DS-01098
(Replaces DS-01044)

Iowa Department of Transportation

DEVELOPMENTAL SPECIFICATIONS
FOR
STORM SEWER

Effective Date
July 17, 2007

THE METRIC STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

This Developmental Specification is a rewrite. Please read carefully.

TABLE OF CONTENTS

The applicable sections of the Urban Standard Specifications for Public Improvements (SUDAS) have been included and modified in this Developmental Specification.

The applicable figures referenced in this Developmental Specification are included on the plans.

DIVISION 3 - TRENCH, BACKFILL, AND TRENCHLESS

SECTION 3010 - TRENCH AND BACKFILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Trench excavation for pipe systems, utility accesses, intakes, and other structures.

B. Trench bedding and foundation stabilization.

C. Pipe and structure placement and backfill.

1.02 DESCRIPTION OF WORK

A. Perform all excavations required to complete the work shown in the plans.

B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.

C. Complete specified backfill operation.

1.03 SUBMITTALS

A. Samples, granular bedding material: submit 10 pound (5 kg) samples of each type, if required.

B. Samples, granular backfill material: submit 10 pound (5 kg) samples, if required.

C. Gradation reports for fill materials and bedding materials, if required.

D. Results of Proctor and In-Place Density Tests on backfill.

E. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Obtain approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

B. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Use of Explosives: Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.

2. Use personnel experienced with explosives.

C. Abandoned Utilities: Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

1.08 MEASUREMENT FOR PAYMENT

A. General: No separate payment will be made for unclassified excavation. Trenching, Bedding, Backfilling, Compaction, and Dewatering shall be included in the costs in the contract unit price for all pipe and structures, except as follows:

1. Rock Excavation: Rock, if encountered and verified by the Engineer, will be measured by the Engineer and paid for by the cubic yard (cubic meter) removed from the excavation, or will be paid for according to Article 1109.03, B of the Standard Specifications unless otherwise provided for in Contract Documents.

2. Over-excavation and trench bottom stabilization. (Measured by the Engineer):

- **a.** Authorized over-excavation and trench stabilization will be measured by the cubic yard (cubic meter) removed.
- **b.** The quantity of stabilization material placed in the over-excavation will be measured in tons (kilograms).
- **c.** Payment will be made for over-excavation, stabilization material, and placement on the basis of the contract unit price or according to Article 1109.03, B, of the Standard Specifications.

3. Unsuitable Backfill:

a. Where excavated material is found to be unsuitable for backfill and cannot be made suitable in the opinion of the Engineer, the Engineer will measure replacement material furnished by Contractor from outside the project limits by cubic yards (cubic meters), furnished, transported, and properly installed. Payment will be made at the

contract unit price per cubic yard (cubic meter) or according to Article 1109.03, B, of the Standard Specifications.

b. Except for over-excavation, removal of unsuitable soil shall be considered as incidental to unclassified excavation.

c. If suitable backfill replacement material is within the project limits, it will not be measured and paid for separately.

B. Open Cut Casing and Carrier Pipe Installation: The length of properly installed casing will be measured along the centerline of the casing. Payment will be made for both the carrier pipe and casing pipe as a combined single bid unit for the appropriate method of installation.

C. Incidental Items: Unless otherwise stated in the contract documents, the following items will be included in the unit price for open cut casing and carrier pipe installation: guides, fillers, levels, backfill, and other appurtenances necessary to perform specified function.

D. Culvert Excavation: Unless specified in the contract documents, include excavation for culverts in the contract unit price for all pipe and structures. If the contract documents have a contract item for Class 20 excavation it will be measured according to Article 2402.12 of the Standard Specifications and paid for according to Article 2402.13 of the Standard Specifications.

E. Over-Excavation not for Stabilization and Repair of Same: No payment will be made.

F. Structure Removal: The Engineer will count the quantity of structures to be removed including each utility access and inlet removed in accordance with the plans. Payment will be for the number removed.

G. Surfacing Removal and Replacement: Unless otherwise specified in the contract documents all temporary or permanent surface removals and replacements for both granular and hard surfaces for streets, drives, and sidewalks will be included in the contract unit prices for all pipe and structures.

H. Abandoned Utilities: Remove and dispose of abandoned utilities within the work zone. This work shall be considered incidental to the contract unit price for pipes and structures.

I. Compaction Testing: All contractor provided services associated with compaction testing shall be considered incidental to the pipe installation.

PART 2 - PRODUCTS

2.01 EXCAVATED MATERIALS

A. Unclassified Excavation: Excavation of all materials encountered, except rock and over-excavation.

B. Rock Excavation: Boulders or sedimentary deposits that cannot be removed without continuous use of pneumatic tools or blasting.

C. Over-Excavation: Excavation of soil or rock in trenches below the pipe zone, see Figure 3010.1 on the plans.

D. Suitable Excavated Materials for Backfill:

1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D2321, Class II through IVA (see Section 3010, 2.01 E of this Developmental Specification).

2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) (see Section 3010, 2.01, E of this Developmental Specification) may be used in the final backfill upon approval of the Engineer.

3. Adjust moisture content of excessively wet, but otherwise acceptable material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.

4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.

5. Lime or fly ash may be added to earth material to produce a suitable backfill material. Uniformly mix soil and additive. Determine Standard Proctor maximum density and optimum moisture content of the modified material. Amount of additive applied is subject to the Engineer's approval.

~~G~~**E. Non-Manufactured (Excavated) Backfill Materials:** (see Sections 3010, 2.03 and 2.04 of this Developmental Specification for manufactured backfill)

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 μm)	LL	PI	Uniformity C_u	Curvature C_c
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100%	‹50% of "Course Fraction"	‹5%	Non Plastic		›4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						‹4	‹1 or ›3
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"				›6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						‹6	‹1 or ›3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100%	Varies	5% to 12%	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils, with Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	‹50% of "Coarse Fraction"	12% to 50%		‹4 or ‹"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					‹7 and ›"A" Line		
		SM	Silty sands, sand-silt mixtures.		›50% of "Coarse Fraction"			›4 or ‹"A" Line		
		SC	Clayey sands, sand-clay mixtures.					›7 and ›"A" Line		
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clay, lean clays.					›7 and ›"A" Line		
IVB (1)	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	›50%	›50	‹"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					›"A" Line		
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line		
		OH	Organic Clays of Medium to high plasticity, organic silts.				›50	‹"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.							

(1) See section 3010, 2.01, D 2 of this Developmental Specification for restrictive use.

F. Unsuitable Material: Remove unsuitable materials from the site including, but not limited to, the following:

1. Rock with gradation not meeting the stated gradation for stabilization material.

2. Individual stones or concrete chunks larger than 6 inches (150 mm), and averaging more than one per each cubic foot (0.03 m^3) of soil.

3. Frozen materials.

4. Stumps, logs, branches, and brush.

5. Trash, metal, or construction waste.

6. Soil in clumps or clods larger than 6 inches (150 mm), and without sufficient fine materials to fill voids during placement.

7. Unsuitable soils, as defined in Section 3010, 2.03, excluding material used as topsoil.

8. Class V Material (ASTM D 2321) as defined in Section 3010, 2.08 of this Developmental Specification.

9. Environmentally contaminated soil.

G. Replacement of Unsuitable Soils:

1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary backfill material.

2. Remove and dispose of unsuitable material from the site.

2.02 STABILIZATION (FOUNDATION) MATERIALS

A. Clean 2 1/2 inch (63.5 mm) crushed stone or crushed P.C. concrete material, with the following gradation:

Sieve	Percent Passing
2 1/2 inch (63 mm)	100
2 inch (50 mm)	90 to 100
1 1/2 inch (37.5 mm)	35 to 70
1 inch (25 mm)	0 to 20
1/2 inch (12.5 mm)	0 to 5

B. The Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within plus or minus 5% of the gradation for each size of material.

2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (STORM SEWERS)

A. Granular bedding shall be gravel or crushed stone complying with the following gradation:

Sieve	Percent Passing
1 1/2 inch (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

Note: The Engineer may authorize the use of crushed PCC for pipe sizes up to 12 inches (300 mm) or a change in gradation subject to materials available locally at time of construction.

B. Use aggregates having a percentage of wear, Grading A or B, not exceeding 50%, determined according to AASHTO T 96.

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

2.04 CLASS II BACKFILL MATERIAL (STORM SEWERS)

A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse grained natural soils (clean) with little or no fines.

B. Class II material is non-plastic soil less than 1 1/2 inches (37.5 mm) in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Class II material may be specified in the contract documents by the Engineer between the pipe embedment zone and the top 2 foot (0.6 m) of final backfill when the trench is under the pavement.

2.05 CLASS III BACKFILL MATERIAL (STORM SEWER)

A. Class III material is natural coarse grained soils with fines.

B. Class III material follows Section 3010, 2.01 of this Developmental Specification and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

2.06 CLASS IVA BACKFILL MATERIAL (STORM SEWER)

A. Class IVA material is natural fine grained inorganic soils.

B. Class IVA material follows Section 3010, 2.01 of this Developmental Specification and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 (75 μm) sieve.	Obtain geotechnical evaluation of proposed material. May not be suitable under deep fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Suitable only in dry trench conditions.

2.07 CLASS IVB BACKFILL MATERIAL (STORM SEWER)

A. Class IVB material is natural fine grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.

B. Class IVB material follows Section 3010, 2.01 of this Developmental Specification and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 (75 μm) sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Upon the approval of the Engineer Class IVB materials may be used as final backfill in a dry trench.

E. Do not use Class IVB materials in the pipe embedment zone.

2.08 CLASS V BACKFILL MATERIAL (UNSUITABLE BACKFILL)

A. Class V Material is natural highly organic soils with a liquid limit of greater than 50%. See Section 3010, 2.01 of this Developmental Specification.

B. Use Class V Material only as topsoil outside of the pavement, unless otherwise specified by the Engineer.

C. Do not use Class V Material in the pipe embedment zone.

2.09 BEDDING AND BACKFILL MATERIALS FOR PIPE CULVERTS

A. Bedding:

1. Use minimum Type C embedment (see Figure 3010.1 on the plans).

2. Install water stop or curtain wall at culvert inlet, as specified in the contract documents.

B. Backfill Material:

1. Use all suitable material excavated for pipe culvert work, as specified in Section 3010, 2.01 of this Developmental Specification for backfill material.

2. If suitable material has excessive moisture, dry it prior to placement.

3. Remove unsuitable material, as specified in Section 3010, 2.01 of this Developmental Specification from the project site.

2.10 BEDDING AND BACKFILL MATERIALS FOR SUBDRAINS

A. Drainable Bedding and Backfill Materials Include:

1. Porous backfill material.

2. Pea gravel.

3. Use as shown on the plans or on the detailed drawings.

B. Porous Backfill Material:

1. Crushed stone or gravel meeting Gradation No. 29 of the Aggregate Gradation Table in Section 4109 of the Standard Specifications.

C. Coarse Aggregate: Use Stabilization Materials, per Section 3010 of this Developmental Specification.

D. Pea Gravel: Use commercially available pea gravel.

E. Impervious Bedding: Use least permeable on-site materials.

F. Engineering Fabric: Use Section 4196 of the Standard Specifications.

2.11 SPECIAL PIPE EMBEDMENT MATERIAL

A. Concrete Supports: Where specified in the contract documents, construct concrete support systems in accordance with Figures 3010.2, 3010.3, 3010.4, 3010.5, 3010.6, and 3010.7 on the plans.

B. Concrete Bedding, Arch, or Encasement:

1. Concrete: commercial, 4,000 psi (27.6 MPa) compressive strength.

2. Unreinforced, unless otherwise shown in the plans.

3. Minimum concrete thickness: 6 inch (150 mm) or as shown on the plans.

C. Flowable Mortar:

1. Approximate quantities per cubic yard (cubic meter):

a.	Cement	100 pounds (60 kg)
b.	Fly ash	300 pounds (180 kg)
c.	Fine aggregate	2,600 pounds (1,545 kg)
d.	Water, approximate	70 gallons (345 L)

2. Compressive strength at 28 days: 100 psi to 200 psi (690 kPa to 1,380 kPa).

D. Controlled Low Strength Material (CLSM):

1. Approximate quantities per cubic yard (cubic meter):

a.	Cement	50 pounds (30 kg)
b.	Fly ash	250 pounds (150 kg)
c.	Fine aggregate	2910 pounds (1,729 kg)
d.	Water, approximate	60 gallons (296 L)

2. Compressive strength at 28 days 50 psi (345 kPa).

2.12 CASING PIPE WITH CARRIER PIPE

See Sections 3020, 201, 2.02, 2.03, and 2.04 of this Developmental Specification.

PART 3 - EXECUTION

3.01 PREPARATION

A. When natural soils for Class II, III, and IV backfill material is required as specified in Figure 3010.1 on the plans, provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features, or replace as shown on the plans.

F. Protect bench marks, control points, and land survey monuments, or replace at Contractor's expense.

3.02 TRENCH EXCAVATION

A. Notify the Engineer prior to the start of excavation activities.

B. Remove and stockpile the top 8 inches (200 mm) of topsoil for subsequent reuse.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches (150 mm) below, and on each side of the pipe. Restore grade using soil suitable for backfill.

E. Correct unauthorized excavation at no cost to Contracting Authority, using bedding or stabilization materials.

F. Provide protective fences and barricades around open excavations, appropriate to the surrounding area.

G. Provide scale tickets for stabilization material to the Engineer at the time of delivery.

H. Provide safety fence around open excavations.

I. Trench Excavation for Storm Sewers and Pipe Culverts:

1. Maximum and minimum pipe trench width: See Figure 3010.1 on the plans.

2. Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping.

- **a.** Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
- **b.** Provide bell holes.

3. Trench bottom, conduit supported by bedding material.

- **a.** Excavate trench as shown in detailed drawings.
- **b.** Install bedding material to support the full length of the pipe barrel.

4. Trench depth:

- **a.** See Figure 3010.1 on the plans.
- **b.** For those material types not shown in Figure 3010.1 on the plans, the maximum height of bury shall be 20 feet (6 m) without a designed trench with the Engineer's certification.

J. Structure Excavation:

1. For concrete structures and parts of structures without footings, 18 inches (450 mm) outside the horizontal projection of the structure.

2. For concrete structures with footings, 18 inches (450 mm) outside the footings.

3. For anchor rods, 12 inches (300 mm) on each side of the rod.

4. For buried anchors, the face of the buried anchor on one side and 24 inches (600 mm) outside the buried anchor on the other face.

3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM

A. Notify the Engineer prior to over-excavation.

B. The Engineer will determine the need for trench bottom stabilization prior to installation of pipes and structures.

C. See Figure 3010.1 on the plans for over-excavation of rock and wet or soft foundations.

D. Provide scale tickets for the stabilization material to the Engineer at the time of delivery.

3.04 SHEETING, SHORING, AND BRACING

A. Ensure sheeting and bracing of all excavations conforms to the latest state and federal regulations governing safety of workers in the construction industry.

B. Leave in place all temporary sheeting below 2 feet (600 mm) over top of pipe unless sheeting removal plan is approved by the Engineer.

C. Move trench boxes carefully to avoid excavated wall displacement or damage.

D. When necessary or required, install adequate sheeting and bracing to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.

E. Damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.

F. Shore, sheet, brace, slope, or otherwise support by means of sufficient strength all sides of trenches in unsuitable, loose or soft material to protect employees working within them.

G. Where excavations are made with vertical sides which require supporting, use sufficiently strong sheeting and bracing to sustain the sides of the excavations and to prevent movement which could in any way injure the work, or adjacent structures, or diminish the working space sufficiently to delay the work.

H. Select sheeting and bracing material which: (1) is of sufficient dimensions and strength to adequately support the sides of trenches and excavations; (2) does not split when driving; and (3) is free of imperfections that may impair its strength or durability.

I. Drive sheeting shall be driven to true alignment. Ensure contact of adjacent pieces.

J. In wet excavation use grooved sheeting to prevent passage of soil. Fill all voids between sheeting and face of excavation with suitable material.

K. Do not remove sheeting and bracing before the completion of the work, unless otherwise directed by the Engineer.

L. For sheeting that is left in place, cut off 18 inches (0.5 m) for clearance below the bottom of the pavement in streets/highways and 18 inches (0.5 m) below the original ground surface, unless otherwise required by the contract documents or the Engineer. Leave in place all temporary sheeting below 2 feet (0.6 m) over top of pipe unless sheeting removal plan is reviewed by the Engineer.

3.05 DEWATERING

A. Do all work in dry conditions; do not install pipes on excessively wet soil.

B. Submit a dewatering plan to the Engineer. Perform the dewatering operation according to the dewatering plan. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.

C. Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.

D. Install a dewatering system appropriate for the soil conditions.

E. Maintain water levels sufficiently below the bottom of trench excavation (typically 2 feet (0.6 m)) to prevent upward seepage.

F. Provide for handling water encountered during construction:

1. Prevent surface water from flowing into excavation. Remove water as it accumulates.

2. Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires the Engineer's approval.

3. Do not discharge water onto adjacent property without property written approval.

4. Maintain and control water discharge as necessary so not to create a safety hazard for vehicular and pedestrian traffic.

5. Direct water discharge ~~shall be directed~~ away from electrical facilities or equipment, and intersections.

6. Use noise and fume reduction equipment to minimize disturbance

7. Provide at least two operating pumps for each trench opened in wet ground and at the same time ~~shall~~ have one pump in reserve.

G. Backfill trenches prior to stopping dewatering operations.

H. Protect trench water discharge points from erosion.

I. Operate dewatering systems to prevent damage to adjoining structures and facilities.

J. Monitor adjoining structures and facilities during dewatering operations. Cease dewatering operations and notify the Engineer if damage is observed.

3.06 PIPE INSTALLATION

Refer to Figures 3010.1 to 3010.9, included on the plans, as appropriate for the installation being made. Use only the types of materials shown for each position within the trench, for the given groundwater conditions, for the compaction to be provided, and for the type of pipe being installed.

A. Pipe Bedding:

1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.

2. Install pipe and system components.

3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.

4. Place bedding in lifts not greater than 6 inches (150 mm) thick and consolidate.

5. Concrete encasement: Install where shown on the plans.

6. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.

7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

B. Haunch Support:

1. Place granular haunch material in lifts not greater than 6 inches (150 mm) in thick and consolidate by slicing with a shovel or using other approved techniques.

2. If required in the contract documents or approved by the Engineer, concrete, flowable mortar, or controlled low strength material may be used instead of other haunch material types. Secure pipe against displacement or flotation prior to placing flowable mortar, controlled low strength material, or concrete encasement.

C. Primary and Secondary Backfill (Pipe Cover):

1. Place pipe cover material in 6 inches (150 mm) lifts and compact to densities required according to class of material. See Figure 3010.1 (sheet 1) on the plans.

2. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types.

3. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

4. Special Pipe Support: If required, provide special pipe support as shown on the plans (see Figures 3010.4 to 3010.6 on the plans).

D. Final Trench Backfill:

1. Backfill trench immediately after recording locations of connections and appurtenances, or at the Engineer's direction.

2. Backfill structures immediately after concrete has reached design strength and connecting work has been completed.

3. Allow no more than 100 feet (30 m) of trench to be open overnight or when work is not in progress except as provided on the plans.

4. Backfill with suitable excavated earth materials:

a. Carefully place backfill over top of pipe and around structures.
b. Compact as required.

5. Compaction:

a. Within street right-of-way, compact each lift to at least 95% of maximum Standard Proctor Density; otherwise, compact to at least 90%.
b. In areas more than 3 feet (900 mm) below pavement structure, place backfill in lifts no thicker than 8 inches (200 mm).
c. In areas less than 3 feet (900) feet below pavement structure, place backfill in lifts no thicker than 6 inches (150 mm). Terminate backfill at 8 inches (200 mm) below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved. Place 8 inches (200 mm) of topsoil in unpaved areas.
d. For Vitrified Clay Pipe (VCP), keep all heavy compaction equipment 5 vertical feet (1.5 vertical meters) above the top of the pipe. In the area less than 5 vertical feet (1.5 vertical meters), use hand held compactors. Do not allow the compactor to come in contact with the pipe.

6. Moisture Range: Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

7. Dispose of surplus and unsuitable materials.

8. Hydraulic compaction (flooding with water) is not allowed unless authorized by the Engineer.

E. Casing Pipe: Bed and backfill casing pipes as for a rigid gravity flow pipe.

3.07 PIPE INSTALLATION IN CONSTRUCTED EMBANKEMENTS

When allowed by the contract documents, pipes may be constructed in embankments as follows:

A. Placing Pipe Sections: See Section 4020, 3.03 of this Developmental Specification.

B. Placing Backfill for Pipes: See Article 2416.04, D of the Standard Specifications.

3.08 STRUCTURE BEDDING

A. Bedding for Structures Bearing on Undisturbed Soils:

1. Shape the bottom to accurate grade and size.

2. Remove loose material, large clods, stones, and foreign materials.

3. In unstable soils or rock conditions see Section 3010, 3.03 of this Developmental Specification for stabilization requirements.

B. Bedding for Structures Bearing on Bedding Material:

1. Over excavate to minimum of 8 inches (200 mm) or as specified in the contract documents.

2. Place bedding material for structures in accordance with the contract documents and with

the material and control specified in Figure 3010.1 on the plans.

3.09 STRUCTURE BACKFILL

A. Removal of Forms and Falsework:

1. Remove forms for utility accesses and intake walls and tops according to Article 2403.18 of the Standard Specifications.

a. References to culverts include all sanitary and storm structures.
b. When allowed by the Engineer, compressive strengths as six times the stated flexural strengths may be used in determining concrete strength of structure roofs.

2. Chip out and repair honeycomb areas per the direction of the Engineer.
3. Break back form ties and fill holes with Portland cement mortar.
4. Remove flashing and thin webs.

B. Backfill Placement: Backfill immediately after structure concrete has reached at least 80% of the design strength and connecting work has been completed, unless otherwise specified. Determine strengths under comparable conditions. If strength is not determined, place backfill after 14 days.

C. Backfill Against Walls and Around Structures:

1. Where backfill is required on both sides of a concrete wall and around sides of monolithic structures, proceed with filling operations simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times. Consider concrete box, arch, and circular culverts to be monolithic structures.

2. Compact the 3 feet (900 mm) closest to all walls or wing faces using pneumatic or hand tampers only.

D. Backfilling with Excavated Material:

Unless otherwise specified, see Section 3010, 3.06 D of this Developmental Specification for suitable excavated materials for backfill.

3.10 OPEN CUT CASING PIPE INSTALLATION

A. Casing Pipe: Install according to Section 3010, 3.01 to 3.07 of this Developmental Specification, as appropriate.

B. Carrier Pipe: Install according to Section 3020, 3.05 of this Developmental Specification.

3.11 FIELD QUALITY CONTROL

A. References:

1. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D 698, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5 Pound (4.54 kg) Rammer and 12 inch (305 mm) Drop. (Standard Proctor Method)

3. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

4. ASTM 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

5. M D 2922 and D 3017, Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).

6. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.

B. Compaction Testing: Provide compaction testing of backfill, using the services of an independent testing laboratory approved by the Engineer, unless testing is provided by the Engineer.

C. Schedule Testing: Notify the Engineer when work is prepared for testing.

D. Soil Testing:

1. Cohesive soils: Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.

2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).

3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).

4. Gradation: Test in accordance with ASTM C 136.

E. Testing Frequency and Locations: Perform testing of the final trench backfill, beginning at a depth of 2 feet (600 mm) above the top of the pipe, as follows:

1. Contractor Provided:

- **a.** Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill at each street crossing.
- **b.** Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill for each 200 horizontal feet (60 horizontal m) of trench.
- **c.** Additional testing may be required by the Engineer if non-compliance or a change in conditions occurs.
- **d.** Coordinate the timing of testing with the Engineer.
- **e.** The Engineer will determine the location of testing.
- **f.** If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill and recompact.

2. Contracting Authority Provided:

- **a.** Coordinate the timing of testing with the Engineer.
- **b.** The Engineer will determine the location of testing.
- **c.** Test frequency will not exceed one test per each 2 vertical feet (600 vertical mm) of consolidated fill for each 200 horizontal feet (60 horizontal m) of trench.

F. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the trench.

G. Retesting: In event of failed tests, the Engineer may require retesting as deemed necessary, at no additional cost to the Contracting Authority.

SECTION 3020 - TRENCHLESS CONSTRUCTION (BORING, JACKING, AND TUNNELING)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Trenchless installation of carrier pipe with casing pipe.

B. Trenchless installation of carrier pipe without casing pipe.

1.02 DESCRIPTION OF WORK

A. Excavate launch and receiving pits.

B. Install casing pipe (if required).

C. Install carrier pipe.

D. Backfill excavations.

E. Possible methods of trenchless installation (refer to Section 3020, 3.05 of this Developmental Specification for restrictions):

1. Auger Boring: A boring method that utilizes a rotating cutting head to form the bore and a series of rotating augers inside a casing pipe to remove the spoil.

2. Compaction Method: Boring methods that displace soil radially rather than removing spoil. Bore hole may be formed with a push rod or impact mole.

3. Directional Drilling: A boring method for installing pipe from a surface launched drilling rig. A pilot bore is formed and then enlarged by back reaming. The product pipe is then pulled in.

4. Pipe Ramming: A boring method that involves driving a steel casing pipe with a percussive hammer. The front end of the casing pipe may be open ended or closed. If open, spoil must be removed from the pipe.

5. Slurry Boring: A boring method which first forms a pilot bore by forcing a drill tube through the ground. The pilot hole is then enlarged by reaming. As the hole is enlarged with the reamer, drilling fluid (slurry) is pumped into the hole to hold the soil cuttings in suspension. After reaming, the product pipe is pulled into place.

6. Microtunneling: A boring method that consists of a remotely controlled pipe jacking operation utilizing a tunnel boring machine. Personnel entry is not required.

7. Pipe Jacking: A jacking method in which pipe is pushed into the ground with hydraulic rams while soil is simultaneously excavated. Excavation is normally completed with a tunnel boring machine. This method requires personnel to enter the tunnel during the excavation process.

8. Utility Tunneling: A method of forming large diameter tunnels. As excavation takes place at the front of the tunnel, a liner is constructed to temporarily support the tunnel. Upon completion of the tunnel, the product pipe is pushed in place.

9. Other proven methods not described here may be allowed upon approval of the Engineer.

1.03 SUBMITTALS

A. Proposed installation methods and equipment.

B. Samples, granular bedding material: submit 10 pound (5 kg) samples, if required.

C. Samples, granular backfill material: submit 10 pound (5 kg) samples, if required.

D. Gradation reports for fill materials and bedding materials unless the material used has been submitted and approved for related work on the project.

E. Results of Standard Proctor and In-Place Density Tests on pit backfill if required.

F. Construction sequence.

G. Catalog cuts, samples, and manufacturer's data and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.

H. Certification that materials being provided meet the requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer. Include shop drawings of casing spacers and proposed spacing.

I. Project Record Documents.

J. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

Obtain approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

B. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on the plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Use of Explosives: Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.

2. Use personnel experienced with explosives.

1.08 MEASUREMENT FOR PAYMENT

A. Boring, Jacking, or Tunneling with Casing Pipe: The length of casing pipe and carrier pipe properly installed will be measured along the centerline of the casing. Payment will be made for both the carrier pipe and casing pipe as a combined single contract unit for the appropriate method of installation.

B. Jacking or Boring without a Casing Pipe: The length of the carrier pipe properly installed will be measured along the centerline of the carrier pipe.

C. Incidental Items: Unless otherwise specified in the contract documents the following items will be included in the contract unit price for boring, jacking, or tunneling:

1. Launch or reception pits, or other construction excavations.

2. Placement, compaction, and testing of backfill material in excavations and pits.

3. Casing Spacers, annular space fillers, levels, backfill, casing and seals, and other appurtenances necessary to perform specified function

PART 2 - PRODUCTS

2.01 CARRIER PIPE

See Section 4010, 2.01 or Section 5010, 2.01 of this Developmental Specification, or refer to the contract documents.

2.02 CASING PIPE

A. Casing Pipe: Use only new, welded, or seamless steel pipe per ASTM A139, Grade B; ASTM A252, Grade 2; or ASTM A53, Grade B.

B. Joints:

1. Comply with American Welding Society Code of Arc and Gas Welding in Building Construction. Fully weld all joints with full penetrating weld.

2. Upon approval of the Engineer, an interlocking casing pipe connection system may be used instead of field welding the sections of casing pipe.

C. Casing Pipe Diameter: Minimum inside diameter as shown on the plans. If not shown, use a minimum casing diameter of at least 4 inches (100 mm) greater than the largest outside diameter of the carrier pipe, including pipe bells.

D. Steel Casing Pipe Minimum Wall Thickness:

NOMINAL DIAMETER INCHES (mm)	WALL THICKNESS, MINIMUM INCHES (mm)	
	UNDER HIGHWAY	UNDER RAILROAD
6 thru 14 (150 thru 355)	0.188 (4.78)	0.25000 (6.35)
16 (465)	0.188 (4.78)	0.28125 (7.14)
18 (450)	0.25 (6.35)	0.31250 (7.94)
20 (510)	0.25 (6.35)	0.34375 (8.73)
22 (560)	0.25 (6.35)	0.34375 (8.73)
24 (600)	0.281 (7.14)	0.37500 (9.53)
26 (660)	0.281 (7.14)	0.40625 (10.32)
28 (710)	0.312 (7.92)	0.43750 (11.11)
30 (750)	0.312 (7.92)	0.46875 (11.91)
32 (815)	0.312 (7.92)	0.50000 (12.70)
34 (865)	0.312 (7.92)	0.53125 (13.49)
36 (900)	0.344 (8.74)	0.53125 (13.49)
38 (965)	0.344 (8.74)	0.56250 (14.29)
40 (1015)	0.344 (8.74)	0.59375 (15.08)
42 (1050)	0.344 (8.74)	0.62500 (15.88)
44 (1120)	0.344 (8.74)	0.65625 (16.67)
46 (1170)	0.344 (8.74)	0.65625 (16.67)
48 (1200)	0.344 (8.74)	0.68750 (17.46)
50 (1270)	Sizes greater than 48 inches (1200 mm) diameter will be as specified in the contract documents	0.71875 (18.26)
52 (1320)		0.75000 (19.05)
54 (1370)		0.78125 (19.84)
56 (1420)		0.81250 (20.64)
58 (1470)		0.81250 (20.64)
60 (1525)		0.84375 (21.43)
62 (1575)		0.87500 (22.23)
64 (1625)		0.90625 (23.02)
66 (1675)		0.93750 (23.81)
68 (1725)		0.93750 (23.81)
70 (1780)		0.96875 (24.61)
72 (1830)		1.00000 (25.40)

2.03 CASING SPACERS

Use manufactured casing spacers to position carrier pipe in casing. Wood skids will not be allowed.

B. Use the following material requirements for casing spacers:

1. **HDPE Band/Panel and Riser:** ASTM D 638.
2. **Stainless Steel or Carbon Steel Band/Panel and Riser:** Type 304 stainless steel per ASTM A 240 or carbon steel per ASTM 36.

   a. **Liner:** Elastomeric PVC per ASTM D 149.
   b. **Spacer Skid/Runner:** Abrasion resistant polymer with a low coefficient of friction.
   c. **Fasteners:** Type 304 (18-8) stainless steel per ASTM A 193.

2.04 BACKFILL FOR ABANDONED TUNNELS

A. Option 1 - PCC, 3,000 psi (20.7 MPa) minimum, approximately 4 inch (100 mm) slump.

B. Option 2 - Flowable mortar or controlled low strength material (CLSM) per Section 3010, 2.11 of this Developmental Specification.

2.05 CASING END SEAL

A. Manufactured synthetic rubber casing end seal with a minimum 1/8 inch (3 mm) thickness and stainless steel bands and fasteners.

B. PCC meeting the requirements of Article 2403 of the Standard Specifications. Do not use PCC casing end seals with flexible pipes.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify suitability of excavated materials for reuse as backfill.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features or replace as shown on the plans.

F. Protect bench marks, control points, and land survey monuments or replace at Contractor's expense.

G. Select a method of installation that: (1) is appropriate for the soil conditions anticipated; (2) allows the pipe to be installed to the desired line and grade within the specified tolerances; and (3) prevents heaving or settlement of the ground surface or damage to nearby facilities.

3.02 EXCAVATION

A. Notify the Engineer prior to the start of tunneling activities.

B. Remove and stockpile the top 8 inches (200 mm) of topsoil for subsequent reuse. Do not mix topsoil with other excavated materials.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, debris, and unsuitable materials.

E. Excavate the minimum size pits necessary to safely and properly perform the work.

3.03 SHEETING, SHORING, AND BRACING (See Section 3010, 3.04 of this Developmental Specification)

Provide and install sheeting, shoring, and bracing or trench boxes as required to safely perform work, protect nearby structures, and work under construction.

3.04 DEWATERING

See Section 3010, 3.05 of this Developmental Specification.

3.05 TRENCHLESS INSTALLATION

A. General:

1. Install pipes by boring, jacking, or tunneling only where required by the plans.

2. Place bedding and backfill of the carrier pipe beyond the end of the casing pipe, in tunneling pits, and in casing pipes installed by open-cut trenching according to Section 3010 of this Developmental Specification.

3. Install pipe at line and grade. Comply with the following:

a. Line and grade permit the carrier pipe to be installed at its true starting elevation and grade within a maximum alignment deviation of the pipe centerline as specified in the contract documents.

b. When no deviation tolerances are specified in the contract documents, the following maximums apply:

1) Gravity Pipe:
Horizontally: ±1.0 foot per 100 feet (±300 mm per 30 m);
Vertically: ±0.2 foot up to 100 feet (±60 mm up to 30 m); an additional ±0.1 foot (±30 mm) per 100 feet (30 m) thereafter. Do not allow backfill in the pipe.

2) Pressurized Pipe:
Horizontally: ±2.0 foot (±600 mm)
Vertically: ±1.0 foot (±300 mm). Maintain minimum depth specified by the local jurisdiction.

c. Greater deviation or interference with other identified facilities may be cause for rejection.

4. Provide additional fittings, utility accesses, or appurtenances needed to accommodate any horizontal or vertical misalignment, if allowed by the Engineer, at no additional cost to the Contracting Authority.

5. Contractor will be allowed to correct errors in grade of the casing pipe in order to achieve design grade of the carrier pipe by pouring an invert in the casing pipe, or by shimming the carrier pipe to a uniform grade, provided adequate clearance remains for proper installation of the carrier pipe.

6. Rejected tunnels shall be replaced at the Contractor's expense. This includes additional fittings, utility access, or appurtenances needed to replace the rejected work.

B. Casing Pipe or Un-cased Carrier Pipe Installation:

1. Install pipe by auger boring, pipe jacking, microtunneling, open-ended pipe ramming, directional drilling (back-reaming required), or utility tunneling.

2. Do not use methods that displace excess soil, rather than removing it, such as impact moling, push rod, or closed end pipe ramming unless specified in the contract documents, or permitted by the Engineer.

3. Water jetting will not be allowed.

4. Use a jacking collar, timbers, and other means as necessary to protect the driven end of the pipe from damage.

5. Fully support borehole at all times to prevent collapse. Insert pipe as earth is removed, or support bore with drilling fluid.

6. Fully weld all casing pipe joints or use an interlocking connection system according to Section 3020, 2.02 of this Developmental Specification.

7. Fill annular space between the inside of the bore hole and the outside of the pipe if the space is greater than 1 inch (25 mm). Use flowable mortar, CLSM (see Section 3010 of this Developmental Specification), or 3,000 psi (20.7 MPa) concrete.

C. Carrier Pipe Installation Through Casing:

1. Clean dirt and debris from the casing pipe after installation.

2. Install casing spacers to pipe sections as necessary to support pipe barrel according to the pipe manufacturer's recommendation.

a. Space according to the pipe manufacturer’s recommendation. As a minimum, place a spacer within 1 foot (900 mm) of each side of the joint and a maximum spacing of 6 feet (1.8 m).
b. Do not allow pipe to be supported by joint bells.
c. Lubricate casing spacers with drilling mud or flax soap. Do not use petroleum-based lubricants or oils.

3. Ensure that thrust loads will not damage carrier pipe joints. Provide thrust collars between joint shoulders of concrete pipe.

4. Provide timbers for sufficient cushioning between the end of the pipe pushed and the jacking equipment to prevent damage to the pipe. Do not allow steel jack face to thrust against unprotected pipe end.

5. Position jacks so the resulting force is applied along the centerline of the pipe, and the force is applied evenly to the entire end of the pipe.

6. Assemble pipe joints in the jacking pit, before pushing the carrier pipe into the casing.

7. Close end of casing pipe around the carrier pipe with a casing end seal. Do not use the PCC casing end seals with flexible pipe.

8. Fill the annular space between the carrier and casing pipe, only if required on the plans, with flowable mortar or CLSM per Section 3010, 2.11 of this Developmental Specification.

3.06 FIELD QUALITY CONTROL

Provide compaction testing of backfill material and embankment, if required, as part of the field quality control for the carrier pipe line being constructed. Ensure that at least one compaction test site occurs at each pit.

DIVISION 4 - SEWERS AND DRAINS

SECTION 4020 - STORM SEWERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Storm Sewers.

B. Footing Drain Sewer Collectors.

C. Storm Sewer Service Stubs.

1.02 DESCRIPTION OF WORK

A. Construct storm sewers.

B. Construct storm sewer service and connections and footing drain sewer collectors.

1.03 SUBMITTALS

A. Manufacturer′s instructions for installation of pipe and appurtenances.

B. Construction sequence.

C. Catalog cuts, samples, manufacturer′s data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.

D. Certification that materials being provided meet the requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer.

E. Project Record Documents.

F. Upon requests, provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Obtain written approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials and handle to avoid damage. Replace damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.

2. Complete elements of work that can affect line and grade in advance of storm sewer construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.08 MEASUREMENT FOR PAYMENT

A. Storm Sewers:

1. Pipe (excluding aprons) will be measured in linear feet (meters) along centerline of pipe in place.

2. Each size and type of pipe installed will be measured from end of pipe to end of pipe.

3. Payment will be made at the contract unit price for each size and type installed.

4. For pipe installed within casing pipe (see Section 3020, 1.08 of this Developmental Specification), the length of casing/carrier pipe, properly installed, will be measured along the centerline of the casing. Payment will be made for both carrier and casing pipe as a single contract unit for the appropriate method of installation.

B. Footing Drain Collectors:

The footing drain collector extends from the storm sewer and provides an outlet for storm sewer services and for footing drains. Terminate the downstream end of footing drain collector at a utility access or cleanout.

1. Pipe will be measured in linear feet (meters) along the centerline of the pipe in place.

2. Each size and type of pipe installed will be measured from end of pipe to end of pipe.

3. Payment will be made at the contract unit prices for each size and type installed.

4. Wye, tap, and fittings shall be considered incidental.

5. The number of cleanouts will be counted. Payment for cleanouts will be made at the contract unit price for each size and type installed.

C. Storm Sewer Service Stub: The storm sewer service stub is the portion on the storm sewer service from the footing drain collector or storm sewer to a point 10 feet (3 m) outside of the right-of-way or as shown on the plans.

1. Pipe will be measured in linear feet (meters) along the centerline of the pipe in place.

2. Each size and type of pipe installed will be measured from centerline of storm sewer or footing drain collector to the end of the pipe.

3. Payment will be made at the contract unit price for each size and type installed.

4. Tap and fittings are incidental.

D. Pipe Aprons:

1. Payment will be made for each pipe apron installed by size and type.

2. When footings for RCP aprons, curtain walls for metal aprons, and/or apron guards are required, they will be paid by each.

PART 2 - PRODUCTS

2.01 STORM SEWERS

A. Reinforced Concrete Pipe (RCP):

1. Conform to ASTM C 76.

2. Minimum Class III, Wall B.

3. Tongue and groove joints.

a. Unless specified otherwise, use cold applied bituminous jointing materials.
b. If specified, use rubber O-ring flexible joint conforming to ASTM C 443.

4. If specified, wrap exterior of each joint with engineering fabric.

B. Reinforced Concrete Arch Pipe (RCAP):

1. Use only where indicated on the plans or approved by the Engineer.

2. Conform to ASTM C 506.

3. Minimum Class A III.

4. Tongue and groove joints. Use cold applied bituminous or rubber rope gasket materials unless otherwise specified.

5. If specified, wrap exterior of each joint with engineering fabric.

C. Reinforced Concrete Elliptical Pipe (RCEP):

1. Use only where indicated on the plans or approved by the Engineer.

2. Conform to ASTM C 507.

3. Minimum Class HE III or Class VE III.

4. Tongue and groove joints. Use cold applied bituminous or rubber rope gasket jointing materials, unless otherwise specified.

5. If specified, wrap exterior of each joint with engineering fabric.

D. Reinforced Concrete Low Head Pressure Pipe (RCPP):

1. Conform to ASTM C 361.

2. Minimum Class C 25.

3. Tongue and groove joints.

4. Conform to ASTM C 361 for rubber O-rings or profile gaskets.

E. Polyvinyl Chloride Pipe (PVC):

1. Use pipe conforming to the following:

- **a.** Types of PVC pipes:
  - **1)** Corrugated exterior, smooth interior, ASTM F 949.
  - **2)** Solid wall, ASTM D 3034 or ASTM F 949.
  - **3)** Closed profile, ASTM D 1803.
  - **4)** Truss, ASTM D 2680
- **b.** PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
- **c.** Minimum pipe stiffness of 46 psi (320 kPa).
- **d.** Gasketed integral bell and spigot joints per ASTM D 3212 and ASTM F 477.

2. Do not use in the right-of-way.

3. Use only outside the right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the PVC pipe will not be disturbed, and where the Engineer allows.

F. High Density Polyethylene Pipe (HDPE):

1. Use pipe conforming to the following:

- **a.** AASHTO M 294, Type S corrugated exterior and smooth interior.
- **b.** ASTM D 3350 minimum resin Cell Classification 335420 C..
- **c.** Minimum pipe stiffness at 5% deflection per ASTM D 2412.
- **d.** Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.
- **e.** Maximum 5% deflection of the average inside diameter by testing after installation per Section 4040, 3.09.

2. Do not use in the right-of-way.

3. Use only outside the right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the HDPE pipe will not be disturbed, and where the Engineer allows.

G. Jointing Material for Concrete Pipe:

1. Bituminous jointing material: Use a cold applied mastic sewer joint sealing compound

recommended by the manufacturer for the intended use and approved by the Engineer. Conform to AASHTO M 198.

2. Rubber rope gasket jointing material: Conform to ASTM C 990.

3. Rubber O-ring or profile gasket: Conform to ASTM C 443 (for RCP) or ASTM C 361 (for RCPP).

H. Bituminous Joint Primer: Meet the requirements of ASTM D 41, which is intended for use in priming concrete pipe joints prior to application of bituminous jointing material.

I. Engineering Fabric:

1. Use for wrapping exterior of storm sewer pipe joints where indicated on plans.

2. Conform with Article 4196.01, B, of the Standard Specifications.

J. Pipe Apron Section:

1. Use where indicated on the plans

2. Reinforced concrete apron sections conforming to Figure 4020.9 on the plans.

3. Metal pipe aprons conforming to Figure 4020.10.

4. Minimum Class III.

K. Flared End Section Apron Guard:

1. Use where indicated on plans.

2. See Figure 4020.3 on the plans.

2.02 INTENTIONALLY LEFT BLANK

2.03 SUBDRAINS, TYPE I

See Figure 4020.5A on the plans.

A. - D. Intentionally left blank.

E. Engineering Fabric: Use fabric conforming to Article 4196.01, B of the Standard Specifications.

2.04 FOOTING DRAIN COLLECTOR (MINIMUM 8 INCH (200 mm) DIAMETER, MAXIMUM 12 inch DIAMETER)

The following requirements also apply to Type II Sudrains (see Figure 4020.5B).

A. Polyvinyl Chloride Pipe (PVC):

1. Conform to ASTM D 3034, minimum thickness SDR 35, minimum pipe stiffness 46 psi (320 kPa).

2. PVC plastic conforming to ASTM D 1784, Cell Classification 12454.

3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

4. Preformed wye or tee service fitting with gasket joints conforming to ASTM D 3034.

5. Preformed saddle wye or saddle tee for service tap conforming to ASTM D 3034.

6. For Type II Subdrain, slot pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch (6 mm to 10 mm) diameter holes along the bottom of the pipe.

B. Polyvinyl Chloride Corrugated Pipe (Corrugated PVC):

1. Corrugated exterior, smooth interior PVC.

2. Conform to ASTM F 949, minimum pipe stiffness 46 psi (320 kPa).

3. PVC plastic conforming to ASTM D 1784, Cell Classification 12454.

4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

5. Preformed wye or tee service fitting with gasket joints conforming to ASTM F 949.

6. Preformed saddle wye or saddle tee for service tap conforming to ASTM F 949.

7. For Type II Subdrain, slot pipe according to ASTM F 949.

C. High Density Polyethylene Pipe (HDPE)

1. Use pipe conforming to the following:

a. AASHTO M 294, Type S corrugated exterior and smooth interior.
b. ASTM D 3350, minimum resin Cell Classification 335420 C.
c. Minimum pipe stiffness at 5% deflection per ASTM D 2412.
d. Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.
e. Maximum 5% deflection of the average inside diameter by testing after installation per Section 4040, 3.09 of this Developmental Specification.

2. Fabricated or preformed saddle wye or saddle tee for service tap conforming to AASHTO M 252 or M 294.

3. For Type II Subdrain, slot or perforate according to AASHTO M 252, Type CP, or Type SP.

D. Reinforced Concrete Pipe (RCP)

1. Conform to Section 4020, 2.01 of this Developmental Specification.
2. If specified for Type II Subdrain, wrap the exterior of each joint with engineering fabric and use no joint sealant.

E. Engineering Fabric: Shall conform to Article 4196.01, B of the Standard Specifications.

2.05 STORM SEWER SERVICE STUBS (MINIMUM 4 INCH (100 mm) DIAMETER)

A. Pipe materials as specified for footing drain collectors may be used for storm sewer services.

B. Polyvinyl Chloride Pipe (PVC):

1. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe SDR 23.5 (153 psi (1055 kPa)), 26 (115 psi (790 kPa), 35 (46 psi (320 kPa)).

2. PVC plastic in conformance with ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot type rubber gasket joint confirming to ASTM D 3212 and ASTM F 477.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.

B. Examine site conditions to ensure that construction operations do not pose hazards to adjacent structures or facilities.

3.02 LINE AND GRADE

A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes.

B. Notify the Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.

C. Make detailed measurements as required to construct work to line and grade established by line and grade hubs.

D. Batter Boards:

1. Set grade points at 25 foot (7.5 m) intervals at convenient offset from centerline of pipe.

2. Set batter boards as necessary to construct to design line and grade.

3. Provide at least three batter boards at all pipe laying areas during construction as check on accuracy of grades.

4. Check line and grade of each pipe length with grade rod and plumb bob.

E. Laser Beam:

1. Set laser equipment to proper line and grade from line and grade hubs.

2. Check line and grade of laser at 25 foot (7.5 m) intervals for first 100 feet (30 m) and then at 50 foot (15 m) intervals for each setup.

3. Check line and grade of each pipe length.

F. Correct Misalignment: Correct misalignment, displacement, or otherwise defective pipe by removing, relaying, or replacing pipe, at no additional cost to the Contracting Authority.

3.03 PIPE INSTALLATION

A. Provide trench excavation, pipe bedding, and backfill as specified in Section 3010 of this Developmental Specification.

B. Provided proper facilities for lowering the sections into place without damaging the pipe.

C. Begin at the lowest point in line. Lay groove or bell end point upstream unless specifically noted otherwise.

D. Prepare trench bottom to design line and grade so that only minor movement of pipe is necessary after installation.

E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.

F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.

G. Do not lay pipe in water or on saturated soil or bedding. Do not allow water to rise in trench around pipe.

H. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.

I. Lay pipe to design line and grade.

J. Provide uniform bearing for full pipe barrel length.

1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.

2. Do not block pipe above bedding.

K. Assemble joints as specified.

L. Protect exposed upstream ends of pipe to prevent soil sediment from entering storm sewer system with a water tight stopper, cap, or plug.

M. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

N. Saw cut ends of pipe at utility accesses, intakes, and structures. Do not hammer cut or break pipe.

O. Provide utility accesses and intakes where indicated on plans and as specified in Section 6020 of this Developmental Specification.

3.04 PIPE JOINTING

A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe.

B. Joint Assembly: Assemble joints according to the pipe manufacturer′s recommendations:

1. Use equipment that does not apply damaging forces to pipe joints.

2. Use bar and block, internal or external jointing devices, or other methods recommended by pipe manufacturers.

C. Reinforced Concrete Pipe (RCP), Reinforced Concrete Arch Pipe (RCAP), and Reinforced Concrete Elliptical Pipe (RCEP):

1. Use cold applied bituminous jointing materials unless otherwise specified.

a. Apply joint material to entire tongue or, to top half of tongue and bottom half of groove, in sufficient quantity to fill joint; close joint between pipes.
b. Fill remaining voids in joint both inside and outside of pipe with joint material; smooth joint material on inside of pipe 24 inches (600 mm) and larger.

2. If rubber O-ring is specified, coat rubber ring gasket and joint with soap based lubricant immediately prior to closing joint.

3. If wrapped pipe joint is specified, see Figure 4020.1A on the plans.

a. Secure engineering fabric in place to prevent displacement during backfill operations.
b. For combination storm sewer/subdrain or Type II subdrain, do not use joint sealant.

4. Joint openings on the outside or inside of the pipe that do not exceed 1/8 inch (3 mm) at the bottom and 5/8 inch (15 mm) at the top are acceptable.

5. Fully encase larger joint openings, unless required for camber, with a Type II concrete collar (see Figure 4020.1A on the plans). Use Class C structural concrete.

D. Reinforced Concrete Low Head Pressure Pipe (RCPP):
Coat rubber ring gasket and joint with soap based lubricant immediately prior to closing joint.

E. Corrugated Metal Pipe (CMP) and Corrugated Metal Arch Pipe (CMAP):

1. Install coupling bands that match the ends of the pipes.

2. End of coupling bands must lap or be fabricated to form a tightly closed joint upon installation.

F. Polyvinyl Chloride Pipe (PVC) and Polyvinyl Chloride Corrugated Pipe (Corrugated PVC):
Coat rubber gasket and joint with soap based lubricant immediately prior to closing joint.

G. High Density Polyethylene (HDPE):
Coat rubber gasket and joint with soap based lubricant immediately prior to closing joint.

H. Connections Between Dissimilar Pipes:

1. Use manufactured adapters or couplings approved by the Engineer.

2. Where adapters or couplings are not available, the Engineer may authorize use of concrete collar as shown in Figure 4020.1A on the plans.

3.05 PIPE END SECTIONS

A. Install reinforced concrete pip aprons where indicated on the plans. Install footings according to Figure 4020.2 when specified.

B. Install metal pipe aprons where indicated on the plans. Install curtain walls when specified.

C. Anchor last three pipe sections and aprons together with two pipe connections per joint. See Figure 4020.1B on the plans.

D. Install apron guard where indicated on plans. See Figure 4020.3 on the plans for details.

3.06 INTENTIONALLY LEFT BLANK

3.07 FOOTING DRAIN COLLECTOR

A. Install footing drain collector per Section 3010 of this Developmental Specification. Install Type II combination subdrain/footing drain collector per Figure 4020.5B on the plans.

B. If specified, install engineering fabric.

C. Provide cleanouts and connections per Figure 4020.6 on the plans.

1. Connect footing drain sewer collectors to storm sewer utility access or intake.

2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.

D. Provide utility accesses, if specified, according to Section 6020 of this Developmental Specification.

3.08 STORM SEWER SERVICE STUBS

A. Provide storm sewer service connection and line from storm sewer or footing drain sewer for each platted lot or building as shown on the plans.

B. Use fabricated or preformed saddle wye or saddle tee for service tap to storm sewers. Clamp with two stainless steel clamps and install according to the manufacturer′s recommendations.

C. Extend storm sewer service from storm sewer or footing drain collector to 10 foot (3 m) outside of the right-of-way line or as shown on the plans.

D. Place a watertight stopper or plug in the end of storm sewer service.

3.09 TOLERANCES

A. Ensure horizontal and vertical alignment of gravity sewer lines do not vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch (6 mm), whichever is larger.

B. Tolerance allowed only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.

C. Reverse slope on pipe is prohibited.

3.10 CONFLICTS

A. Provide temporary support for existing water, gas, telephone, power, and other utilities or services that cross trench.

B. Compact backfill under existing utility crossing as specified in Section 3010 of this Developmental Specification or construct utility line supports where indicated on the plans or as directed by the Engineer.

3.11 STORM SEWER ABANDONMENT

When sewers are to be abandoned, place standard sewer plugs according to Figure 4010.2 on the plans. Prior to placing the plug, ensure that the line is not in use. If noted on the plans, fill the line with gravity flow or pump the line full of flowable mortar or controlled low strength materials (see Section 3010 of this Developmental Specification).

SECTION 4040 - TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Testing and inspection of storm sewers.

1.02 DESCRIPTION OF WORK

Test and inspect storm sewers, footing drain sewers, and building storm sewers.

1.03 SCHEDULING

A. Notify the Engineer when installation is complete and ready for testing.

B. Notify the Engineer at least 24 hours prior to performing testing.

C. The Engineer must be present to review testing procedures and to record results.

1.04 MEASUREMENT FOR PAYMENT

A. Testing and inspection of storm sewers is incidental to construction.

B. Include costs for testing and inspection in the contract unit prices for sewer construction.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT

A. Conform with applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

PART 3 - EXECUTION

3.01 CLEANING

A. Clean all storm sewers by flushing with water and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris as directed by the Engineer prior to final acceptance.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer systems.

3.02 VISUAL INSPECTION

A. Check each section of storm sewer by lamping.

B. Light should be visible through section of pipe lamped.

C. Visually inspect each section of pipe.

D. Repair or replace defective pipe or joints or remove and relay pipe not meeting alignment tolerances as directed by the Engineer.

3.03 - 3.08 INTENTIONALLY LEFT BLANK

3.09 DEFLECTION TESTING

A. Perform deflection tests on all sanitary sewer flexible pipes, including PVC and PVC truss, and all HDPE storm sewer pipe 12 inch (300 mm) diameter or greater.

B. Perform deflection tests after backfill has been in place at least 30 calendar days and before paving activity takes place or as per appropriate sections of these specifications.

C. Ensure pipe deflection does not exceed 5% of average inside diameter as established by ASTM Standards.

D. Pull approved 9-arm deflection mandrel through sewer by hand.

E. Approved mandrel must conform to applicable ASTM Standards.

F. Remove and replace pipe exceeding deflection limits.

G. Handle and divert existing flows during deflection testing.

DIVISION 6 - STRUCTURES FOR SANITARY AND STORM SEWER

SECTION 6020 - UTILITY ACCESSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Utility accesses for storm sewers.

B. Adjustment of existing utility accesses.

C. Connection to existing utility accesses.

D. Abandonment of utility accesses.

1.02 DESCRIPTION OF WORK

Construct storm sewer utility accesses, modify existing utility accesses, and abandon utility accesses where shown in the plans.

1.03 SUBMITTALS

A. Shop drawings showing compliance with this Developmental Specification.

B. Shop drawing schedule of new utility accesses showing total depth, relative elevations of all connecting storm sewer lines, all drops, and orientation of connecting lines.

C. Catalog cuts of iron castings, chimney seals, and sewer line connection gaskets.

D. Upon request, provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

Obtain written approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

Store and handle materials to avoid damage. Replace damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.08 MEASUREMENT FOR PAYMENT

A. Utility Access: One of the following methods will be specified:

1. Utility Access by Lump Sum: The number of new utility accesses properly installed will be counted. Payment will be at the unit price for each type and size of utility access properly installed. The contract unit price for utility accesses shall include all excavation, bedding, backfill, compaction, concrete, reinforcing steel, and all appurtenances, including chimney seals, castings, and covers necessary for proper installation.

2. Utility Access by Vertical Feet: For new utility accesses properly installed, the number of combined base and casting units for each size and type will be counted. In addition, the utility access vertical dimension in feet (meters) from the flowline to the bottom of the casting will be measured. Payment will be at the contract unit price for each combined base and

casting unit properly installed. In addition, payment will be made by the contract unit price for the vertical dimension of the utility access.

B. Drop Connection: The vertical feet (meters) of drop, from the flow line of the incoming sewer to the flow line of the drop at its entry into the utility access, will be measured for each size of sewer line. Payment will be at the contract unit price for vertical feet (meters) of drop per size of sewer line.

C. Casting Extension Rings: The number of existing utility casings raised with casting extension rings to match the elevation of a pavement overlay will be counted. Payment will be made at the contract unit price for each casting extension.

D. Utility Access Adjustment, Minor: Removal or additions of utility access adjusting rings will be considered incidental to utility accesses, unless otherwise specified as a contract item. If specified as a contract item, it will be at the contract unit price for each adjustment. If so specified, the number of utility accesses adjusted to finished grade by raising or lowering an adjustable casting or by addition or removal of utility access adjusting rings will be counted. Whether specified as a pay item or not, new casting is included.

E. Utility Access Adjustment, Major: The number of utility accesses adjusted to grade by addition or removal of utility access riser, cone or flat top sections, or the exchange of existing sections with sections having different vertical dimensions will be counted. Payment will be at the contract unit price for each major adjustment. The contract unit price shall include all excavation, bedding, backfill, compaction, concrete, reinforcing steel, and all appurtenances, including the new casting and new chimney.

F. Connection to Existing Utility Accesses: The number of connections made to existing utility accesses will be counted. Payment will be at the contract unit price for each connection.

G. Abandoned Utility Accesses: The number of utility accesses abandoned in place will be counted. Payment will be at the contract unit price for each abandoned utility access.

PART 2 - PRODUCTS

2.01 CONCRETE UTILITY ACCESS COMPONENTS

A. Concrete:

1. Precast: Comply with ASTM C478.

2. Cast in place: Refer to Section 2403 of the Standard Specifications.

B. Riser Sections:

1. Inside Diameter: Use 48 inch (1200 mm) diameter riser or as shown in the contract documents.

2. Wall Thickness: See Figures 6020.1 to 6020.21 on the plans. For precast, see ASTM C 478.

3. Coating:

a. Exterior: When exterior waterproof coating is specified, provide bituminous or coal tar coating.

b. Interior: When utility access lining is specified, line according to lined, reinforced concrete pipe, Section 4010, 2.01 of this Developmental Specification.

4. Riser Joints:

a. Male and female ends.
b. Sanitary sewer utility access:

1) Rubber 'O' ring or profile gasket, flexible joint, per ASTM C 443.
2) Bituminous joint compound or butyl sealant wrap per ASTM C 877 to all exterior joints.

5. Lift Holes: Lift holes not to protrude through utility access wall. Provide non-shrink grout conforming to Materials IM 491.13, Appendix B, to cover lift hole plug and to fill joints.

C. Top Configuration:

1. Capable of supporting HS-20 loading.

2. Use eccentric cone, unless otherwise specified or allowed.

D. Base: Use precast or cast in place concrete base.

E. Pipe Connection:

1. New Storm Sewer Utility Access:

a. Precast utility accesses: Fabricated openings.
b. Cast in place structures: Structure wall poured around pipe stub.

2. Existing Storm Sewer Utility Access:

a. Cored or Drilled Opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
b. Knock Out Opening: See Figure 4020.1A on the plans.

F. Utility Access Steps:

1. Comply with ASTM 478.

2. Manufactured of polypropylene encased steel.

3. Uniformly space steps at 12 to 16 inches (300 mm to 400 mm).

4. Align with vertical side of eccentric top section.

5. First step no more than 36 inches (900 mm) from top of casting.

2.02 UTILITY ACCESS ADJUSTMENT RINGS (GRADE RINGS)

A. Use one of the following methods for grade adjustments of utility access frame and cover assemblies:

1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and free from cracks, voids, and other defects. Set concrete rings with asphalt mastic in trowelable or rope form.

2. High Density Polyethylene Grade Adjustment Rings:

Property	Test Method	Acceptable Value
Recycled Plastic	ASTM D 1248	N/A
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min. 1.1 to 113.5 L/10 min.
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 psi (14 kPa to 34.5 MPa)

a. Tapered adjusting ring thickness ranges from 1/2 inch to 3 inches (12 mm to 75 mm).
b. Install grade adjustment rings on clean flat surfaces according to the manufacturer's recommendations with the proper butyl rubber sealant/adhesives.
c. Do not use polyethylene adjusting rings when they are exposed to HMA pavement.

B. Ensure the inside dimension of the adjustment ring is not less than the inside diameter of the utility access frame.

C. Construct utility accesses with at least one adjustment ring totaling 4 inches (100 mm) minimum and 12 inches (300 mm) maximum for new utility accesses and 4 inches (100 mm) minimum and 16 inches (400 mm) maximum for existing utility accesses.

2.03 CASTINGS (RING AND COVER)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Casting Types:

Figure No.	Casting Type	Ring/ Cover	Gasket	Bolted Cover (Floodable)	Typical Surface
6020.17	E	STD	No	N/A	Non-paved/flexible[1]
6020.18	F	ADJ	No	N/A	PCC[2]
[1]Includes HMA, seal coat, gravel, and brick.					
[2]Includes castings in concrete boxouts.					

C. Utility Access Casting extension Ring:

1. Gray cast iron conforming to ASTM A 48, Class 35.

2. Size the extension ring to fit the existing ring and cover.

3. Maximum height of 3 inches (75 mm)

4. Match the dimensions of the existing ring and cover with an allowable diameter tolerance of -1/4 inch (6 mm) for the frame ridge and +1/4 inch (6 mm) for the cover recess.

5. The height of the extension ring as required to raise the top of the casting to make it level or no more than 1/4 inch (6 mm) below the finished pavement surface.

2.04 CEMENT MORTAR

Refer to Section 2403 of the Standard Specifications.

2.05 REINFORCING STEEL

Refer to Section 2403 of the Standard Specifications.

2.06 INTENTIONALLY LEFT BLANK

2.07 INVERT

A. Construct utility access up to one half of pipe diameter to produce a smooth half pipe shape between pipe inverts. Slope invert bench toward pipe 1/4 inch per foot (21 mm/m) perpendicular to flow line.

B. Use a precast invert on all precast base sections, unless otherwise allowed by the Engineer. See Figure 6020.1 on the plans

PART 3 - EXECUTION

3.01 UTILITY ACCESS INSTALLATION

A. Excavation: Excavate according to Section 3010 of this Developmental Specification.

B. Subgrade Preparation:

1. Undisturbed soil: Hand grade to accurate elevation.

2. Disturbed soil: Machine compact to 95% of maximum Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by the Engineer.

C. Installation of Cast in Place Base:

1. Excavate and prepare subgrade to the required elevation to accommodate the cast in place base.

2. Place Class C concrete base as specified.

3. Embed lower riser section in base concrete a minimum of 3 inches (75 mm).

4. Ensure proper vertical and horizontal alignment of base riser section.

D. Installation of Precast Base with Base Riser Section:

1. Excavate and prepare subgrade to the required elevation to accommodate the cast in place base.

2. Place aggregate subbase as specified.

3. Embed lower riser section in base concrete a minimum of 3 inches (75 mm) and ensure proper vertical and horizontal alignment of base riser section.

E. Additional Risers Sections: Install additional riser section as required.

F. Repairs: Repair all honeycomb areas or damaged areas as directed by the Engineer.

G. Pipes: Install and bed pipes. Place bedding and pipe embedment material according to Section 3010 of this Developmental Specification.

H. Utility Access Invert: Install utility access invert if not precast. If precast, remove all projections and repair all voids to ensure a hydraulically smooth channel between pipe ends.

I. Top Sections: Install utility access cone or flat top section.

J. Utility Access Adjustment Ring(s): Bed each concrete ring with cold-applied bituminous jointing compound. Bed each polyethylene ring with manufacturer's approved product. Use a minimum stack height of 4 inches (100 mm) and a maximum adjustment ring stack height of 12 inches (300 mm). For greater adjustment, modify lower riser section(s).

K. Utility Access Ring and Cover: Install utility access ring and cover and accurately adjust to proper grade. Where utility access is to be in a paved area, adjust slope to match finished surface.

L. Storm Sewer Utility Access Joints: If required, apply engineering fabric wrap meeting the requirements of Article 4196.01, B, of the Standard Specifications to storm sewer utility access joints.

M. Backfill and Compaction: Place and compact per Section 3010 of this Developmental Specification. Use extra care to ensure proper and uniform compaction of backfill around structure.

3.02 CONCRETE, REINFORCEMENT, AND PLACEMENT

Refer to Section 2403 of the Standard Specifications.

3.03 MODIFICATION OF EXISTING UTILITY ACCESSES

A. Casting Extension Rings: Install and adjust for proper alignment.

B. Minor Adjustment (adding or removing adjusting rings): adjustment by adding or removing adjusting rings:

1. Remove casting.

2. As necessary, add a maximum height of 16 inches (400 mm) of adjustment rings to adjust existing utility access to finished pavement grade or finished topsoil grade. Bed each ring with cold applied bituminous jointing material. Bed each polyethylene ring with manufacturer's approved product.

3. Remove one or more adjustment rings, as appropriate to reduce casting elevation.

4. Replace casting. Install new frame and cover on modified adjusting ring.

5. Refer to Section 2301 of the Standard Specifications for additional utility access adjustment requirements in pavement.

C. Major Adjustment (adding or removing riser or cone sections):

1. Remove castings.

2. Remove top.

3. Remove and replace riser section and/or top section, as appropriate.

4. Replace casting. Install new frame and cover.

5. Fasten utility accesses to castings with bolts.

D. Connection to Existing Utility Accesses:
Unless otherwise specified in the contract documents, or approved by the Engineer, core all new openings in existing utility accesses.

1. Excavate as appropriate. Mark utility access barrel for point of insertion of added sewer line.

2. Divert flow as necessary. Obtain the Engineer's approval for the diversion plan. Maintain sewer service at all times unless otherwise permitted by the Engineer.

3. Carefully core out opening to utility access. Remove existing utility access invert as necessary to install pipe at required elevation and develop hydraulic channel.

4. Cored opening:

a. Insert flexible watertight connector into new opening.
b. Install and tighten internal expansion sleeve to hold flexible connector in place.
c. Insert pipe through flexible connector and tighten external compression ring.
d. Do not grout opening or pour collar for cored opening with flexible connector.

5. Cut and chipped opening (knockout):

a. When allowed, refer to Figure 6020.21 on the plans.
b. Install waterstop around outside of pipe. Secure in place.
c. Position end of pipe flush with interior wall of utility access and with waterstop located within wall opening.
d. Grout opening between utility access wall and outside of pipe with non-shrink grout.
e. Pour concrete collar around pipe and exterior utility access opening as shown on Figure 6020.21 on the plans.

6. Reconstruct utility access invert.

7. Bed pipe and backfill per Section 3010 of this Developmental Specification.

3.04 INTENTIONALLY LEFT BLANK

3.05 ABANDONED UTILITY ACCESSES

A. Unless specified otherwise, remove top and walls of structure to a minimum of 10 feet (3 m) below subgrade in paved areas or 10 feet (3 m) below finish grade in other areas.

B. Plug all pipes in structure using 3,000 psi (20.7 MPa) concrete.

C. Fill remaining structure using flowable mortar per Section 3010 of this Developmental Specification.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

3.06 UTILITY ACCESS TESTING

Comply with Section 6040 of this Developmental Specification.

SECTION 6030 - INTAKES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Intakes for storm sewers.

B. Special structures for storm sewers.

1.02 DESCRIPTION OF WORK

A. Construct intakes and special structures for storm sewers.

B. Modify existing intakes

C. Abandon intakes.

1.03 SUBMITTALS

A. Shop drawings showing compliance with this Specification.

B. Schedule of new intakes showing total depth, and relative elevations and orientations of all connecting storm sewer lines.

C. Catalog cuts of iron castings.

D. Upon request, provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Obtain written approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store and handle materials to avoid damage. Replace damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.08 MEASUREMENT FOR PAYMENT

A. Intake: The number of all properly completed intakes will be counted. Payment will be at the contract unit price for each size and type, and includes all bedding, backfill, compaction, grates, and appurtenances for proper installation.

B. CMP Slotted Drain Pipe: The total feet (meters) installed per plan will be measured. The contract unit price includes stabilization material, if used, and granular bedding material or alternative controlled density fill, and concrete flume unless it is an integral part of adjacent surface treatment. Payment will be at the contract unit price per foot (meter) for each size.

C. Intake Adjustment: Each item will be counted as a completed individual unit. Payment will be at the contract unit price for each adjustment as per plan.

D. Special Structure: Each item will be counted as a completed individual unit

PART 2 - PRODUCTS

2.01 INTAKES

A. Conform to elevations, locations, and connection orientations shown on the plans.

B. Intake type: Refer to the plans.

C. Configuration and Dimensions: Refer to detailed drawings.

D. Top Configuration:

1. As noted on detailed drawings.

2. Number of grate sections: Refer to the plans.

E. Joints, Wall:

1. Precast: Male and female ends, mastic seal.

2. Poured in place: construction joints.

F. Concrete:

1. Precast: Precast concrete intakes constructed according to the requirements of Section 2403 of the Standard Specifications and with the dimensions and reinforcement shown in the detailed drawings will be allowed.

2. Cast in place:

a. Refer to Section 2403 of the Standard Specifications.
b. Minimum concrete reinforcing cover 2 inches (50 mm).
c. Minimum total section thickness: see detailed drawings.

G. Base:

1. Separate. Use with base riser section with square bottom edge.

2. Precast may have surface finish block outs on one side only.

H. Pipe Connection:

1. Precast intake: Factory fabricated openings.

2. Poured in place structures: Structure wall poured around pipe stub.

I. Utility Access Steps: None, unless required on the plans. If required, space steps at 12 to 16 inches (300 mm to 400 mm). Comply with ASTM C 478.

2.02 INTAKE ADJUSTMENT RINGS (GRADE RINGS)

A. Complete all grade adjustments of intake frame and cover assemblies utilizing one of the following:

1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and free from cracks, voids, and other defects. Set concrete rings with asphalt mastic.

2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.

a. Ensure material properties have been tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g/10 min. 1.1 to 113.5 L/10 min.
Density	ASTM D 792	0.94 to 0.98 g/cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 psi (14 kPa to 34.5 MPa)

b. Do not use polyethylene adjusting rings when they are exposed to hot mix asphalt pavement.
c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness shall range from 1/2 inch to 3.0 inches.
d. Install grade adjustment rings on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. Ensure the inside dimensions of the adjustment ring are not less than the inside dimensions of the intake grate opening.

C. Construct intakes with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches (300 mm) for new and existing intakes.

2.03 CASTINGS (COVERS AND GRATES)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Type: Refer to the plans. (Figures 6020.7 through 6020.19 and 6030.13 through 6030.16).

2.04 CEMENT MORTAR

Refer to Section 2403 of the Standard Specifications.

2.05 REINFORCING STEEL

Refer to Section 2404 of the Standard Specifications.

2.06 INVERT

A. Poured in place concrete. Establish a full seal between base and base riser section.

B. Shape to provide a smooth transition between pipe inverts.

C. Bring intake invert up to one half of pipe diameter to produce a half pipe shape.

2.07 PRECAST CONCRETE TEE

Precast concrete tee pipe section may be used in lieu of standard utility access base and base riser section.

1. For sewers 42 inch (1050 mm) and larger.

2. Where required on the plans.

3. Where approved by the Engineer.

2.08 CMP SLOTTED DRAIN PIPE

A. Slotted drain pipe per ASHTO M 36.

1. 2 3/4 inch by 1/2 inch (70 mm by 12.7 mm) corrugations.

2. Wall thickness per plans.

3. Structural components: ASTM A 36 steel.

4. If helical pipe is used, form at least one annular corrugation at each end of each pipe section.

5. Pipe manufacturer to provide fully compatible fittings, end caps, and accessories.

B. Stabilization Material: per Section 3010.

C. Granular Bedding Material: per Section 3010.

D. Flowable Mortar: per Section 3010, if required.

E. Flume as per plans, unless integral with adjacent surface treatment.

PART 3 - EXECUTION

3.01 INTAKE INSTALLATION

See Figures 6030.1 through 18

A. Subgrade Preparation:

1. Undisturbed soil: Hand grade to accurate elevation.

2. Disturbed soil: Machine compact to 95% of Standard Proctor Density and hand grade to accurate elevation, or install stabilization material as directed by the Engineer.

3. Unstable soil: Install stabilization material as directed by the Engineer.

B. Concrete Intakes:

1. Install stabilization material if unstable base exists.

2. Install granular bedding material if required by detailed drawings.

3. Install base: Ensure proper vertical and horizontal alignment of base riser section.

4. Install additional riser section as required. Seal all joints.

5. Repair all honeycomb areas or damaged areas.

6. Compact backfill up to connecting pipes.

7. Connect and bed pipes per Section 3010 of this Developmental Specification. Grout inside pipe/riser joint.

8. Install intake invert. Remove any projections and repair any voids to ensure a hydraulically smooth channel through the intake.

9. Install top.

10. Install adjustment rings. Install at least two rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches (300 mm). For greater adjustment, modify riser section(s).

11. Install top casting. Adjust accurately to proper line and grade.

12. Backfill and compact. Refer to Section 3010. Use extra care to ensure proper and uniform compaction of backfill around structure.

C. CMP Slotted Drain:

1. See Figures 6030.17 and 6030.18 on the plans.

2. Install only outside public streets.

3. Install stabilization material in trench bottom per detailed drawings, if required by the Engineer.

4. Install granular bedding material per detailed drawings.

5. Install slotted drain. Ensure proper top elevation and crown, if any. Complete installation of bedding, up to subgrade level for concrete flume.

6. Install concrete flume as shown on plans unless integral with adjacent surface treatment.

7. Alternative installation: Installation of controlled density fill in lieu of bedding material if so directed by the Engineer. Secure pipe against movement or flotation prior to pouring controlled density fill.

D. Anchoring Castings: Bolt down all castings not encased in concrete.

3.02 CONCRETE, REINFORCEMENT, AND PLACEMENT

Refer to Section 2403 of the Standard Specifications.

3.03 MODIFICATION OF EXISTING TYPE M-B INTAKES (Utility Access Section)

A. Minor Adjustment:

1. Add adjustment rings if necessary, up to a total ring stack height of 16 inches (400 mm).

2. Remove one or more adjustment rings, as appropriate to reduce casting elevation.

B. Major Adjustment:
If height increase greater than 16 inches (400 mm) is required or if height decrease is greater than can be accomplished by removing adjustment rings, remove top, modify barrel riser as appropriate, and replace or reconstruct top section. Reinstall castings.

3.04 SPECIAL STRUCTURES

A. Construct according to this Section, as applicable.

B. Refer to plans for locations, dimensions, and special details and provisions.

3.05 ABANDONED INTAKES

A. Remove the entire structure to a minimum of 10 foot (3 m) below subgrade in paved areas or 6 feet (2 m) below finish grade in other areas.

B. Plug all pipes in the structure. Refer to detailed drawings.

C. Fill remaining structure using flowable mortar per Section 3010, 2.11 C.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

SECTION 6040 - TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Testing and inspection of utility accesses, intakes, and other utility structures.

1.02 DESCRIPTION OF WORK

Test and inspect storm sewer utility accesses and intakes, and other utility structures.

1.03 SCHEDULING

A. Notify the Engineer when installation is complete and ready for testing.

B. Notify the Engineer at least 24 hours prior to performing testing.

C. The Engineer must be present to review testing procedures and record results.

D. Provide material certifications to the Engineer.

1.04 MEASUREMENT FOR PAYMENT

Include costs for testing in the contract unit prices for utility accesses, intakes, and utility structures except as specified in Section 2403 of the Standard Specifications.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT

A. Conform to applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

PART 3 - EXECUTION

3.01 CLEANING

A. Clean all utility accesses, intakes, and structures by removing sheeting, bracing, shoring, forms, soil sediment, concrete waste, and other debris as directed by the Engineer.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer system.

3.02 VISUAL INSPECTION

A. Examine Structure For:

1. Damage.

2. Slipped forms.

3. Indication of displacement of reinforcement.

4. Porous areas or voids.

5. Proper placement of seals, gaskets, and embedments.

B. Verify that structure is set to true line, grade, and plumb.

C. Verify structure dimensions and thicknesses.

3.03 REPAIR

A. Repair or replace any unacceptable work at no additional cost to Contracting Authority.

B. Repair all visible leaks.

C. Remove concrete webs or protrusions.

D. Remove form ties and repair tie holes.

E. Refer also to Section 2403 of the Standard Specifications.

3.04 INTENTIONALLY LEFT BLANK

3.05 TEST FAILURE

If test fails, reseal openings, repair utility access, and retest. An alternate test method conforming to this specification may be used for a retest if desired.