(b) Trenches shall have a minimum width of 10 inches. unless Narrow Trenching is proposed where minimum trench width is 1 inch and maximum is 3 inch, but no greater than 1 inch maximum of conduit size.

(c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement and Sidewalks," B.R.C. 1981.

(d) Narrow Trenching can about the concrete lip line of curb gutter with 12-inch minimum conduit depth.

(e) Narrow Trench cannot be placed within 2 feet of vehicle wheel paths. If street is signed, labeled or striped as a shared roadway for both bicycle and vehicular traffic, narrow trench cannot be within 2 feet of the common wheel paths.

(f) Narrow Trench alignment on roadways must be marked out and follow the designated path so that the finished product has straight lines. Trenches that deviate from a straight path will be subject to mill and overlay, at the city's discretion upon inspection.

(4) **Trench Specifications - Landscaped Areas**

(a) All trenches shall be open cut unless otherwise permitted by the City.

(b) Trenches shall have a minimum width of 10 inches., with exception to narrow trenching where minimum width is 1 inch and max is 3 inches.

(c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.

(d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees shrubs or other landscaping or if construction is within 5 feet of a tree. All utility construction near existing trees shall abide by the tree protection requirements specified in Chapter 3, "Streetscape Design," of these Standards.

(5) **Alternative Installation Methods:** Boring or Narrow Trenching methods may be allowed by the Director if the Director finds that these methods are advantageous to the city or if industry standard open trench methods are impractical.

(a) Missile method for tunneling under curb/gutter and sidewalks can be used as an Alternative for lateral installation associated with Narrow Trenching. Any voids must be between tunnel walls and conduit placed must be filled with flowable fill and use of a concrete vibrator is required.

(6) **Joint Use Trench Requirements**

(a) Joint trenching operations require advanced planning and coordination with the utilities involved.

(b) Vertical and horizontal separations between telecommunications or cable systems and other facilities shall be maintained as required by NESC Section 32, Underground Conduit Systems. Conduit systems for telecommunications and cable systems shall be separated from conduit systems for power supply systems by:

(i) 3 inches of concrete,

(ii) 4 inches of masonry, or

(iii) 12 inches of well-tamped earth.

(7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.

(a) For Narrow Trenching, warning tape is recommended but not required.

(8) **Manholes**

(a) All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane, road shoulders, sidewalk, multi-use path, or bike lane.

(b) Manholes or handholes shall be placed at maximum 1,200 feet intervals. In no case shall conduit bend radius exceed 180 degrees between manholes. Manholes shall be installed at each street intersection at a minimum. Manholes shall be rectangular: 6 feet wide by 7 feet long by 4 feet deep; or circular 4 feet diameter with a nominal depth of 4 feet minimum.

(c) Manholes or handholes shall be installed flush or ¼" below the surrounding grade.

(C) Aboveground Facilities

(1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.

(2) **Obstruction to Traffic Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.

(3) **Clearances:** All aboveground telecommunications facility construction shall conform with the minimum clearances as specified in Section 23 of the NESC.

(a) Cables shall maintain the following minimum clearances between any adjacent or crossing power cables under all conditions of cable loading:

(i) Horizontal clearances shall be at least 5 feet from power cables at a potential of up to 129 kV, and at least 5 feet plus 0.4 inches per kV over 129 kV from power cables exceeding a potential of 129 kV.

(ii) Vertical clearances shall be at least 4 feet from power cables at a potential of up to 750 V, at least 6 feet from power cables at a potential of 750 V to 22 kV, at least 6 feet plus 0.4 inches per kV over 22 kV from power cables at a potential between 22 kV and 470 kV. Vertical clearances shall comply with NESC Rule 233C3 for minimum clearance from cables at a potential greater than 470 kV.

(b) Cables, poles, and stubs shall maintain the following minimum clearances from power conductors, power poles and other objects:

(i) Poles shall have a minimum clearance of 4 feet from fire hydrants, signal pedestals, and call boxes.

(ii) Cables shall have a minimum horizontal clearance from power poles in no wind conditions.

(iii) Poles and stubs shall have a minimum horizontal clearance of 5 feet in no wind condition from power wires up to 50 kV.

(c) Poles shall have a minimum separation of at least 2 feet from the street side of the curb to the nearest part of the pole and shall be located a sufficient distance from the street side of the curb to avoid contact with ordinary vehicles using the road.

(d) Poles shall have at least 12 feet horizontal clearance from the nearest rail to the nearest part of the pole.

(e) Cables shall have at least 2 feet vertical clearance from Police and Fire Alarm facilities.

(f) Cables shall have at least 3 feet clearance in all directions from signs, chimneys, tanks, and other installations.

(g) Cables shall maintain the following minimum vertical clearances as measured from the lowest point of the cable when crossing the following objects:

(i) Roads, Streets, and all areas subject to truck traffic: 18 feet.

(ii) Alleys, Driveways, and Parking Lots: 18 feet.

(iii) Railroad tracks: 28 feet.

(iv) Roofs, not accessible: 4 feet.

(v) Spaces and Ways, accessible to pedestrians only: 12 feet.

(vi) Roofs, accessible to vehicular traffic, but not trucks: 12 feet.

(h) Cables shall maintain a minimum vertical clearances of 16 feet as measured from the lowest point of the cable when running alongside but not overhanging roads, streets, or alleys.

(i) A minimum vertical clearance of 40 inches shall be maintained between telecommunications cables and power cables at the attachment points on joint use poles.

9.22 Electric Power Facility Standards

The following standards shall apply to all electric power related facilities constructed within the City's public rights-of-way or easements.

(A) General

(1) **Undergrounding Required:** All electric power facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.

(2) **National Standards:** All electric power facility construction shall conform to the requirements of the following standards:

(a) 1993 National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.

(b) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).

(c) Colorado Public Utilities Commission.

(d) Williams-Steiger Occupational Safety and Health Act (OSHA).

(3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific underground and/or aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director for review and approval.

(4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

(B) Underground Facilities

(1) **Underground Cable Protection**

(a) All primary circuits (greater than 600 volts) located under concrete road surfaces, where circuit density is high, and in all arterial roads shall be installed in conduit, 4-inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.

(b) All secondary circuits (600 volts or less) supplying services larger than 800 amperes shall be installed in conduit, 2-inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.

(c) Multiple duct bank systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.

(2) **Depth of Cover**

(a) The minimum depth of cover over primary circuits (greater than 600 volts) shall be 42 inches.

(b) The minimum depth of cover over secondary circuits shall be 30 inches (600 volts or less).

(c) The minimum depth of cover over circuits for street lighting and signals shall be 18 inches.

(3) **Trench Specifications - Roadways and Other Paved Surfaces**

(a) All trenches shall be open cut unless otherwise permitted by the Director.

(b) Trenches shall have a minimum width of 10 inches.

(c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement and Sidewalks," B.R.C. 1981.

(4) **Trench Specifications - Landscaped Areas**

(a) All trenches shall be open cut unless otherwise permitted by the Director.

(b) Trenches shall have a minimum width of 10 inches.

(c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.

(d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.

(5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the city or if open trench methods are impractical.

(6) **Joint Use Trench Requirements**

(a) Joint trenching operations require advanced planning and coordination with the utilities involved.

(b) Vertical and horizontal separations between electric power facilities and other facilities shall be maintained as required by the NESC section 32 Underground Conduit Systems.

(7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit or cable in the trench.

(8) **Manholes:** All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane including road shoulders, sidewalks, multi-use paths, or bike lanes.

(C) Aboveground Facilities

(1) **General**

(a) All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.

(b) All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.

(2) **Clearances:** The minimum overhead transverse clearance shall conform to National Electrical Safety Code Standards but shall not be less than 18 feet measured from the highest point of the road prism to the bottom of the cable.

9.23 Gas Distribution Facility Standards

The following standards shall apply to all gas distribution related facilities constructed within the City's public rights-of-way or easements.

(A) General

(1) **Undergrounding Required:** All gas distribution facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.

(2) **National Standards:** All gas distribution facility construction shall conform to the requirements of the following standards:

(a) Minimum Federal Safety Standards for Natural Gas Pipelines in the Code of Federal regulations 49 Part 192.

(b) Colorado Public Utilities Commission.

(c) Williams-Steiger Occupational Safety and Health Act (OSHA).

(3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific gas distribution line and appurtenances locations and specifications, shall be submitted to the Director for review and approval.

(4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

(B) Underground Facilities

(1) **Materials**

(a) Steel or plastic material shall be used for the gas distribution pipe.

(b) All plastic pipe must be installed below ground level.

(2) **Depth of Cover**

(a) Depth of cover shall be measured from the final grade to the top of the pipe.

(b) Minimum depth of cover for shall be 36 inches for transmission lines and 30 inches for distribution lines.

(c) Minimum depth of cover for service lines shall be 24 inches.

(d) Transmission and distribution lines installed under streams and ditches must have minimum cover of 48 inches.

(3) **Trench Specifications - Roadways and Other Paved Surfaces**

(a) All trenches shall be open cut unless otherwise permitted by the Director.

(b) Trenches shall have a minimum width of 10 inches.

(c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement and Sidewalks," B.R.C. 1981.

(4) **Trench Specifications - Landscaped Areas**

(a) All trenches shall be open cut unless otherwise permitted by the Director.

(b) Trenches shall have a minimum width of 10 inches.

(c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.

(d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.

(5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the city or if open trench methods are impractical.

(6) **Joint Use Trench Requirements**

(a) Joint trenching operations require advanced planning and coordination with the utilities involved.

(b) Vertical and horizontal separations between gas distribution facilities and other facilities shall be 6 inches minimum.

(7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.

(8) **Components**

(a) Transmission line valves shall be installed in boxes or be otherwise readily accessible.

(b) Transmission line pressure relief and pressure limiting devices shall be installed in underground vaults, unless aboveground installation is permitted by the Director.

(c) All service lines shall be equipped with shutoff valves.

(d) An electrically conductive tracer wire shall be installed with all plastic and non-conductive pipes.

(9) **Casing Pipe:** Gas pipe shall be installed in casings under all highways. Casing pipe shall be steel pipe with a wall thickness of 1/4 inch minimum extending at least 5 feet beyond the limits of any highway improvements.

(10) **Corrosion Protection**

(a) All pipes susceptible to corrosion shall be cathodically protected and have a protective coating.

(b) All corrosion susceptible pipes must also be electrically isolated from other metallic structures.

(C) Testing Requirements

All newly constructed pipes shall be tested prior to placing the line in service. No pipe shall be placed in service, or returned to service, with leaks or without adequate corrosion protection.

(1) **Pressure Testing:** All pipes shall be pressure tested for leakage as described in CFR 49 part 192. In order to establish the maximum allowable operating pressure (MAOP), pipes shall be tested at 1-1/2 times the MAOP.

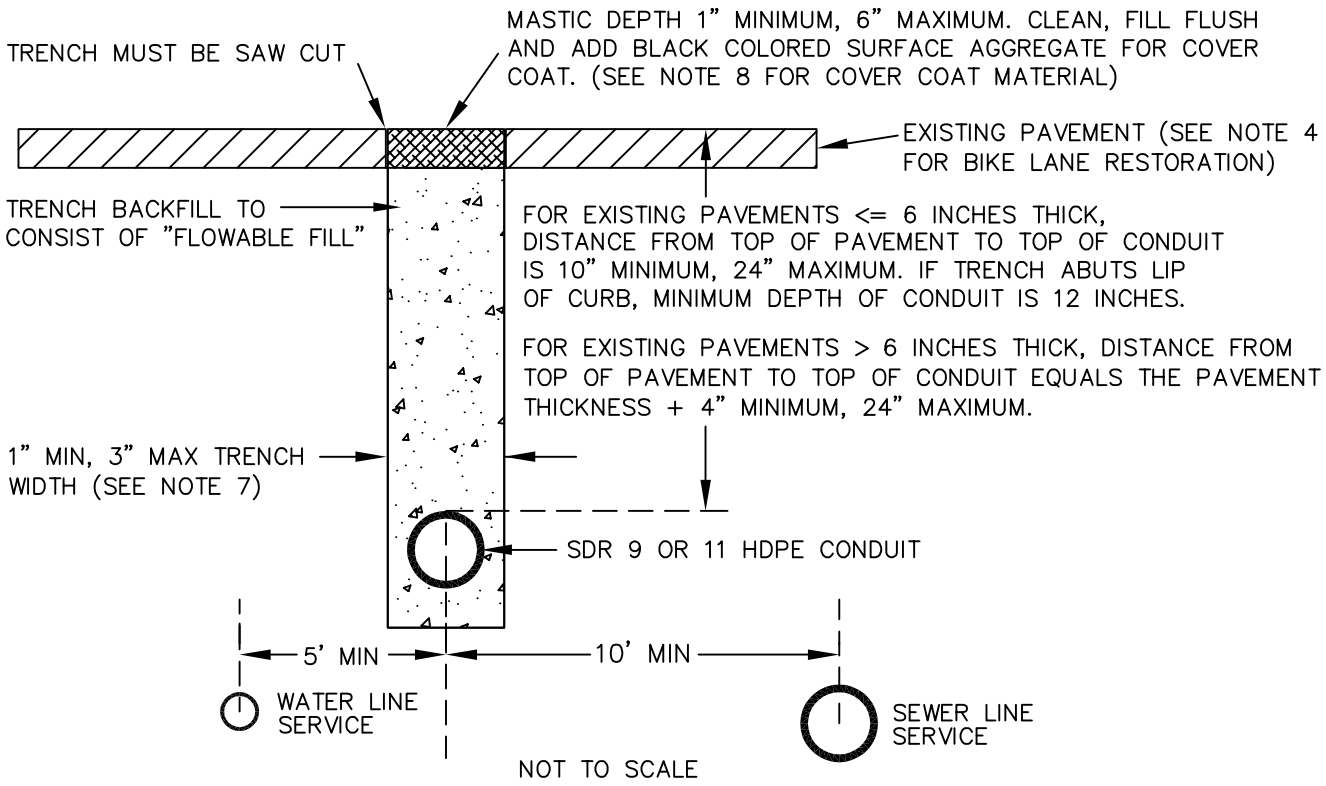
(2) **Corrosion Control Testing:** Corrosion control devices shall be tested whenever the pipe is exposed for maintenance or repair. Additionally, all corrosion control devices must be tested at least once each calendar year.

(3) **Records Retention:** Records of the testing shall be maintained for the life of the pipe.

(D) Aboveground Facilities

(1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.

(2) **Traffic Obstruction Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.



NOTES:

1. ANY NARROW TRENCH LOCATED UPON A DESIGNATED STATE HIGHWAY MUST HAVE AN ACCESS/UTILITY PERMIT THROUGH THE COLORADO DEPARTMENT OF TRANSPORTATION.
2. FLOWABLE FILL SHALL BE IN ACCORDANCE WITH CITY OF BOULDER SPECIFICATIONS.
3. NARROW TRENCH RUNNING PARALLEL IN TRAVEL LANE MUST MAINTAIN 2' OFFSET FROM VEHICLE WHEEL PATHS.
4. FOR ANY NARROW TRENCH LOCATED WITHIN A DESIGNATED BIKE LANE, PAVEMENT RESTORATION SHALL INCLUDE MILL AND OVERLAY OF ENTIRE WIDTH OF THE BIKE LANE. IF TRENCH ABUTS CONCRETE LIP LINE AND BIKE LANE IS GREATER THAN 3 FEET WIDE (MEASURED FROM EDGE OF STRIPING TO EDGE OF CONCRETE LIP EDGE) MILL AND OVERLAY IS NOT REQUIRED. PAVEMENT CUTS FOR LATERALS REQUIRE FULL WIDTH RESTORATION.
5. PAVEMENT RESTORATION WITHIN A DESIGNATED BIKE LANE SHALL BE COMPLETED WITHIN 10 CALENDAR DAYS OF BACKFILLING.
6. REFER TO OTHER APPLICABLE DETAILS AND STANDARDS FOR FULL WIDTH PAVEMENT REPLACEMENT FOR SIDEWALKS AND MULTI–USE PATHS.
7. TRENCH WIDTH SHALL BE 1" MAXIMUM GREATER THAN CONDUIT SIZE.
8. COVER COAT: USE HARSCO BLACK BEAUTY PRODUCT OR EQUIVILENT MATERIAL MEETING CDOT SPECIFICATIONS 703.05 – AGGREGATE FOR COVER COAT MATERIAL. REFER TO MASTIC ONE PRODUCT SPECIFICATIONS FOR TEMPERATURE AND APPLICATION REQUIREMENTS.

DRAWN BY: JSH CHECKED BY: APPROVED BY: DIRECTOR OF PUBLIC WORKS	CITY OF BOULDER, COLORADO TELECOMMUNICATIONS CONDUIT AND CABLE NARROW TRENCH	ISSUED: REVISED: _____ DRAWING NO. 4.05A