VOLUME 3

DRAINAGE

VOL. 3-06

CONSTRUCTION SPECIFICATIONS AND STANDARD DRAWINGS

DECEMBER 2021

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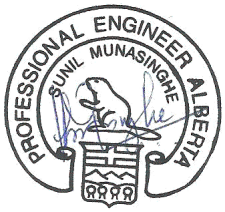
Professional Engineer Seal	Responsible for Sections
 MEMBER NO. 104884 Dec 02. 2021 **Sunil Munasinghe, P.Eng.** **Manager, Structural Design**	**1 to 11 and 24, 29**
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Permit to Practice
PERMIT TO PRACTICE EPCOR WATER SERVICES INC. RM SIGNATURE: _____ RM APEGA ID #: 72101 DATE: Dec 02, 2021 **PERMIT NUMBER: P006368** The Association of Professional Engineers and Geoscientists of Alberta (APEGA) **Abhishek Bhargava, P.Eng.** **Senior Manager, Drainage Engineering**

Volume 3 in this update is split into six sub-volumes, as following tables, for easy reference and timely update of individual sub-volume to address industry requirements and technological advancements.

Vol. 3-01: Development Planning Procedure and Framework

New Section	Old Section	Description
1	1	Planning
2	2	Planning Approval Process - General
3	3	Planning and Design Studies
4	4	Typical Area Master Plan Requirements
5	5	Typical Neighbourhood Design Report Requirements
6	6	Typical Requirements for Hydrogeotechnical Impact Assessments
7	7	Sanitary Sewer - Policy, Goals and Objectives
8	12	Storm Drainage System - Policy, Goals and Objectives
Appendix A	Appendix G	Pump Station Decision Model

Vol. 3-02: Stormwater Management and Design Manual

New Section	Old Section	Description
1	13	Stormwater Runoff Analysis
2	13	Tables of Runoff and Rainfall Information
3	15	Major Conveyance System Design
4	16	Stormwater Management Facility Design
5	17	LID Facility Design
6	18	Lot Grading and Surface Drainage Design
Appendix A	Appendix B	Computer Model Transfer Requirement Check List

Vol. 3-03: Design Guidelines

New Section	Old Section	Description
1	8	Sanitary Sewer Design Criteria
2	14	Minor Conveyance System Design
3	19	Sewers, Appurtenances and Structures
4	20	Structural Design for Pipe
Appendix A	Appendix C	Catch Basin Inlet Capacity Curves
Appendix B	Appendix D	Guidelines for the Design and Installation of Rigid Gravity Sewer Pipe in the City of Edmonton
Appendix C	Appendix E	Guidelines for the Design and Construction of Flexible Thermoplastic Pipe in the City of Edmonton
3.11.5 ii and iii	Appendix H	Appendix H: Outfall Structure Monitoring embedded in Sections 3.11.5 ii and iii

Vol. 3-04: Pump Station and Forcemain Design Guidelines

New Section	Old Section	Description
1	9	Sanitary Wastewater Pumping Systems
2	10	General Design Requirements for Pump Stations
3	11	Design of Sewage Forcemains
Appendix A	Appendix A	Design Guidelines for Electrical and Control Systems for Wastewater Pump Stations
2.13.2 ii and iii	Appendix F	Appendix F: Pumpwell Unit Confined Space Entry Fall Arrest and Rescue System updated and embedded in Sections 2.13.2 ii and iii

Vol. 3-05: Drawing Requirements, Approvals and Asset Acceptance/Transfer

New Section	Old Section	Description
1	21	Detailed Engineering Drawings
2	22	As-Built Drawing Requirements
3	23	Project Acceptance
4	-	Product Approval Procedure

Vol. 3-06: Construction Specifications

New Section	Old Section	Description
1	02412	Tunnel Excavation Using Sequential Excavation Method
2	02415	Tunnelling by Tunnel Boring Machines
3	02422	Steel Ribs and Lagging
4	02423	Shotcrete Tunnel Lining
5	02426	Pipe Jacking
6	02427	Precast Concrete Tunnel Lining
7	02435	Tunnel Liner Grouting
8	02441	Microtunnelling
9	02444	Shaft Construction
10	02445	Bored Undercrossings
11	02446	Horizontal Directional Drilling
12	02531	Sewage Forcemains
13	02535	Sewers
14	02538	Sewer Services
15	02559	Factory Applied Pipe Insulation
16	02620	Subdrains
17	02631	Manholes and Catch Basins
18	02632	Drainage Manholes Frames and Covers
19	02640	Corrugated Steel Pipe Culvert
20	02645	Precast Concrete Box Sewers
21	02952	Temporary Flow Control
22	02953	Cleaning Sewers
23	02954	Inspection of Sewers
24	02955	Pipe Bursting
25	02956	Joint Grouting Concrete Sewers
26	02957	Relining Sewers
27	02958	Leakage Testing of Sewers
28	02959	Deflection Testing of Flexible Pipe
29	03310	Concrete for Water and Drainage Structures

Vol 3-06: Standard Drawings

New Drawing Number	Old Drawing Number	Description
DR-02-04-01	-	Typical Davit Base, Guard Rail and Hatch Layout on Control Structure
DR-02-05-01	7001	Bioretention Cleanouts
DR-02-05-02	7003	Soil Cell Cleanouts
DR-06-13-01	7980	Trench Bedding Types
DR-06-13-02	7981	Concrete Pipe Butt Joint Detail
DR-06-14-01	7063	Standard Riser Connections to Storm and Sanitary Sewers in Common Trench
DR-06-17-01	7005	Standard 600 Catch Basin with Type 2A Grating and Frame
DR-06-17-02	7006	Standard 600 Catch Basin with Type K-7 Grating and Frame
DR-06-17-03	7007	Neck Section Details for Type 4A, 6B and 8 Grating and Frame
DR-06-17-04	7008	Neck Section Details for Type F-51 and K-7 Grating and Frame
DR-06-17-05	7009	Standard 900 Catch Basin with Type DK-7 Grating and Frame
DR-06-17-06	7010	Standard 900 Catch Basin with Type F-51 Grating and Frame with Side Inlet
DR-06-17-07	7011	Standard 1200 CB Manhole with Type 6B or 8 Grating and Frame
DR-06-17-08	7012	Standard 1200 CB Manhole with Type F-51 Grating and Frame with Side Inlet
DR-06-17-09	7013	Standard 1200 Manhole for Piping up to 600mm Diameter with Type 6A Cover and Frame
DR-06-17-10	7014	Neck Section Details for Standard 1200 Manhole
DR-06-17-11	7020	Benching Detail for Standard 1200 Manhole
DR-06-17-12	7021	Safety Steps for Manholes
DR-06-17-13	7030	Grade Rings
DR-06-17-14	7031	Rings/Tops
DR-06-17-15	7032	Slab Tops for Standard 900 Catch Basin
DR-06-17-16	7033	Slab Top for Standard 900 Catch Basin
DR-06-17-17	7034	Slab Tops for Standard 1200mm Manhole
DR-06-18-01	7040	Type 2A Two Piece Side Inlet Catch Basin Grating and Frame
DR-06-18-02	7041	Type 4A Two Piece Side Inlet Catch Basin Manhole Grating and Frame
DR-06-18-03	7042	Type 8 Catch Basin Manhole Grating and Frame
DR-06-18-04	7043A/B	Type 6 Standard Manhole Frame, Cover and Round Catch Basin Cover
DR-06-18-05	7043C	Type 6S Manhole Frame and Cover
DR-06-18-06	7044	Type 80 Cover and Floating Type Manhole Frame
DR-06-18-07	7045	Type K-7 and DK-7 Catch Basin Frame and Grating
DR-06-18-08	7047	Type F-51 Three Piece Catch Basin Frame and Grating with Side Inlet
DR-06-18-09	7048	Type F-51 Two Piece Curb Component Frame and Grating
DR-06-18-10	7050	Type 41 Manhole Frame and Cover
DR-06-18-11	7051	Type 6C Slotted Flat Cover to be used on Type 6 Frame for Air Release
DR-06-19-01	7062	Culvert End Riprap

The following is a list of revisions in **Vol. 3-06: Construction Specifications and Standard Drawings**

Section/Drawing Number	Changes
2	**“**Soft Ground Shield Driven Tunnelling” changed to “Tunnelling by Tunnel Boring Machines”.
13.3.3.1	Sewer service abandonment requirement deleted.
All Sections	“the City” changed to “EPCOR”.
DR-02-04-01	New drawing “Typical Davit Base, Guard Rail and Hatch Layout on Control Structure” added.
DR-06-13-02	Waterstops and reinforcement requirement added.

TABLE OF CONTENTS

TABLE OF CONTENTS

1 TUNNEL EXCAVATION USING SEQUENTIAL EXCAVATION METHOD

1.1 GENERAL

1.1.1 Scope

This section specifies the requirements for excavation of tunnels by sequential heading and bench method or methods used to excavate and support a tunnel in a specific sequence, often by dividing the tunnel face into sections, normally referred to as Sequential Excavation Method (SEM).

1.1.2 Related Sections

Steel Ribs and Lagging	Section ***3***
Shotcrete Tunnel Lining	Section ***4***
Tunnel Liner Grouting	Section ***7***

1.1.3 Definitions

.1 "Heading" shall be used to describe the excavation in the upper portion of tunnel.

.2 "Bench" shall be used to describe the excavation in the lower portion of tunnel.

.3 "Initial support" shall be used to describe shotcrete, steel ribs, lagging, blocking and other related ground support installed after excavation.

.4 "Minimum excavation" shall be used to describe the minimum excavation required to install the specified initial support shown on the drawings.

1.1.4 Monitoring

.1 Instruments may be installed at ground surface or as designated by an independent instrumentation specialist, to monitor tunnel excavation and related ground movement, if required by the Engineer or EPCOR.

.2 Instruments will be monitored both on a routine basis and as reasonably requested by the Contractor and the Engineer.

.3 Monitoring results will be provided to EPCOR by the instrumentation specialist or the contractor.

.4 Use monitoring results to adjust the excavation and support system installation to achieve minimum loss of ground for safe excavation.

.5 Install and monitor any extra instrumentation necessary for the safe conduct of the work at no additional cost to EPCOR. Such instrumentation results shall be copied to the Engineer on timely basis after readings are taken.

1.1.5 Submittals

Provide the following within 15 calendar days of the award of the contract:

- List of construction equipment.
- Method and equipment used for spoil disposal from tunnel area.
- Drawings and descriptions of excavation, sequencing and ground support installation, complete with shop drawings of initial tunnel lining stamped by a professional Engineer.
- Details of a ground monitoring program if required.

1.2 PRODUCTS

Not Applicable.

1.3 EXECUTION

1.3.1 Preparation

.1 Before the ground is disturbed or existing concrete is removed at a worksite, the Contractor must contact the utility owners, advise on proposed work, request locations of the utilities and not begin any work until all utility locations are identified and marked.

.2 All required permits must be obtained and current.

1.3.2 Excavation

.1 Excavate to elevations, alignment and dimensions shown on the drawings.

.2 Adhere to excavation and initial support sequences and restraints set out in shop drawings and as approved by the Engineer in writing.

.3 Use underground excavation methods, techniques and procedures that will result in minimum voids behind the tunnel liner. Remove soil to the minimum excavation lines shown on the drawings. The choice of excavation machinery or tools shall be the responsibility of the Contractor, based on the anticipated soil conditions derived from the geotechnical report or what could be reasonably expected. The Contractor shall have contingency plans for removal of boulders or minor changes in ground and these changes will be accounted for in the Contractor's methodology and cost.

.4 If the ground conditions vary considerably from what the geotechnical report indicates, the Contractor shall inform the Engineer immediately.

.5 Excavate tunnel by SEM, in accordance with designed procedures, sequences and support systems.

.6 The height of the heading excavation shall be as indicated on shop drawings prepared by a professional engineer. Straight faced or full faced excavation in excess of 1.5 m will not be permitted unless approved by the Engineer and by Alberta Occupational Health and Safety.

.7 In unstable ground, adjust the height of the heading, sequentially excavate and support the face and roof in small exposed areas as necessary to minimize loss of ground.

.8 In unstable ground, pre-support of the tunnel roof may be required. The use of forepoling, spiling or other pre-support techniques may be employed as necessary to minimize ground loss and ensure worker safety.

.9 If necessary, determine the nature of the ground before the excavation cycle by probing a minimum of 3 m in advance of the face with suitable drilling equipment. Drill two holes, one horizontal hole at mid- height of the face, the second located near the crown and angling upwards at approximately 20º.

.10 The excavation may be accomplished by hand operated tools or by mechanical means. The appropriate safety authorities and the Engineer must approve any machines that affect air quality.

1.3.3 Alignment and Grade Tolerances

.1 The centre line of the tunnel shall not be more than 100 mm from the design alignment.

.2 The invert of the tunnel shall not deviate from the given grade by an amount greater than 40 mm plus 10 mm for each metre of diameter $\left(\succ 40\ \text{mm} + \frac{10\ \text{mm}}{1.0\ \text{m of diameter}} \times \text{m diameter}\right)$. If this tolerance is exceeded, make corrections at no cost to EPCOR. The Engineer shall approve the method of correction.

1.3.4 Advance Limits

.1 Excavate the tunnels to the minimum excavation lines of whatever size and shape fits the external dimensions for the type of support system being used at the time.

.2 Should the excavation deviate beyond the required minimum excavation lines, for whatever reason, thereby reducing the effectiveness of the designed initial support system, remedial action

shall be taken immediately to ensure that the possibility of ground settlement is reduced to a minimum. Such remedial action will include, but not be limited to, the following:

- Blocking of ribs.
- Adding ribs.
- Immediate application of shotcrete.
- Immediate installation of lagging and blocking.
- Immediate installation of spilings.
- Prompt backfill grouting of fallout voids and cavities.

1.3.5 Sequencing and Scheduling

.1 All materials required for tunneling including but not limited to shotcrete material, steel ribs, spiling, meshing, lagging sufficient for 10 working days or at least 100 m length of tunnel shall be on site before commencement of tunnel excavation.

.2 Organise the tunnel excavation operations to be as continuous as practical. No part of the tunnel circumference will be allowed to remain unsupported for longer than the minimum time required to install initial support. If the tunnel excavation and initial support installation cycle is discontinued, stabilise the face before leaving the tunnel.

.3 Follow up closely behind the placement of support on the tunnel floor with a firm surface for tunnel traffic to prevent deterioration of the tunnel floor.

.4 Provide adequate drainage and remove collected water from any infiltration or rain.

1.3.6 Protection and Disposal

.1 The equipment and method of disposal of excavated material from the tunnel must be approved by the EPCOR prior to starting work.

.2 Protect and maintain tunnel support system from damage.

.3 Maintain tunnel free of waste, debris at all times. Control water infiltration so that is does not interfere with the excavation procedure and prevent deterioration of the tunnel invert.

1.3.7 Safety

.1 Conduct operations to EPCOR safety standard procedures- Tunnel Safety Regulations and the applicable provisions of all relevant regulatory and inspecting authorities.

.2 Continuously monitor and inspect the tunnel excavation at the face and at all times install adequate support to the walls of the tunnel to ensure a safe and stable condition.

.3 Perform remedial action directly to ensure that soil surrounding the excavated tunnel is maintained in a stable condition.

.4 The Engineer may work with the Contractor to address any safety concerns with the excavations.

.5 Nothing in these specifications shall be construed to relieve the Contractor from sole responsibility for safety.

END OF SECTION

2 TUNNELLING BY TUNNEL BORING MACHINES

2.1 GENERAL

2.1.1 Scope

This section specifies the requirements for tunnel excavation through soft ground using Tunnel Boring Machine (TBM), including the loading, transportation and disposal of excavated materials to disposal sites.

2.1.2 Related Sections

Steel Ribs and Lagging	Section ***3***
Precast Concrete Tunnel Lining	Section ***6***
Tunnel Liner Grouting	Section ***7***
Shaft Construction	Section ***9***

2.1.3 Definitions

"Minimum Excavation" refers to a minimum diameter of earth excavated by the TBM in order to install a specified liner system.

2.1.4 Monitoring

.1 Where required by EPCOR, instruments shall be installed by an independent instrumentation specialist retained by the contractor at ground surface to monitor tunnel excavation and related ground movement.

.2 Instruments will be monitored both on a routine basis and as reasonably requested by the Contractor and the Engineer.

.3 Monitoring results will be provided to EPCOR and contractor by the instrumentation specialist immediately upon receipt.

.4 Use monitoring results to adjust the excavation and support system installation to achieve minimum loss of ground for safe excavation.

.5 Install and monitor any extra instrumentation necessary for the safe conduct of the Work at no additional cost to EPCOR. Such instrumentation results shall be copied to EPCOR on timely basis after readings are taken.

2.1.5 Submittals

.1 Provide details of the methods and equipment to be used for spoil disposal from the tunnel area within 15 calendar days of the award of the contract:

.2 Submit shop drawings and details for the proposed initial tunnel lining system as outlined in appropriate related sections.

2.2 PRODUCTS

Not applicable.

2.3 EXECUTION

2.3.1 Preparation

.1 Before the ground is disturbed or existing concrete is removed at a worksite, the Contractor must contact the utility owners, advise on proposed work, request locations of the utilities and not begin any work until all utility locations are identified and marked.

.2 All required permits must be obtained and current.

2.3.2 Excavation

.1 Excavate to alignment, elevations and dimensions on the drawings and install initial tunnel lining.

.2 Should excavation deviate beyond the required minimum excavation lines for whatever reason, remedial action shall be immediately taken by the Contractor to ensure that possibility of ground settlement is reduced to a minimum. Such remedial action will include, but not be limited to the following:

- Blocking of ribs.
- Adding ribs.
- Immediate installation of lagging and blocking.
- Prompt backfill of fallout voids and cavities with grout.
- Soil stabilisation in advance of the excavation.

2.3.3 Alignment and Grade Tolerances

.1 Centreline of the tunnel shall not be more than 150 mm off the given line.

.2 The invert of the tunnel shall not deviate from the given grade by an amount greater than 40 mm plus 20 mm for each metre of diameter $\left(\succ 40\ \text{mm} + \frac{20\ \text{mm}}{1.0\ \text{m of diameter}} \times \text{m diameter}\right)$. If this tolerance is exceeded, make corrections at no cost to EPCOR. EPCOR shall approve the method of correction.

2.3.4 Excavating Equipment

.1 The choice of equipment for the tunnel excavation is the responsibility of the Contractor and shall be made on the basis of expected soil conditions outlined in the geotechnical report and borehole logs. The Contractor shall make allowances in the choice of equipment to account for reasonable and minor deviations in ground conditions and shall have contingency plans for removal of boulders or other minor changes in ground conditions. Prior approval from EPCOR is required for the method of disposal of excavated material from the tunnel, prior to any work on the project.

.2 If, in the opinion of the Contractor, a change in ground conditions occurs, the Engineer shall be notified immediately.

.3 Protect and maintain the tunnel support system from damage from the soil disposal system or from any other equipment.

.4 Maintain tunnel free of waste, debris at all times. Manage any water infiltration so that the excavation process and the soil stability are not adversely affected.

2.3.5 Safety

.1 Conduct operations to EPCOR safety standard procedures - Tunnel Safety Regulations and the applicable provisions of all relevant regulatory and inspecting authorities

.2 Continuously monitor and inspect the tunnel excavation at the face and at all times install adequate support to the walls of the tunnel to ensure a safe and stable condition.

.3 Perform remedial action directly to ensure that the ground surrounding the excavated tunnel is maintained in a stable condition.

.4 The Engineer may work with the Contractor to address any safety concerns with the excavations.

.5 Nothing in these specifications shall be construed to relieve the Contractor from sole responsibility for safety.

END OF SECTION

3 STEEL RIBS AND LAGGING

3.1 GENERAL

3.1.1 Scope

.1 This section specifies the requirements for the installation of initial/temporary support system for newly excavated tunnels including erection of steel ribs, placement of wood lagging, blocking and spiling as required.

.2 This section does not cover instances where the permanent/final lining is installed immediately after excavation, e.g. segmental liner tunnels.

3.1.2 Related Sections

Soft Ground Shield Driven Tunnelling	Section ***2***
Tunnel Excavation using Sequential Excavation Method	Section ***1***
Tunnel Liner Grouting	Section ***7***

3.1.3 Definitions

.1 The term "Steel Ribs" shall be used to describe the circular or curved steel ribs used to support the ground around the tunnels and tunnel transition.

.2 The term "Spilings" shall be used to describe sheet piling that is installed into soft unstable ground at the tunnel face or in the tunnel crown, ahead of excavation, when necessary.

.3 "Initial support" shall be used to describe steel ribs, wooden lagging, blocking and other related temporary ground support, installed after excavation.

3.1.4 Responsibility of the Contractor

.1 The Contractor is responsible for all aspects of the safety of the tunnel initial ground support systems.

.2 The Contractor is responsible for the design of the initial support system in accordance with the specifications. Design criteria are listed on the drawings or EPCOR standards.

.3 Should ground fall out or excessive voids occur in the tunnel roof or face, for any reason, take immediate action to limit loss of ground and inform the Engineer.

3.1.5 Variations to Initial Support System

The guidelines for installation of tunnel initial support system are as indicated on the drawings and outlined in the specifications. However, the following changes may be required by the Engineer either prior to the commencement of the contract or as the work proceeds:

.1 Assessment of spacing for Steel rib.

.2 Requirement of spiling, amount required and location of installation.

3.1.6 Submittals

.1 Within 20 working days of contract award, the Contractor shall submit the following to the Engineer:

- Shop drawings showing initial support system, stamped by a professional Engineer registered in Alberta.
- Detailed description of the installation method.

.2 The work on tunnel excavation shall not begin until the Engineer approves the initial support system in writing.

3.1.7 Quality Assurance

.1 If requested by the Engineer, submit one certified copy of mill reports covering chemical and physical properties of steel used in the work.

.2 All materials shall be in accordance with CSA Standards.

3.2 PRODUCTS

3.2.1 Steel Ribs, Dutchmen, and Blocking

All material used for steel ribs shall conform to CSA-G40.21 and structural shapes to Grade 350W and plates to Grade 300W. Design and fabrication of the ribs shall conform to CAN/CSA-S16. The ribs shall be supplied complete with bolts, nuts, plates, spikes, drift pins, dowels, wedges, tie rods, steel Dutchmen, shims and other accessories required for assembling and erecting the supports.

3.2.2 Spilings

.1 Select appropriate spiling for ground to be encountered. If material used for spiling is steel, it shall conform to CSA-G40.21 Grade 300W. Fabrication of spilings shall conform to CAN/CSA-S16.

.2 Design and supply a suitable mechanical device for installing the spilings into the ground at the tunnel face without causing excessive shock or vibration to the surrounding ground.

3.2.3 Drains

In wet areas of ground, drains shall be installed to remove water away from the working face and may consist of slotted plastic pipes or tubes, dimpled plastic sheets, geotextile cloth, geotextile wicks or other material as approved by the Engineer.

3.2.4 Timber Lagging and Blocking

Rough cut construction material, as per design requirements.

3.3 EXECUTION

3.3.1 Installation Sequencing

.1 The installation of the tunnel initial support shall be carried out as an integral part of the tunnel excavation.

.2 The routine sequence of excavation and initial support for sequential excavation method is shown on the drawings and shall be adhered to unless the Engineer approves modifications in writing. For shield driven tunnel excavation, initial support shall be installed within the tail shield and expanded when the TBM shield advances forward past the rib section.

.3 Initial support will typically consist of steel rib and timber lagging installed as follows:

- Install rib section immediately after the excavation has advanced the required distance.
- Install timber lagging and blocking.
- Expand rib section, if required, to required dimension as soon as possible.

3.3.2 Steel Ribs

.1 Install in the manner indicated on the shop drawings approved by the Engineer.

.2 Ribs installed in the bench shall be expanded until tight against the excavated wall. Dutchmen and shims shall be installed to maintain the expanded rib shape.

3.3.3 Spilings

.1 Install spilings as necessary to support unstable ground in the excavation.

.2 The actual number of spilings over any rib, at any location in the crown heading, will vary dependent on the ground condition encountered.

.3 Spilings shall be smoothly installed into the heading face over the rib at the crown.

.4 In the event of being unable to install any spiling fully into its planned location, for any reason, no attempt shall be made to withdraw the spiling.

.5 Spilings not fully installed shall have the part behind the steel rib at the heading-face cut off and removed so that it does not interfere with placement of the final lining.

.6 Installation forces on spilings shall be controlled so that no buckling or sagging occurs in the spilings.

3.3.4 Lagging and Blocking

.1 Lagging and blocking, if and when used as part of the tunnel initial support system, will be suitably cut and sized to fit into ground fallout area, excavation overbreak and the like, as part of the support system.

.2 When tunnel face excavation is halted for more than 36 hours or where ground conditions are unfavorable, the tunnel face shall be boarded and blocked to prevent excessive soil loss from the tunnel face. Excavation shall proceed in a sequential, controlled method through partial face blocking so that loss of ground and settlement is minimized.

3.3.5 Excavation and Ground Support Records

Provide daily, on a form approved by the Engineer, the following information:

.1 For Sequential Excavation Method

- Station of the partial rib at the heading face and station of the full-circle-rib at the bench face and rib spacing.
- Ground type being excavated.
- Details of spilings, lagging and face blocking installed.

.2 For Tunnel Boring Machine Excavation

- Station of the last rib installed.
- Ground type being excavated.
- Rib spacing.

END OF SECTION

4 SHOTCRETE TUNNEL LINING

4.1 GENERAL

4.1.1 Scope

This section specifies the requirement for the supply and application of early set primary and secondary shotcrete for initial tunnel support and normal set shotcrete for final liner.

4.1.2 Related Sections

Tunnel Excavation using Sequential Excavation Method Section ***1***

Soft Ground Shield Driven Tunnelling Section ***2***

4.1.3 Quality Control

.1 Comply with American Concrete Institute recommended practice for shotcreting.

.2 Concrete and concrete testing to comply with CSA-A23.1 and CSA-A23.2 respectively.

.3 Preparation and testing of shotcrete conform to ASTM C1140.

.4 The Contractor in accordance with CSA-A23.1 will carry out inspection and testing of concrete and concrete materials for the purposes of quality control. EPCOR may also perform testing at its discretion for the purposes of quality assurance.

.5 The minimum tests required for quality control shall be:

- Air content and slump shall be tested every batch until specifications are met and then once every third batch thereafter.
- Concrete strength shall be tested by taking three cylinders for every 50 m^3 placed, with a minimum of one set per project. They shall be field cured. One cylinder to be broken at 7 days and the remaining two at 28 days.

.6 For the purpose of quality control, the Engineer will, from time to time, require the Contractor to shoot test panels of fibre reinforced shotcrete for flexural and toughness testing.

.7 Inform the Engineer, at least three days in advance of start up of all shotcrete operations.

.8 The Engineer will take additional test samples during cold weather concreting. Cure samples on job site under same conditions as the concrete that they represent.

.9 Non-destructive methods for testing concrete shall be in accordance with CSA-A23.2.

.10 If the tests performed by the Contractor or the Engineer indicate that shotcrete fails to meet the specified requirements, then adopt such remedial measures as the Engineer may require, at no expense to EPCOR.

.11 Toughness strength requirements will be considered satisfactory or unsatisfactory on the same basis as compressive strength requirements in CSA-A23.1.

4.1.4 Definitions

.1 **Primary Shotcrete:** early set unreinforced shotcrete applied to excavated ground in tunnels.

.2 **Secondary Shotcrete:** early set reinforced shotcrete applied to primary shotcrete. Reinforcement shall be either steel fibre, polypropylene fibre or steel wire mesh, as shown on the drawings.

4.1.5 Submittals

A minimum of 20 working days before commencing work, the Contractor shall supply the following:

.1 Information on all equipment to be used.

.2 Proposed mix-designs and test results for shotcrete, including brand-names of admixtures.

.3 Names and resumes of foremen and nozzle operators.

4.1.6 Trial Mix Testing Program

.1 Retain a qualified laboratory to independently take samples and test shotcrete during the development of the mix design.

.2 Ten working days before start of shotcreting perform full-scale shotcrete test using intended equipment. In the Engineer's presence, shoot on plywood panels to minimum 100 mm thickness, both horizontally and vertically upwards. Use trial specimens of all proposed shotcrete mixes to be used in the Work.

.3 Take samples of and test the above trial specimens of shotcrete.

.4 EPCOR may do simultaneous testing during the development of this mix design.

4.2 PRODUCTS

4.2.1 Cement

Cement in shotcrete shall be Type HS - High Sulphate-resistant hydraulic cement, conforming to the requirements of CSA-A3000.

4.3 EXECUTION

4.3.1 Preparation

.1 For processing of aggregates, refer to CSA-A23.1, Clause 5.

.2 Primary shotcrete, placed directly on freshly excavated ground, requires no surface preparation other than removal of loose material, rebound etc. and the control of water.

.3 Any water that is running or seeping into the surface to be covered with primary shotcrete will be suitable drained and ducted into the tunnel or grouted before shotcrete is placed.

.4 Other surfaces that require shotcrete such as shotcrete to steel ribs and steel spilings, lagging or mesh, shall have all loose material, rebound and deleterious material removed and the surface dampened before shotcrete is placed.

4.3.2 Proficiency of Workers

Nozzlemen shall have previous experience on at least one comparable project in the past five years or shall work under the immediate supervision of a foreman with such experience. Each crew shall demonstrate to the Engineer acceptable proficiency in the application of shotcrete to vertical and overhead test panels before beginning production work.

4.3.3 Placing

.1 Primary shotcrete for initial tunnel support shall always be placed immediately after each tunnel sequence has been excavated.

.2 The Contractor may choose to use either a wet or a dry mix shotcrete process. If the dry mix process is used, demonstrate to the satisfaction of the Engineer, that excessive dust problems can be minimised and that Alberta Occupational Health and Safety Act, Regulations, and Code and EPCOR safety standards are complied with.

.3 Pre-dampened mix shall be used 60 minutes after initial contact with water.

.4 Thoroughly mix shotcrete used in wet mix equipment for a period of at least 1-½ minutes prior to use. Any shotcrete that is not used within 60 minutes after initial mixing shall be wasted and the mixer washed out with clean water. The slump for wet mix shotcrete shall be limited 60 mm to 100 mm.

.5 Apply shotcrete to provide a dense, smooth, firmly adhering coating at no point less than the thickness required by the design drawings. Each layer shall be applied before the shotcrete in the preceding layer has set completely. Rebound shall be kept clear of the shotcrete being placed. The re-use of rebound materials will not be permitted.

4.3.4 Cold Weather Requirements

.1 No shotcrete shall be placed when the temperature inside the tunnel or shaft chamber is below 10ºC.

.2 During cold weather, all materials stored outside shall be pre-heated throughout their bulk to 10ºC or above, before delivery to the shotcrete equipment.

.3 Any chemical additives that may be effected by cold shall be stored in an above freezing environment throughout its life until used in the shotcrete.

4.3.5 Curing

.1 All permanent finished shotcrete surfaces shall be cured using a water spray, curing compound or any other suitable method approved by the Engineer. Curing shall extend for a period of at least seven days following the date on which curing commences. No curing compound shall remain on surfaces that will be subsequently covered with concrete or with additional layers of shotcrete.

.2 Shotcrete, used to support the ground during tunnel driving operations, shall be kept damp for two days after applications.

.3 Normal set shotcrete shall trowelled to obtain smooth surface.

4.3.6 Clean-up

.1 Rebound and waste shall be disposed of off-site.

.2 Water contaminated with toxic chemicals or any toxic or potentially toxic chemicals shall not be allowed to enter EPCOR' sewers or be removed with the tunnel spoil. Make suitable arrangements for separate disposal of this material as and when it becomes necessary.

4.3.7 Repair

Damage to the primary shotcrete liner shall immediately be repaired to the satisfaction of the Engineer.

4.3.8 Safety Measures

.1 Alkali hydroxides and other chemicals contained in shotcrete admixtures and moderately toxic and can cause skin and respiratory irritation unless adequate safety measures are undertaken. In applying shotcrete containing toxic admixtures the nozzlemen and helpers shall wear appropriate protective clothing and equipment such as eye, respiratory and hand protection as per the Safety Data Sheet (SDS). Ability to flush skin or eyes shall be readily available in the immediate vicinity of shotcrete application in case of contact.

.2 The Contractor is fully responsible for implementation of a project safety program for the project. Nothing in this specification relieves the Contractor of that responsibility.

END OF SECTION

5 PIPE JACKING

5.1 GENERAL

5.1.1 Scope

This section specifies the requirements for the supply and installation of sewer pipes by pipe jacking methods.

5.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Tunnel Excavation using Sequential Excavation Method	Section ***1***	
Microtunnelling	Section ***8***	
Sewers	Section ***13***	
Inspection of Sewers	Section ***23***	
Leakage Testing of Sewers	Section ***27***	

5.1.3 Definitions

.1 Tunnel Boring Machine (TBM) is a mechanical excavating machine used to create an underground void through which a pipe or conduit is installed.

.2 Pipe Jacking is the installation of sewer pipe by pushing a series of pipe lengths through an excavated tunnel from a jacking pit to a receiving pit. It may be used to propel a TBM.

5.2 PRODUCTS

5.2.1 Pipe Design Approval

.1 Submit for approval the type and design of pipe proposed for use in the pipe jacking operation.

.2 Submit detailed information to show that the proposal will meet the requirements of the installation process, as well as the expected service loads and conditions.

.3 The submission should include calculations showing the axial loading capacity of the pipe, the maximum expected jacking loads during the installation and the safety factor used.

.4 Calculation shall include how the design of the pipe and the joint take into account and allow for the eccentric loadings that arise from uneven distribution of the jacking loads and deviations of the line during installation. Calculations will be required to show that the proposed pipe is capable of meeting all potential permanent loading and temporary loading during construction.

.5 Provide confirmation that the proposed pipe is manufactured to close dimensional tolerances on length, diameter, at the joints and for perpendicular surfaces.

.6 Provide confirmation that the joint is designed for the following conditions:

- To be formed within the pipe wall thickness. No internal or external projections shall be allowed.
- To transfer the longitudinal jacking loads, including eccentric loads from line deviations without over stressing or spalling of the joint faces.
- To meet the service watertightness requirements (internal and external).

.7 For jointed pipe, the Contractor will provide a 360° packing ring at every joint to provide even distribution of the axial load across the joint. This ring shall be made from homogeneous material that will compress in a mechanically stable manner over the expected level of deformation. The packing ring shall be manufactured and fixed to the pipe so that no part projects beyond the pipe wall thickness, and shall not interfere with the performance of the joint.

.8 The Contractor shall submit guarantees or warranty conditions and a statement of any restrictions of installation requirements imposed by the manufacturer.

5.2.2 Precast Concrete Pipe

.1 Precast concrete jacking pipe shall conform to CSA/CAN-A257.2, rubber gasket, straight-wall. Pipe shall be true to design dimensions and shall have bell and spigot mating surfaces perpendicular to the pipe axis within a variation of 6 mm.

.2 Bell and spigot design shall be such that no axial thrust loads are borne by the spigot. Pipe shall be supplied with metal bands if required for axial loading. Deflections at joints shall not exceed manufacturer's recommendations.

.3 Concrete shall be made with Type HS High sulphate-resistant hydraulic cement and shall have a minimum compressive strength of 41 MPa.

.4 Reinforcement shall consist of inner and outer cages. Elliptical reinforcement shall not be used. Reinforcement shall be supplemented by an additional cage at the inside of the bell of the pipe joint.

.5 Cushion material consisting of rubber, plywood or other suitable material shall be supplied and used to carry axial thrust across all joints. The dimensional details, cushion material, and method of attachment shall be submitted for EPCOR's approval.

.6 All joints shall be completed with rubber gaskets to conform to CAN/CSA-A-257.3 or ASTM C443M and shall be capable of providing a watertight seal.

5.2.3 Fibreglass Reinforced Resin Pipe

.1 Fibreglass reinforced resin pipe shall be centrifugally cast polyester resin, sand filled and fibreglass reinforced, conforming to ASTM D3262.

.2 Pipe shall be designed to withstand earth pressure, live loads, and axial thrust loads with a minimum safety factor of 1.5.

5.2.4 Steel Pipe

.1 Steel pipe: to AWWA C200, minimum wall thickness schedule 40 or standard wall, unless otherwise shown on the drawings. Steel sheet to ASTM A570/A570M Grade 36. Pipe shall have not more than one longitudinal seam and not more than two girth seams for single random length. Supply pipe in single and double random lengths.

.2 Exterior finish: to AWWA C210, two-part epoxy.

.3 Interior finish: to AWWA C210, two-part epoxy.

.4 Pipe joints: to be butt welded joints with bevelled ends. Interior and exterior finishes on the pipe to be touched up with epoxy paint after welding.

5.2.5 Grout

Cement grout where required for backfill (non-structural) purposes, shall meet the following minimum specifications:

Type HS High Sulphate-Resistant Hydraulic Cement	1 part
Sharp, Clean Sand (Submit gradation for approval)	2 parts
Water	For a 28-day strength of 0.7 MPa

5.3 EXECUTION

5.3.1 Equipment

.1 Pipe jacking methods shall be integrated with the tunnel excavation to maintain a continuously and completely supported excavation throughout.

.2 All power machinery and tools within the tunnel headings and shaft shall be operated by electricity, compressed air, or other approved power. The use of gasoline power or of internal combustion engines in the tunnels or shafts is prohibited.

.3 Pipe jacking equipment shall distribute jacking forces uniformly around the periphery of the pipe and a thrust ring shall be used to transmit pressures to the end of the pipe uniformly. As a minimum, the main jacks shall have a capacity of 1.2 times the maximum allowable jacking force of the pipe. Intermediate jacking stations shall be installed when the Contractor deems necessary to ensure that allowable jacking forces are not exceeded.

.4 If a pipe lubrication system is used, the Contractor shall obtain approval of the proposed lubricant, which shall be non-toxic and environmentally safe. The Contractor shall arrange for and pay for the necessary water for lubrication.

.5 Continuously monitor line and grade utilizing a laser capable of monitoring the entire length of each tunnelling operation and having a beam deviation over this length of 6 mm or less.

5.3.2 Tunnelling and Jacking

.1 The methods of tunnelling and jacking shall be as selected by the Contractor and appropriate to the equipment used and soil conditions anticipated.

.2 The tunnelling and jacking operation shall provide for continuous hole protection by tunnelling shield or pipe.

.3 Tolerance for pipe alignment shall be as follows:

.1 For pipes 900 mm and smaller, maximum deviation from line is 150 mm.

.2 For pipes 1050 mm and larger, maximum deviation from line is 50 mm per 300 mm of pipe diameter.

.3 The pipe invert elevation shall not deviate from the design elevation by more than 12 mm plus 6 mm per 300 mm of pipe diameter $\left(\not> 12\ \text{mm} + \frac{6\ \text{mm}}{300\ \text{mm of diameter}} \times \text{mm diameter}\right)$, nor have any measurable sags between manholes.

.4 If this tolerance is exceeded, the Contractor is required to make corrections at the Contractor's own cost, subject to the approval of the Engineer.

.4 Where the annular space between the pipe wall and tunnel excavation exceeds 25 mm, the annular space shall be completely filled by pressure grouting. Where the pipe supplier requires or recommends grouting of annular space, this shall be done regardless of dimensions. The placing of pipe shall be in accordance with the manufacturer's directions and recommendations.

.5 If a pipe lubrication system is used, the lubricant should be replaced with backfill grout as per Clause 5.2.5, or meeting the project requirement.

5.3.3 Testing and Inspection

.1 Laboratory Testing

.1 Test pipe in accordance with CAN/CSA-A257.0. The manufacturer shall furnish 0.5% of order but not less than 2 specimens of each size and type for every 300 m of sewer for test purposes. Load testing and hydrostatic testing shall be performed and witnessed by the EPCOR's representative.

.2 The Contractor shall bear the cost of testing.

.3 EPCOR shall be notified in advance at all testing.

.2 Leakage Testing

Leakage tests shall be conducted on all sanitary sewers to the requirements outlined in Section ***27*** - Leakage Testing of Sewers.

.3 Visual Inspection

.1 Television and/or visual inspection of the completed sewer to be as directed in Section ***23*** - Inspection of Sewers.

.2 The inspection shall be performed after all mains, manholes and service connections have been installed.

.4 Flush all mains and locate all manholes for inspection.

END OF SECTION

6 PRECAST CONCRETE TUNNEL LINING

6.1 GENERAL

6.1.1 Scope

This section specifies the requirements for construction of a tunnel using precast concrete segmental liner.

6.1.2 Related Sections

Tunnelling by Tunnel Boring Machines	Section ***2***
Tunnel Liner Grouting	Section ***7***
Sewers	Section ***13***
Leakage Testing of Sewers	Section ***27***

6.1.3 Pre-Qualification of Manufacturer

.1 All precast elements within the scope of this specification and drawings shall be fabricated by a manufacturing plant certified in the appropriate category according to CSA-A251.

.2 The Canadian Welding Bureau under CSA-W47.1 shall approve all fabricators of steel components.

6.1.4 Submittals

.1 Submit the following data to EPCOR for review at least ten days in advance of fabrication and not later than 30 working days from contract award:

- Shop drawings showing fabrication details.
- Detailed description of installation method.

.2 Do not proceed with manufacture of units prior to receiving the approval from EPCOR in writing.

6.1.5 Product Delivery, Storage and Handling

.1 Support units at points that will not cause stresses to the concrete for which it was not designed.

.2 Take care to prevent cracking or other damages.

.3 Identify all miscellaneous items clearly.

6.1.6 Responsibility of the Contractor

.1 The Contractor is responsible for the manufacture of segmental liner sections.

.2 The Contractor is responsible for all aspects of the safety of the tunnel ground support systems.

.3 Install the tunnel segments as recommended by manufacturer.

.4 Should ground fall out or excessive voids occur in the tunnel roof, for any reason, take immediate remedial action and inform the Engineer.

6.2 PRODUCTS

6.2.1 Precast Concrete Segments

.1 Precast concrete segments shall conform to CSA-A23.4 and shall be as shown on the drawings.

.2 Welded wire fabric shall conform to requirements of CSA-G30.5.

6.2.2 Joint Sealant

Joint sealant compound shall be as recommended by the segmental liner manufacturer and approved by the Engineer.

6.2.3 Grout

Expanding grout for grouting the joints and lifting bar ports shall be non-shrink, non-metallic aggregate developing minimum compressive strength of 35 MPa at 28 days.

6.3 EXECUTION

6.3.1 Preparation

All material required to line a 100 m length of the tunnel or material required for 10 days shall be on site before commencement of tunnel excavation.

6.3.2 Alignment and Grade Tolerances

.1 Centreline of the tunnel shall not be more than 150 mm off the given line.

.2 The invert of the tunnel shall not deviate from the given grade by an amount greater than 40 mm plus 20 mm for each metre of diameter $\left(\succ 40\ \text{mm} + \frac{20\ \text{mm}}{1.0\ \text{m of diameter}} \times \text{m diameter}\right)$. If this tolerance is exceeded, make corrections at no cost to EPCOR. The Engineer shall approve the method of correction.

6.3.3 Installation of Segments

.1 Install segments as recommended by the manufacturer.

.2 Apply sealing compound to all joints.

.3 Use concrete and steel blocking to support segments in place after expansion.

.4 Alternate location of expansion joint.

.5 Grout all lifting bar recesses. Grout all circumferential joints and those transverse joints, which, in the opinion of the Engineer, are open or misaligned enough to adversely, affect hydraulics or cause potential future infiltration problems.

6.3.4 Tunnel Liner Grouting

At locations where the liner could not be fully expanded to its design diameter or where ground loss occurred during excavation and prior to lining, voids behind the precast lining will be pressure grouted in accordance with Section ***7*** - Tunnel Liner Grouting.

6.3.5 Clean-up

When tunnel is completed, remove all equipment from the tunnel area, clean and remove all debris and mud from within the tunnel.

6.3.6 Inspection and Testing

.1 Maintain a high level of quality control in the manufacture of the precast segments. Submit to EPCOR a complete set of test results necessary to assure adherence to specifications. A minimum of one test per day of production shall be taken on the concrete.

.2 EPCOR may periodically perform additional tests as required and the manufacturer shall provide reasonable access to EPCOR's quality assurance laboratory for inspection of the manufacturing and testing processes.

.3 General quality control and quality assurance requirements are specified in Chapter 8 – Quality Assurance and Chapter 9 – Quality Control, both in Volume 1: General.

.4 Conduct infiltration testing in accordance with the requirements of Section ***27*** - Leakage Testing of Sewers.

6.3.7 Excavation and Ground Records

The following information shall be provided daily on a form approved by the Engineer:

- Station of the last set of fully expanded segmental liner sections.
- Type of ground encountered during the day.
- Location and volume of any ground loss.

END OF SECTION

7 TUNNEL LINER GROUTING

7.1 GENERAL

7.1.1 Scope

This section specifies the requirements for the supply, mixing and injection of sand-cement or cement grout mixes, to be used for filling behind tunnel liners.

7.1.2 Related Sections

Tunnel Excavation using Sequential Excavation Method	Section ***1***
Soft Ground Shield Driven Tunnelling	Section ***2***
Steel Ribs and Lagging	Section ***3***
Precast Concrete Tunnel Lining	Section ***6***

7.1.3 Quality Assurance

.1 Grouting to conform to CSA-A23.1 and ASTM C404.

.2 Cement to conform to CSA-A3000.

7.1.4 Definitions

.1 Void grouting shall mean the injection of cement grout or mortar grout comprised of cement, fine sand and water to fill voids in the top of the tunnel liner due to incomplete pouring of concrete in concrete lined sections or voids between permanent liner and temporary liner.

.2 Backfill grouting shall mean drilling and grouting of holes to fill voids between the soil formation and the initial support system.

.3 Washing is the process of cleaning drill cuttings and sludge from a drill hole by injecting water or water and air into the hole and returning the fluid and suspended matter toward the surface.

.4 Grouting pressure shall mean the pressure of grout as measured at the header while grout is being pumped into the hole.

.5 Effective pressure shall mean the pressure of grout, while being pumped at the point of absorption in the hole, as calculated from the measured grouting pressure at the header and allowing for the pressure head of grout in the hole.

.6 Grout take is the quantity of materials injected in a hole expressed in units of bags of cement and m^3 of sand or volume of ready mixed grout.

.7 Grout holes refer to holes drilled through concrete, shotcrete, spiling or any other initial support component for the purpose of injecting grout.

7.1.5 Testing

.1 Test trial batches of all grout mixes.

.2 Routinely test production grout as the Engineer directs at no additional cost to EPCOR.

.3 Record all grouting operations on approved forms.

7.1.6 Measurement and Payment

.1 Backfill grouting is incidental to tunnel initial support and ground control and no extra payment shall be made.

.2 Void grouting is incidental to the installation of tunnel liner and no extra measurement nor payment shall be made.

.3 No payment for tunnel liner grouting shall be made unless it is specifically required and specified as a control for infiltration and is itemised as such in the bill of quantities.

7.2 PRODUCTS

7.2.1 Grout Materials

.1 Water: fresh, clean and free from deleterious amount of silt organic matter, alkali, acids, salts and other impurities in conformity with CSA-A23.1. Temperature of water used in grout shall be less than 27ºC and greater than 5ºC.

.2 Cement: Type HS High sulphate-resistant hydraulic cement to CSA-A3000.

.1 Cement that is found to contain lumps or foreign matter that the Engineer considers detrimental to the results of grouting will be rejected and shall immediately be removed from the site by the Contractor.

.2 Cement shall be above 0ºC when added to the grout mixture.

.3 Sand: clean, durable stone particles, free from lumps of clay and objectionable foreign matter, having a moisture content of less the 3% of dry weight and conforming to ASTM C404 with the following modified requirements:

Sieve Size	% Passing by Mass
2.36 mm	100
1.18 mm	95 - 100
600 µm	60 - 85
300 µm	30 - 50
150 µm	10 - 30
75 µm	0 - 5

.4 Admixtures: Retarding and expanding admixtures for cement and sand/cement grouts shall be subject to the Engineer's approval.

7.2.2 Grout Mixes

.1 Submit a grout mix design to the Engineer for review. Grout shall normally consist of a mixture of Type HS High sulphate-resistant hydraulic cement, water, approved additives and sand as required. Fly ash may be utilized with the prior approval of the Engineer.

.2 The mixture shall be designed to suit particular conditions encountered. Proportions of materials used in the grout mixture and any adjustments thereto during grouting operations shall be only as approved by the Engineer. All grout shall contain an expansion agent of a type and amount approved by the Engineer to eliminate shrinkage.

.3 The Engineer may require the addition of material other than those specified above.

.4 Use chemical additives in grout mixes only with prior written approval of the Engineer.

.5 Handle, store and protect all cement and additives in such manner that they will not deteriorate or become contaminated. Deteriorated or contaminated materials shall not be used in the work.

.6 Grout mixes shall be both with and without sand, non-bleeding and attain the following compressive strengths:

Grout Application	Minimum Compressive Strength at 28 days (MPa)	Tunnel Liner Design Condition
Fill the annular space between host pipe and sliplining pipe or native ground and tunnel liner	Minimum 2	Only if the new liner is designed to take the full load as a stand alone liner
	35	If the existing tunnel (host pipe) shares the load with the new liner
Fill voids	35 or equal to the design of the concrete liner	

.7 Minimum cement content of the grout mix to be 160 kg/m^3.

7.3 EXECUTION

7.3.1 Drilling

.1 For backfill grouting, drill nominal 25 mm diameter holes through the tunnel initial support system. Where spilings and lagging are encountered, tape and thread as required to install grout nipples.

.2 For void grouting core nominal 50 mm diameter grout holes through the concrete liner.

7.3.2 Layout and Preparation

.1 Grout holes through initial support for backfill grouting to be located at lowest points of known voids and voids suspected by the Engineer to exist. Vent-pipes or tubes to be located to vent highest points of voids, where applicable.

.2 Grout holes through permanent concrete liner for void grouting to be located at the crown. Hole spacing along the line of the tunnel to be located between steel ribs and at not more than 3 m centres or at locations of known voids or both.

.3 Packers or threaded connectors with valves attached to be all in the pace before grouting is to commence.

7.3.3 Batching, Mixing and Agitating

.1 Measure or weigh all grout materials into the mixer in complete "Batch-Units" compatible with mix used and mixer size.

.2 Mix complete batches of grout for minimum 3 minutes or until thoroughly mixed and then transfer whole batch to agitator and clean out mixer, if necessary.

.3 Keep grout batches agitated in the agitator tank until they are completely used. Any grout batches kept in the agitator for over one hour are to be dumped and the agitator cleaned out.

7.3.4 Pumping and Grout Pressure Control

.1 Pumping to be at a controllable rate without significant fluctuations of pressure.

.2 Nozzle operator to continuously monitor and adjust pressure at header-unit during pumping.

7.3.5 Backfill Grouting

.1 Fill voids with grout until a pressure of 50 kPa applied to the liner is reached unless directed otherwise by the Engineer.

.2 Grouting to continue until totally undiluted grout comes out of the vent-pipes or tubes or adjacent grout- holes or until refusal.

7.3.6 Void Grouting

.1 Grouting to commence at lowest point of tunnel being grouted and to proceed to highest point.

.2 Grouting of small voids or voids of unknown extent to commence using mix without sand. Should grout takes exceed 0.5 m^3 in 5 minutes, change to a grout mix with sand.

.3 Grouting of each connection shall continue until refusal, at a pressure of 50 kPa.

.4 The Engineer may require additional grouting behind concrete tunnel liner, if there is reason to believe the grouting was incomplete.

7.3.7 Grouting Records

.1 Accurately measure and record all aspects of the grouting operations as they are performed and submit results to the Engineer.

.2 Records shall be kept on approved forms and submitted to the Engineer in a timely manner.

7.3.8 Clean-up

.1 Fill void grouting holes flush with the interior surface of the tunnel.

.2 Clean all interior surfaces of the tunnel of excess grout.

END OF SECTION

8 MICROTUNNELLING

8.1 GENERAL

8.1.1 Scope

This section specifies the requirements for the excavation of earth utilizing TBMs that are operated by remote operating centres and no man entry is required for operational purpose, for installing sewer pipe.

8.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Pipe Jacking	Section ***5***	
Shaft Construction	Section ***9***	
Sewers	Section ***13***	

8.1.3 Definition

Microtunnelling: A method of ground excavation using a tunnelling machine which generally has a remotely propelled, mobile, cutting mechanism. The microtunnelling machine is distinguished from augers or boring machines, which excavate by stationary engines and use flights and extensions to excavate and remove spoil.

8.1.4 Regulations

.1 The Alberta Occupational Health and Safety Act, Regulation, and Code.

.2 EPCOR Tunnel Safety Regulations.

8.1.5 Submittals

Provide the following within 15 working days of the award of the Contract:

- Method and equipment used for spoil disposal from tunnel area.
- Drawings and descriptions of excavation and ground support operations.
- Details for monitoring of ground settlements.
- Shoring design for access shaft or pit excavations.
- Construction procedures.

8.2 PRODUCTS

Refer to Clause ***5.2*** of Section ***5*** – Pipe Jacking

8.3 EXECUTION

8.3.1 Equipment

.1 The Contractor shall be responsible for selecting the microtunnelling method and equipment. Tunnelling machines shall be remotely controlled and have monitoring systems, built-in or external, that can adequately maintain the tunnel excavation to the required tolerances.

.2 The Contractor shall confirm that the system proposed will be able to manage all ground and groundwater conditions that were indicated by boreholes, geotechnical reports or elsewhere and that could be reasonably foreseen.

.3 The equipment shall conform to the following criteria:

.1 Face support shall be provided, either by full earth pressure balance, slurry or other system that will control ground settlement and is approved by the Engineer.

.2 The overall diameter of the shield shall not be greater than that of the pipe by more than 25 mm.

.3 The system shall have a continuous monitoring system for detecting and recording deviations from the required line and level up to 5 mm. The monitoring system located at a surface control station should be equipped to record jacking loads and face pressures. The monitoring system should be checked periodically to ensure that it is performing properly.

.4 The system shall be equipped with remote steering control with line, level and gradient prediction capability.

8.3.2 Shaft or Pit Construction

.1 Pits shall be excavated to minimum dimensions required for TBM insertion and jacking unit.

.2 Temporary shoring and bracing shall be designed by a professional engineer competent in this field. Submit stamped shoring and bracing design to the Engineer prior to excavation of pits.

.3 Wherever practical, pits shall be at locations on the line where manholes are required. The Engineer shall approve pits in other locations.

.4 Pits shall be fenced to provide safety to the public.

.5 Dewater pits as required to maintain a suitable floor for operations.

.6 The pits shall be designed to provide a thrust wall reaction in excess of the anticipated maximum jacking load.

.7 The thrust wall of the pit shall be designed to be capable of resisting the jacking load without movement in excess of 50 mm.

.8 The Contractor may submit proposals for provision of launching (jacking) and reception shafts, constructed from concrete precast sections, which can be converted into permanent manholes.

8.3.3 Pipe Installation by Microtunnelling

.1 The Contractor shall be responsible for:

.1 Selecting and operating all the equipment required to undertake the work in a timely and efficient manner.

.2 Providing an experienced and expert operator for controlling and operating the equipment. The operator shall be present at all times when the microtunnelling equipment is in use.

.2 The tolerance for grade and alignment shall be:

- For pipes 900 mm and smaller, maximum deviation from line is 150 mm
- For pipes 1050 mm and larger, maximum deviation from line is 50 mm per 300 mm in pipe diameter.
- The pipe invert elevation shall not deviate from the design elevation by more than 6 mm plus 6 mm per 300 mm in pipe diameter $\left(\succ 6\ \text{mm} + \frac{6\ \text{mm}}{300\ \text{mm of diameter}} \times \text{mm diameter}\right)$, nor have any measurable sag between manholes.

.3 If this tolerance is exceeded, the Contractor is required to make corrections at the Contractor's own cost, subject to the approval of the Engineer.

.4 Records of deviations from the specified line and level will be continuously recorded together with records of jacking loads and pressure balance loads.

.5 The work shall be organized at the surface so that the storage of pipes, disposal of soil and location of plant shall be kept as compact as possible so as to minimize disruption to traffic and the public.

.6 The level of noise arising from the operation and equipment employed shall adhere to the City's Community Standards Bylaw 14600. For workers exposed to noise, the Contractor shall adhere to Alberta Occupation Health and Safety Act, Regulation, and Code.

.7 Where a slurry system is proposed, adequate arrangements should be employed to reduce the volume of material arising and recover the slurry where possible. Disposal of residual spoil should be to an approved site at the Contractor's expense.

.8 Provide and pay for all power and water supplies needed to undertake the Work.

.9 Notwithstanding the provisions of the specification, the Engineer may require the Contractor to take action to assure the safety of the excavations. Promptly comply with such requirements. Nothing in these specifications shall be construed to relieve the Contractor from sole responsibility for safety.

8.3.4 Removal of Boulders

.1 In the event that boulders are encountered and such boulders cannot be crushed or removed by the TBM or removed through the pipe, the Contractor shall excavate down from the surface and remove such boulders.

.2 Alternate methods, such as blasting, may be submitted for approval, but no work shall be undertaken without prior written authority.

.3 Excavations to remove boulders shall be protected and backfilled as specified in Clauses ***8.3.2*** and ***8.3.5.***

8.3.5 Backfill of Pits

.1 Remove and dispose of all saturated soil in the pit before backfilling.

.2 Pipe bedding material shall be approved granular material, class as shown on drawings and specified in Section ***13*** - Sewers.

.3 The pit shall then be backfilled in lifts not exceeding 300 mm. Backfilling shall be in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

.4 Sheeting, shoring and bracing shall be removed as backfilling proceeds in a manner that provides continuous soil support and safety for workers in and about the pit.

.5 The surface shall be restored to conditions that existed prior to disturbance or as indicated by drawings.

END OF SECTION

9 SHAFT CONSTRUCTION

9.1 GENERAL

9.1.1 Scope

This section specifies the requirements for the supply and installation of vertical access shafts and associated structures for sewers.

9.1.2 Related Sections

Manholes and Catch Basins	Section ***17***	
Concrete Forms and Accessories	Section 7.10	Volume 2: Complete Streets
Reinforcing Steel	Section 7.12	Volume 2: Complete Streets
Concrete for Water and Drainage Structures	Section ***29***	

9.1.3 Material Testing

Tests for concrete are specified in Section ***29*** - Concrete for Water and Drainage Structures.

9.1.4 Standards

Materials supplied for work covered by this section shall be in accordance with ASTM, CGSB and Canadian Standards.

9.1.5 Shop Drawings

.1 Submit shop drawings for all cast in place reinforced concrete structures at least 15 calendar days prior to installation.

.2 Provide details of excavation procedure, and submit shop drawings for initial support system to the Engineer for review 10 calendar days prior to excavation.

9.2 PRODUCTS

9.2.1 Concrete

.1 Concrete shall be made with Type HS High sulphate-resistant hydraulic cement.

.2 Refer to Section ***29*** - Concrete for Water and Drainage Structures, for mix design requirements and standards for concrete production.

9.2.2 Mortar

.1 Mortar shall conform to the following mix:

- 1 part Type HS High sulphate-resistant hydraulic cement
- 1½ parts clean sharp sand
- Water to provide workability

.2 Grout to be non-shrink type.

9.2.3 Shaft Bases

Poured-in-place concrete as detailed on the drawings.

9.2.4 Shaft Manhole Barrels and Tops

.1 Barrels - circular precast sections and joints as specified in Section ***17*** - Manholes and Catch Basins.

.2 Cast-in-Place Walls - as detailed on the drawings.

.3 Top Sections - top section shall be precast slab top, or precast conical, eccentric in accordance with Section ***17*** and as shown on drawings.

.4 Covers, Frames - as shown on the drawings, and specified in Section ***17***.

.5 Safety Steps - cast into precast section or drilled into cast concrete, with maximum spacing 410 mm, as specified in Section ***17***.

.6 All precast units to conform to CAN/CSA-A257.3.

9.2.5 Miscellaneous Metal

.1 All miscellaneous metal used inside shaft manholes, or buried as part of shaft sewer manholes shall be steel, hot dipped galvanised after fabrications.

.2 All inserts and insert bolts shall be stainless steel to the grade specified on the drawings.

9.2.6 Shaft Backfill

Backfill for the annular space between temporary shaft liner and precast access manhole structure to be fillcrete as specified in Section 3.1 - Trench Backfill, Volume 2: Complete Streets or approved equal.

9.3 EXECUTION

9.3.1 Excavation and Initial Shaft Lining

.1 The Contractor is responsible for selecting the excavation method, designing and installing the shaft initial support based on borehole information or geotechnical reports. The Contractor shall monitor the ground conditions during excavation to ensure the proposed procedure can be accomplished without ground loss, settlement, and within legislated safety guidelines. If the ground conditions differ significantly from what was assumed in the Contractor's design, inform the Engineer immediately.

.2 The Contractor shall install the initial shaft lining and secure it in the excavation. Any pre-drilled hole and subsequent insertion of pre-built liner will be secured by backfilling with fillcrete/grout around the annulus.

.3 Remove water from excavations prior to placing structural concrete. Where water is present, provide a continuous dewatering system to prevent the flow of water affecting the setting of the concrete.

.4 Over excavate at the base to remove unsuitable ground as required for structure installation, and place a mud slab as required.

9.3.2 Structural Shaft Lining

Construct access shaft and structures in accordance with details on the drawings.

9.3.3 Precast Structures

.1 Set bottom sections plumb on poured bases prior to concrete setting completely and seal base joint with mortar.

.2 Install gaskets and set manhole sections in place, in accordance with the directions of the manufacture.

.3 Manhole steps shall be aligned with a maximum spacing of 410 mm.

.4 Seal all interior joints with mortar.

.5 Place backfill around manholes for the full depth.

.6 Set the conical tops, frame and cover and adjust to finished grades.

.7 Clean manhole rungs and remove dirt, mortar, debris and other material from access shaft manholes.

9.3.4 Cast in Place Structural Lining

Set formwork, install steel reinforcement, and place concrete in accordance with the drawings and Section 7.10 – Concrete Forms and Accessories, Section 7.12 – Reinforcing Steel, both in Volume 2: Complete Streets and Section ***29*** – Concrete for Water and Sewer Structures.

9.3.5 Infiltration Testing

Infiltration into the completed shaft to be a maximum of 5 litres/minute

END OF SECTION

10 BORED UNDERCROSSINGS

10.1 GENERAL

10.1.1 Scope

This section specifies the requirements for the installation of sewer pipes referred to as “carrier pipe”, under designated rights-of-way by means of boring, jacking or tunneling.

10.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewers	Section ***13***	

10.1.3 Regulations

Regulations of the Board of Transport Commissioners, the National Energy Board and Alberta Transportation apply to the work of this section with regard to highway, railway and pipeline crossings.

10.1.4 Submittals

Submit in writing to the Engineer, complete details regarding the jacking, boring or tunnelling method proposed, and do not commence work until after the Engineer has advised in writing that the work may proceed.

10.2 PRODUCTS

10.2.1 Casing Pipe

.1 Casing pipe diameter will be governed by the carrier pipe size, minimum clearance to adjacent utilities or structures, the size of the pipe insulators and by the type of carrier pipe joint, so that the carrier pipe can be installed without damage and the annular space between the casing and carrier pipes can be adequately backfilled. The Contractor may propose alternate casing pipe diameters to suit the proposed installation methods, for approval by the Engineer.

.2 Casing pipe lengths will be governed by the Contractor’s construction methods and equipment, and as indicated on the drawings.

.3 The casing shall be steel pipe. Minimum casing wall thickness as indicated on the drawings, and to be selected by the Contractor such that no deformation occurs during installation, and that the casing provides a true alignment both vertically and horizontally.

10.2.2 Concrete

.1 In accordance with CSA-A23.1 – 25 MPa at 28 days.

.2 Cement: Type HS High sulphate-resistant hydraulic cement.

10.2.3 Grout

.1 Cement: Type HS High sulphate-resistant hydraulic cement.

.2 Sand or crushed rock screenings to the following gradation:

Sieve Size	% Passing by Weight
9.50 mm	100%
4.75 mm	50 - 100%
2.00 mm	30 - 90%
0.425 mm	10 - 50%
0.075 mm	0 - 10%

10.2.4 Pipe Insulators and Spacers

Two-part epoxy painted steel band with plastic.

10.3 EXECUTION

10.3.1 Excavation

.1 Excavate trenches, working shafts or pits as necessary to install the casing pipe, in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

.2 De-water the trench as necessary.

10.3.2 Casing

.1 Undercrossings may be cased with pipe, or be uncased if the ground conditions permit and if permitted on drawings.

.2 Install the casing pipe by jacking, boring or tunnelling. Monitor line and grade of the casing pipe with appropriate instruments. Monitor loss of ground, over-excavation or settlement of the structures, pipes or surface above the undercrossing. Halt all operations, take immediate remedial action and inform the Engineer if loss of ground or over-excavation is detected.

.3 Install the casing pipe so that the carrier pipe can be laid to the line and grade as shown on the drawings, with tolerances as required for the carrier pipe as specified in related sections.

.4 Backfill any detectable voids around the outside of the casing pipe with sand or grout.

10.3.3 Carrier Pipe

.1 Refer to related sections for the specification for carrier pipe.

.2 Attach plastic or other approved pipe insulators at predetermined intervals to ensure that the pipe is correctly located in the casing pipe and to prevent flotation and sags. The use of wooden spacers will not be allowed.

.3 Fill the annular space between the carrier pipe and casing pipe with pneumatically blown sand or pressure grout, unless indicated otherwise on the drawing.

.4 Fill each end of the casing around the carrier pipe with a waterproof concrete plug, unless the casing is under railroad tracks, or otherwise shown on the drawings.

10.3.4 Backfill

.1 Backfill trenches or pits in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

.2 Where working shafts, pits or trenches have been excavated below normal trench depth and wider than a normally excavated trench to accommodate boring, jacking or other equipment, the Contractor shall provide an engineered design for the backfill of the subgrade. Unless otherwise approved by the Engineer, the over-excavated depth shall be backfilled with Class A bedding or fillcrete.

.3 If the excavation for working shafts, pits, or trenches is such that trench conditions assumed for the design of the pipe are affected by the Contractor's methods, the Contractor shall provide an engineered design for a higher class of bedding for the pipe or a stronger class of pipe, or both, on the affected side(s) of the cased section, and install the pipe and bedding at no extra cost to EPCOR, and as directed by the Engineer.

.4 Do not backfill pits until the Engineer has inspected the installation.

END OF SECTION

11 HORIZONTAL DIRECTIONAL DRILLING

11.1 GENERAL

11.1.1 Scope

This section specifies the requirements for the installation of pipes or conduits utilizing horizontal directional drilling methods.

11.1.2 Related Sections

Trench Backfill Section 3.1 Volume 2: Complete Streets

11.1.3 Directional Drilling Method

.1 Definitions

.1 A horizontal directional drilling rig is a mechanical drilling device used to create a horizontal borehole through which a pipe or conduit is installed.

.2 Return and spoils are the drilling mud and cuttings collected in the entry and exit pits as well as any fluid which escapes from the borehole to the surface.

.2 General Description

Directional drilling is the installation of a pipe by drilling a pilot bore from the entry pit to a pre-determined exit location. The drilling head is then replaced with the reamer and the drilling string is pulled back to the entry hole, enlarging the hole while simultaneously pulling the pipeline product into place.

.3 Design Submittal

Submit methodology, specific to each crossing, complete with design and construction details for the proposed directional boring operation.

11.1.4 Work Content

Include all engineering services, plant, labour, material, and services for the following:

.1 Preparation of the site including removal of vegetation, location of all existing utilities along the proposed path, excavation of all utility crossings, excavation of entry, exit, and slurry containment pits.

.2 Installation of a new pipe by the directional drilling method.

.3 Testing of installed section and restoration of all affected surfaces to their pre-construction conditions.

11.1.5 Constraints

.1 Schedule work to minimize interruption to existing services and local traffic.

.2 Obtain all necessary permits or authorizations to carry construction activities near or across all buried pipelines and conduits.

.3 Submit for approval proposed methods to control, collect, transport and dispose of drilling fluids and spoils.

11.1.6 Submittals

.1 Provide the following within 5 working days of the award of the contract:

.1 Complete methodology, specific to each crossing, including:

- equipment specifications and capabilities,
- size of pilot hole,
- number and size of pre-reams,
- use of rollers, baskets and side booms to suspend and direct pipe during pull back,

- type and capabilities of tracking system and
- the number of sections in which the product is to be installed.

.2 Schedule of work.

.3 Drawing of work site, including location and footprints of equipment, and the locations of the entry, exit and slurry containment pits.

.4 Drawing of pullback installation showing partial or full closure of roadways and their approximate duration.

.5 Drilling fluid management plan, including drilling fluid containment, recycling/transport and approve disposal site.

.6 Emergency procedures for inadvertently boring into a live power line, natural gas line, water line, sewer line, or fibre-optic cables. Procedures must comply with regulations.

.7 Method of dealing with inadvertent returns of surface seepage of drilling fluids and spoils.

.2 At least two weeks prior to commencing work submit data from the manufacturer regarding the tensile strength and recommended minimum bending radius of the pipe.

11.2 PRODUCTS

Not applicable. Refer to the Section that specifies the pipe or conduit.

11.3 EXECUTION

11.3.1 Equipment

.1 The Contractor shall be responsible for the directional drilling method and equipment. The Contractor shall confirm that the drilling rig and mud mixing system have the capacity required to successfully complete the installation knowing the length of the crossing and product type and diameter, and considering ground and groundwater conditions that can be reasonably foreseen.

.2 Operating range and degree of accuracy of proposed tracking system shall be adequate to meet project conditions. Tracking/steering equipment shall allow for continuous monitoring of the drilling head along the entire proposed alignment. If a poor contact with sound is expected to occur at any section, this should be communicated to the Engineer prior to commencement of construction.

.3 The drilling unit must be equipped with an electrical strike safety package. The package should include warning sound alarm, grounding mats and protective gear.

11.3.2 Pre-Commencement

.1 Notify owners of subsurface utilities and on either side of the proposed drill path of the impending work through the one-call program. All utilities along and on either side of the proposed drill path are to be located.

.2 All utility crossings shall be exposed using hydro-excavation, hand excavation or another approved method to confirm depth.

.3 The proposed drill path shall be determined and documented, including its horizontal and vertical alignments and the location of buried utilities and substructures along the path.

.4 Excavation for entrance and exit pits is to be of sufficient size to avoid a sudden radius change of the pipe and resultant excessive deformation.

11.3.3 Installation Procedures

.1 General

.1 Only trained operators should be permitted to operate the drilling equipment, and manufacturer's operating instructions and safety practice shall always be followed.

.2 Drilling mud pressure in the borehole should not exceed that which can be supported by the overburden to prevent heaving or hydraulic fracturing of the soil ("Frac-out").

.3 Entrance and exit angles of the drill string should range between 8º and 20º and 5º and 10º respectively. Any deviation from these values shall first be approved by the Engineer.

.4 If a drilled hole beneath an artificial surface must be abandoned the hole shall be filled with grout or bentonite to prevent future subsidence.

.5 Pipe installation should be performed in a manner that minimizes the over-stressing and straining of the pipe.

.2 Drilling and back-reaming

.1 Drilling mud may be used during drilling and back-reaming operations, pending the approval of a fluids management plan.

.2 A sufficient number of pre-reams shall be utilized as to avoid heaving while enlarging the hole to the desired diameter.

.3 During back-reaming the conduit must be sealed at either end with a cap or lug to prevent water, drilling fluids and other foreign materials from entering the pipe.

.4 Pipe rollers, skates or other protective devices should be used in the installation of products 150 mm outside diameter or larger.

.5 Where possible and unless otherwise approved by the Engineer, the product pipeline will be fused, welded or connected into one string prior to commencement of the pull-back operation.

.6 The pilot hole shall be back-reamed to accommodate and permit free sliding of the product inside the borehole according to the following specifications:

Nominal Pipe Diameter	Back-Reamed Hole
50	75 to 100
75	100 to 150
100	150 to 200
150	250 to 300
200	300 to 350
250	350 to 400
>300	Minimum of 1.5 times product pipe outside diameter

11.3.4 Service Connections

.1 Trenching shall be used to make connections (if required) or join ends of conduits installed by the directional boring method.

.2 Sufficient pipe length for joining adjacent sections of pipe shall be pulled into the entrance pit. This additional pipe shall not be damaged or interfere with the subsequent drilling of the next section of pipe.

.3 Connections and tie-ins to HDPE pipe shall only be made after a suitable time period in order to allow the pipe to recover and rebound from the insertion forces. Recovery period shall be equal to at least twice the pull-back time.

11.3.5 Drilling Fluids - Collection and Disposal Practices

.1 Excess drilling mud slurry shall be contained in a lined pit or containment pond at exit and entry points until recycled or removed from the site. Entrance and exit pits shall be of sufficient size to contain the expected return of drilling mud and spoils.

.2 When working in an area of contaminated ground, the slurry shall be tested for contamination and disposed of in a manner that meets government requirements.

.3 Precautions shall be taken to keep drilling fluids out of the streets, manholes, sanitary and storm sewers, and other drainage systems including streams and rivers.

.4 Recycling drilling fluids is an acceptable alternative to disposal.

.5 The Contractor shall make a diligent effort to minimize the amount of drilling fluids and cuttings spilled during the drilling operation and shall clean-up all drilling mud overflows or spills.

11.3.6 Acceptance

.1 The Contractor shall provide a set of as-built drawings including both alignment and profile. Drawings should be constructed from actual field readings. Raw data should be submitted at any time upon EPCOR's request.

.2 Pipeline product shall be installed within the pre-specified alignment and grade tolerance as shown on the drawings and provided in the project specifications.

END OF SECTION

12 SEWAGE FORCEMAINS

12.1 GENERAL

12.1.1 Scope

The supply, installation, testing and inspection of pressure pipe for use as sewage forcemains.

12.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Aggregates	Section 2.1	Volume 2: Complete Streets
Concrete for Water and Drainage Structures	Section ***29***	

12.1.3 As-Built Drawings

Provide as-built drawings on project completion. Give directions and list equipment required for opening and closing valves, details of pipe material, location of cleanouts, locations of air and vacuum release valves, maintenance and operating instructions.

12.2 PRODUCTS

12.2.1 Steel Pipe

.1 Steel pipe shall be ASTM A53 Grade B, minimum standard wall thickness, unless otherwise shown on drawings.

.2 All underground steel piping shall be exterior coated with Polyethylene Tape wrapping to AWWA C214 or Yellow Jacket No: 1, total minimum thickness 1.27 mm.

.3 All interior lining shall be cement mortar lined to AWWA C205 or epoxy lined to AWWA C210.

.4 Flanges: to AWWA C207

.5 Pipe fittings: to AWWA C208 and exterior protected to AWWA C203.

12.2.2 Polyvinyl Chloride (PVC) Pipe:

.1 Pipe, fittings and joints conform to CSA-B137.3.

.2 Pressure class and Standard Dimensional Ratio as indicated on the drawings.

.3 Pipe joints: bell and spigot with rubber gaskets or mechanical joints to AWWA C111/A21.11, with transition gaskets to pipe manufacturer's specifications.

.4 Rubber gaskets: to AWWA C111/A21.11.

12.2.3 High Density Polyethylene (HDPE) Pipe

.1 Conform to CSA-B137.1 and CGSB 41-GP-25M, PE 3408.

.2 Joint pipe using thermal butt fusion to AWWA C207.

.3 Fittings

.1 To be flanged to AWWA C207.

.2 Fittings shall match the pipe supplied and shall be supplied by the manufacturer of the pipe or by suppliers approved by the pipe manufacturer.

.3 All fittings to be compatible in materials and dimensions with the pipe.

12.2.4 Pipe Bedding Materials

.1 Class I, Class II, and Class III materials as defined in Section ***13*** – Sewers are suitable for use as foundation material and in the embedment zone. For ease of compactability and to facilitate proper placement of material in the haunch area of the pipe, a suggested gradation for sand within the pipe embedment zone are the following limits:

Sieve Size (mm)	Percent Passing by Mass
10	100
5	70 - 100
0.16	5 - 20
0.08	0 -12

.2 Washed gravel: Where specifically specified for use, washed gravel shall consist of washed, crushed or screened stone or gravel consisting of hard and durable particles meeting the following gradation limits and free from sand, clay, cementitious, organic and other deleterious material.

Sieve Size (mm)	Percent Passing by Mass
5	maximum 10
0.08	maximum 2

12.2.5 Tracer Wire

Tracer wire to be an electric #14 AWG Solid SBC (1/64") polyethylene insulated wire or metal tape detectable to 3 m bury.

12.3 EXECUTION

12.3.1 Preparation

Pipes and fittings to be clean and dry. Carefully inspect materials for defects before installing. Remove any defective materials from site.

12.3.2 Trenching and Backfilling

.1 Trench and backfill in accordance with Section 3.1 – Trench Backfill, Volume 2: Complete Streets.

.2 Place and compact pipe bedding in accordance with Standard Drawing ***DR-06-13-01***, Type 2 Installation, unless shown otherwise on the construction drawings.

12.3.3 Installation

.1 Steel Pipe

Lay and join steel pipe in accordance with AWWA Manual M11.

.2 Polyvinyl Chloride (PVC) Pipe

.1 Lay and join PVC pipe in accordance with AWWA Manual M23 with specified bedding.

.2 All pipes shall be thoroughly inspected for damage just prior to installation. Evidence of gouges or cuts exceeding 10% of the wall thickness shall be cause for rejection.

.3 All joints shall be clean and smooth at all times during the jointing operation.

.4 Avoid bumping gasket and knocking it out of position or contaminating with dirt or other foreign material. Gaskets so disturbed to be removed, cleaned, lubricated and replaced before jointing is attempted.

.5 Deflections, where possible, shall be made by long radius curves keeping pipe deflections within the manufacturer's recommended limits.

.6 Short lengths of pipe not exceeding 1 m shall be installed on both sides of all fittings and valves.

.7 When laying operations are not in progress, the open ends of the pipe shall be kept water tight to prevent trench water from entering.

.8 Any pipe that has floated shall be re-laid.

.3 High Density Polyethylene (HDPE) Pipe

.1 Install polyethylene pipe in strict conformance with the manufacturer's recommendations for the specific pipe being installed.

.2 Just prior to placement in the trench, check the pipe to ensure the surface is free of debris, stones, nails, loose concrete or other material that may ultimately damage the pipe. Any gouges or cuts that are deeper than 10% of the wall thickness shall result in rejection of that section of pipe. Other defects such as kinking and ovality shall not be cause for rejection providing the sections involved are satisfactorily repaired and meet the limits outlined by the pipe manufacturer.

.3 Any spillage of petroleum products on any polyethylene pipe material shall result in rejection of that section.

.4 Stainless steel bolts for fittings, to the class shown on the drawings shall be used in conjunction with insulating bolt sleeves and washers to install all fittings.

.5 The pipe shall be lifted and placed into the trench, not rolled.

.6 Make all allowances for expansion and contraction of pipe due to temperature changes, especially when tying into rigid structures and existing lines.

.7 Backfilling shall follow a minimum of 20 m behind the point where the pipe passes over the top of the trench. Backfilling equipment shall maintain a minimum of 1 m vertical separation above the pipe.

12.3.4 Tracer Wire

Install tracer wire along the entire length of all plastic pipe installations. The tracer wire shall be brought to the ground surface in an accessible location, marked, and located on as-built drawings. Number of test locations shall be as shown on plans, and spacing shall not exceed 300 m.

12.3.5 Thrust Blocks

.1 Place concrete thrust blocks at bends, tees and fittings and on undisturbed ground.

.2 Keep pipe couplings free of concrete.

.3 Bearing area of thrust blocks to be as shown on the drawings.

12.3.6 Field Testing of Forcemain

.1 Test Parameters

.1 Forcemain to be flushed before commencing testing.

.2 Carry out field testing in accordance with Clause ***27.3.4*** of Section ***27*** – Leakage Testing of Sewers.

.2 Prior to acceptance of the forcemain, a continuity check shall be conducted on the tracer wire to verify that the wire has not been broken during installation.

END OF SECTION

13 SEWERS

13.1 GENERAL

13.1.1 Scope

This section specifies requirements for supplying and installing sewers and for the abandonment of existing sewers.

13.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1: General
Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewer Services	Section ***14***	
Manholes and Catch Basins	Section ***17***	
Inspection of Sewers	Section ***23***	
Leakage Testing of Sewers	Section ***27***	
Deflection Testing of Flexible Pipe	Section ***28***	

13.1.3 Submittals

At least 15 working days prior to commencing work inform EPCOR of the proposed source of bedding material and provide access for sampling.

13.1.4 As-Built Drawings

.1 Provide as-built drawings on completion of contract. Give details of pipe material, strength and/or wall thickness designation, invert elevations at manholes and connections, location of tees, bends, clean-outs, manholes, service connections, laterals and caps. Refer to Section 2 of the Vol. 3-05 Drawing Requirements, Approvals and Asset Acceptance/Transfer.

.2 Provide as-built information on the Service Report Form for all drainage services affected by the work. Refer to Section ***14*** – Sewer Services for details.

.3 Record abandonments on the as-built drawings.

13.1.5 Quality Control

Pipe Zone Material

.1 For pipe installed by trenching methods, the Contractor shall supply a sample of pipe zone material and associated moisture density curves to ASTM D698 and sieve analysis to ASTM C136.

.2 Contractor to perform field density tests to ASTM D2167 or to ASTM D2922.

.3 The Contractor shall perform as many tests as are necessary to ensure that the work conforms to the requirements of the contract. Under no circumstances shall the frequency of testing be less than 1 density test per MH-to-MH section.

13.2 PRODUCTS

13.2.1 Concrete Pipe

.1 Markings

.1 Markings for indirect design projects shall be according to CAN/CSA A257.2.

.2 Markings for direct design projects shall conform to ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations.

.2 Product

.1 Non-reinforced circular concrete pipe and fittings: to CAN/CSA-A257.1 Class 3, designed for flexible rubber gasket joints to CAN/CSA-A257.3 made with Type HS High sulphate-resistant hydraulic cement to CSA-A3000.

.2 Reinforced circular concrete pipe and fittings: to CAN/CSA-A257.2 with flexible rubber gasket joints to CAN/CSA-A257.3, made with Type HS High sulphate-resistant hydraulic cement to CSA-A3000. Elliptical reinforcement is acceptable upon specific approval given by EPCOR prior to the manufacture of the pipe. Pipes with elliptical reinforcement must be clearly marked with the following labels:
- "Elliptical reinforcing"
- "Pipe must be installed with swift lift at the crown of the pipe"

.3 Lifting systems

.1 Pipe lifting systems shall be provided. However, the following rules shall be observed:

- Pipe 900 mm and less in diameter, no lift holes.
- Pipe greater than 900 mm diameter; designed lifting systems with cast-in anchors that are compatible with a "*Swift Lift*" system shall be provided.
- When elliptical reinforcement steel is used the cast in anchor must be orientated to ensure the elliptical reinforcing is in the proper orientation during installation and prior to backfill.

.2 Seal lift holes watertight after installation of pipe.

13.2.2 Plastic Pipe

.1 PVC (PSM Type) Pipe:

.1 Smooth wall PVC pipe products and fittings shall conform to Sections 4 and 5 of CSA Standard B182.2 for all basic material requirements and manufactured quality and dimensional tolerance.

.2 Materials used for pipe shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM Standard D1784. Materials used for moulded fittings shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM Standard D1784.

.1 Notwithstanding the requirements of Section 4 of CSA Standard B182.2, compounds with different cell classifications than that noted above shall not be used without the prior approval of EPCOR.

.2 Minimum wall thickness shall be as required for SDR 35 unless otherwise approved by EPCOR.

.3 Pipe shall be installed within two years from the production date indicated on the pipe.

.2 Open Profile Wall PVC Pipe:

.1 Closed profile and dual-wall corrugated pipe, (if specifically approved by EPCOR for a project) and open profile PVC pipe products and fittings shall conform to Sections 4 and 5 of CSA Standard B182.4 for all basic material requirements and manufactured quality and dimensional tolerance.

.2 Materials used for pipe and fittings shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM Standard D1784.

.3 Notwithstanding the requirements of Section 4 of CSA Standard B182.4, compounds with different cell classifications than that noted above shall not be used without the prior approval of EPCOR.

.4 Minimum waterway wall thickness shall conform to CSA-B182.4 Table 3 for pipe stiffness of 320 kPa.

.5 Pipe shall be installed within two years from the production date indicated on the pipe.

13.2.3 Pipe Embedment Zone Materials

.1 Materials for use as foundation, embedment, and backfill are classified in Table 1 of the Guidelines for the Design and Construction of Flexible Thermoplastic Pipe in the City of Edmonton. They include natural, manufactured, and processed aggregates and the soil types classified according to ASTM Test Method D2487.

.2 Class I, Class II, and Class III materials are suitable for use as foundation material and in the embedment zone subject to the limitations noted herein and in Table 2 of the Guidelines for the Design and Construction of Flexible Thermoplastic Pipe in the City of Edmonton.

.3 Class IV-A materials should only be used in the embedment zone in special design cases, as they would not normally be construed as a desirable embedment material for flexible pipe.

.4 Class IV-B, Class V Soils, and Frozen Materials are not recommended for embedment, and should be excluded from the final backfill except where specifically allowed by project specifications.

For ease of compactability and to facilitate proper placement of material in the haunch area of the pipe, a suggested gradation for sand within the pipe embedment zone are the following limits:

Sieve Size (mm)	Percent Passing by Mass
10	100
5	70 – 100
0.16	5 – 20
0.08	0 –12

The above material is an example of a Class II embedment material.

.5 Washed gravel: Where specifically specified for use, washed gravel shall consist of washed, crushed or screened stone or gravel consisting of hard and durable particles meeting the following gradation limits and free from sand, clay, cementitious, organic and other deleterious material:

Sieve Size (mm)	Percent Passing by Mass
25	100
5	Maximum 10
0.08	Maximum 2

Washed gravel meets the technical requirements for classification as a Class I embedment material.

13.2.4 Concrete

Concrete mixes and materials for bedding, cradles, encasement and supports to be in accordance with Section ***29*** - Concrete for Water and Drainage Structures.

13.2.5 Quality Control for Pipe, Fittings, and Appurtenances Material

.1 Concrete Pipe

.1 For indirect design projects, the manufacturer of concrete pipe shall perform quality control and quality assurance testing in accordance with CAN/CSA-A257.0, CAN/CSA-A257.1, CAN/CSA-A257.2 and CAN/CSA-A257.3.

.2 For direct design projects, the manufacturer of concrete pipe shall perform quality control and quality assurance testing in accordance with ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations. Hydrostatic joint integrity shall also be demonstrated in accordance with Section 7 of CSA A257.0.

.2 PVC (PSM Type) Pipe

The manufacturer of PVC (PSM Type) pipe shall perform quality control and quality assurance testing in accordance with CSA-B182.2.

.3 Profile Wall PVC Pipe

The manufacturer of Profile Wall PVC pipe shall perform quality control and quality assurance testing in accordance with CAN/CSA-B182.4 in conjunction with ASTM F794 with minimum waterway wall thickness as per Table 3.

13.3 EXECUTION

13.3.1 Preparation of Pipe

.1 Clean pipes and fittings of debris, dirt, mud, ice and snow before installation. Inspect materials for defects before installing. Remove defective materials from site.

.2 Inspect every pipe for damage in shipment. Reject any damaged pipe and have it removed from the site.

13.3.2 Pipe Embedment Zone Classification and Construction

.1 The pipe embedment zone is detailed on Standard Drawing ***DR-06-13-01***. The pipe embedment zone consists of the foundation (where required), bedding and haunch, and initial backfill as detailed on the standard drawing.

.2 Construction requirements within the pipe embedment zone for both concrete pipe and flexible pipes (PVC pipes) shall be based on the following modified ASCE 15 Standard Installation Types as depicted on Standard Drawing ***DR-06-13-01*** as detailed in the project specific specifications or construction drawings. Where no Type of installation is specified or noted, a Type II Installation shall be inferred. Each Standard Installation Type can be described as follows:

.1 Type 1 Installation – Embedment installation shall be compacted to a minimum of 95% Standard Proctor utilizing Class 1A or 1B material. Type 1 installation requires that the material, density and method of installation be CERTIFIED by Professional Engineer. The use of Type 1 installation requires EPCOR pre-approval on a case by case basis.

.2 Type 2 Installation – Embedment installation shall be compacted to a minimum of 90% Standard Proctor utilizing Class 1A, 1B, or II embedment materials, or 95% Standard Proctor when utilizing Class III embedment materials.

.3 Type 3 Installation – Embedment installation shall be compacted to a minimum of 85% Standard Proctor utilizing Class 1A, 1B, II, or 90% Standard Proctor when utilizing Class III embedment materials.

.4 Type 4 Installation – Embedment installation with no compaction utilizing Class 1A, 1B, II or III material, or compacted to 85% Standard Proctor utilizing Native Materials. Type 4 installations are approved only for appropriately designed concrete pipe applications.

.5 Class A Bedding (Concrete Cradle Construction) – Class A bedding is generally the construction of a pipe with a concrete cradle in the bedding and lower haunch zone. Class A bedding shall only be used where identified in the project specific specification and under no circumstances shall it be used in conjunction with flexible pipe.

13.3.3 Foundation Zone Requirements and Construction

.1 The foundation soil shall be moderately firm to hard in situ soil, stabilized soil, or compacted fill material.

.2 When unsuitable or unstable material is encountered, the foundation shall be stabilized.

.3 Where groundwater and soil characteristics may contribute to the migration of soil fines into or out of the foundation, embedment soils, sidefill, and/or backfill materials, methods to prevent migration shall be provided.

13.3.4 Verification that Proposed Construction Method is Consistent with Design Intent

.1 Project specific design requirements for the in-place density of outside bedding material, haunch material, and initial backfill shall be noted on the plans or in the project specifications or as detailed herein. As the precise measurement of these densities in the bedding and haunch zones during

construction is often not technically feasible, the Contractor shall demonstrate to the Engineer for the project that their proposed method of placement of these materials is sufficient to achieve the specified results, through a trial compaction demonstration.

.2 Should the materials proposed for use in the embedment zone change during the course of the works the Contractor shall notify the Engineer and carry out additional compaction trials, sufficient to demonstrate that their proposed method of placement is consistent with achieving the specified requirements.

.3 The trial compaction demonstration shall in no way relieve the Contractor from their contractual requirement of meeting the minimum performance criteria for completed installations as specified herein.

13.3.5 Bedding and Haunch Construction

.1 The bedding shall be constructed as per the specified installation type and in accordance with the Contractor's proposed construction method as verified in the compaction trial demonstration. Bedding shall be placed in such a manner to maximize the bedding angle achieved, to provide uniform load-bearing reaction, and to maintain the specified pipe grade.

.2 Shape bedding true to grade and to provide continuous, uniform bearing surface for barrel of pipe. Do not use blocks when bedding pipe.

.3 Lay pipe on an uncompacted layer of pipe zone material of minimum depth as shown on the drawings. Place pipe zone material under haunches of pipe, tamping and compacting material to ensure that no voids remain in the haunch zone. Compact outer bedding and haunch zones to Standard Proctor density specified for appropriate installation Type.

.4 Bell holes shall be excavated in the bedding when installing pipe with expanded bells such that the barrel and not the pipe bells support the pipe.

.5 Placement of haunching materials shall be carried out by methods that will not disturb or damage the pipe.

.6 The haunching material shall be worked in and tamped in the area between the bedding and the underside of the pipe before placement and compaction of the remainder of the material in the embedment zone.

.7 Compaction equipment and methods used in the haunch zone shall be compatible with the materials used, the location in the trench, and the in-place densities required.

.8 Where groundwater and soil characteristics may contribute to the migration of soil fines into or out of the bedding and haunch zones with the native soils, foundation materials, and/or other backfill materials; methods to prevent migration shall be provided.

.1 When native soils conditions are adverse or where indicated by project specifications, use washed gravel in lieu of sand

.2 When washed gravel used, use filter cloth to separate sand and washed gravel.

.9 Where trench bottom is rock, lay pipe on a 150 mm cushion of washed gravel or bedding sand.

.10 When concrete bedding is specified, the pipe may be positioned on concrete blocks to facilitate placing of concrete. Anchor or weight pipe to prevent flotation when concrete is placed. Do not backfill over cast-in place concrete within 24 hours after placing.

13.3.6 Initial Backfill

.1 Placement of initial backfill material shall be carried out by methods that will not disturb or damage the pipe.

.2 Compaction equipment and methods shall be compatible with the materials used, the location in the trench, and the in-place densities required.

.3 A primary purpose of initial backfill is to protect the pipe from any impact damage that may arise from the placement of overfill materials. Minimum thickness of the initial backfill layer shall be as

indicated on the standard installation drawings. In instances where final backfill material contains large objects or is required to be deposited from very high heights, initial backfill shall be extended to such additional height above the pipe as is necessary to prevent damage from occurring to the pipe during backfilling operations.

.4 Before using heavy compaction or construction equipment directly over the pipe, ensure that sufficient backfill has been placed over the pipe to prevent damaging either the pipe or the embedment zone materials.

13.3.7 Installation of Pipe

.1 Lay and join pipes in accordance with manufacturer's recommendations.

.2 Installation of PVC pipe and fittings shall conform to CSA-B182.11 and the construction requirements identified in the Guidelines for the Design and Construction of Flexible Thermoplastic Pipe in the City of Edmonton.

.3 Installation requirements for Direct Design concrete pipe shall conform to the supplemental construction requirements identified in with ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations

.4 Handle pipe with approved equipment. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.

.5 Lay pipes on prepared bedding, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.6 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.7 Do not exceed maximum joint deflection recommended by pipe manufacturer.

.8 Do not allow water to flow through pipe during construction, except as may be permitted by Engineer.

.9 Whenever work is suspended, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.10 Position and join pipes by approved methods. Do not use excavating equipment to force pipe sections together.

.11 Block pipes as required when any stoppage of work occurs to prevent creep during down time.

.12 Plug lifting holes, swift lift cups and lift pin divots with non-shrink grout.

.13 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner, as recommended by pipe manufacturer, without damaging pipe and to leave a smooth end at right angles to axis of pipe.

.14 Connect pipe to manholes in accordance with Construction Specification Section ***17*** – Manholes and Catch Basins***.***

.15 Use approved field connections for connecting pipes to existing sewer pipes. For connections of service to the main pipe refer to Section ***14*** - Sewer Services.

.16 When complete, the sewer must be thoroughly cleaned out of all dirt, stones and rubbish.

13.3.8 Pipe Jointing

.1 Install gaskets in accordance with manufacturer's recommendations.

.2 Support pipes with hand slings or crane as required to minimise lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

.3 Align pipes carefully before jointing.

.4 Maintain pipe joints free from mud, silt, gravel and other foreign material.

.5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.

.6 Complete each joint before laying next length of pipe.

.7 Minimize joint deflection after joint has been made to avoid joint damage.

.8 At rigid structures, install the first pipe joints not more than 1.2 m from the side of the structure.

.9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

.10 Poured concrete pipe joints will require EPCOR approval prior to construction. Refer to Standard Drawing ***DR-06-13-02***.

13.3.9 Trench and Final Backfill

.1 Trench and final backfill in accordance with Section 3.1 – Trench Backfill, Volume 2: Complete Streets.

.2 Do not allow contents of existing sewer or sewer connection to flow into trench.

.3 Trench line, depth and bottom of trench excavation require approval by the Engineer prior to placing bedding material and pipe.

.4 Do not use heavy vibratory equipment for compaction until at least 1 m of backfill has been placed above the elevation of the top of the pipe.

13.3.10 Tolerance of Sanitary Sewers

.1 Alignment

The centre line of 900 mm and smaller diameter pipes shall not be more than 150 mm off the designated alignment. The centre line of pipe greater than 900 mm shall not be more than 50 mm per 300 mm of diameter off the designated alignment. Where the pipeline alignment is supposed to be straight between manholes a line of sight through the pipe shall exist from manhole to manhole.

.2 Grade

The invert of the sewer main shall not deviate from the designated grade by an amount greater than the total of 6 mm plus 20 mm per metre of diameter of sewer pipe $\left(\nearrow 6\ \text{mm} + \frac{20\ \text{mm}}{1.0\ \text{m of diameter}} \times \text{m diameter}\right)$.

.3 Joints

Deflections at joints of concrete pipe shall not exceed those as permitted in the specifications for concrete pipe CAN/CSA-A257. Deflections at the joints of other pipe material shall not exceed those recommended by the manufacturer.

13.3.11 Field Leakage Testing

.1 Perform testing identified in the Contract or as specified by EPCOR.

.2 For identified testing, follow Section ***27*** - Leakage Testing of Sewers.

13.3.12 Visual Inspection and Acceptance Criteria

.1 Carry out CCTV and/or visual walk-through inspection of the completed sewer as described in the Section ***23*** - Inspection of Sewers.

.2 Perform inspection after all mains, manholes and service connections have been installed.

.3 Repair all defects which will impair the structural integrity or the performance of the sewer system including, but not limited to improper joints, cracked, sheared or excessively deflected pipe, sags and rises which pond water in excess of twice the allowable deviation from grade, protruding service connections and visible infiltration or exfiltration.

.4 Flexible Pipe Defects

.1 Where there is visual evidence of excessive or non-symmetrical deflection (e.g. a non-elliptical deformation pattern), formal deflection tests shall be conducted in accordance with Section 28 – Deflection Testing of Flexible Pipe.

.2 For DR35 PVC pipe or profile pipe with equivalent pipe stiffness, the maximum allowable deflection shall be 5% of the CSA base inside diameter (BID) for short term observations (i.e. more than 30 days and less than 1 year) and 7.5% of CSA BID for long term observations (1 year or greater).

.3 Excessive or non-symmetrical deflection shall be reviewed by the Engineer and a determination shall be made as to whether the deformation is in excess of the strain limits for the pipe. Deformation less than the allowable strain limits can be re-excavated and have the embedment zone re-built to resolve the deficiency. Deformation in excess of the strain limit of the pipe material shall have the corresponding section of pipe removed and replaced.

.4 Under circumstances where the excavation of a pipe to resolve an excessive deformation deficiency is not technically feasible due to its depth or its location relative to other utilities and the amount of deformation is determined by the Engineer to be within the strain limits of the pipe, the Contractor may make special application to the Engineer to achieve resolution of the deficiency through the use of an approved re-rounding device specially designed for use in the re-round of flexible pipes. Approval for the use of re-rounding devices will only be made in special circumstances on a case-by-case basis and will always be subject to an increased monitoring period for acceptance at the Contractor's expense. The length of the monitoring period shall be determined by EPCOR on a case-by-case basis. Only re-rounding devices that work on the principle of imparting vibration to the surrounding embedment zone as a means of stabilizing the pipe-soil structure will be considered for use.

.5 Defects in flexible pipe that involve cracks and fractures to the pipe structure shall be cut out and replaced. Minor scratches from handling or inspection activities that are less than 10% of the wall thickness of the pipe are not defective, while pronounced scratches and scratches deeper than 10% of the wall thickness shall be deemed to be defective and shall be cut out and replaced.

.5 Rigid Pipe Defects

.1 Cracks in concrete pipe shall be reviewed by the Engineer to make a determination as to whether they are in excess of the design crack width for service cracking. While project specific requirements may vary, acceptable service cracking is generally deemed to be cracks that measure 0.25 mm (0.01") in width at a distance of the lesser of 25 mm away from the inner pipe surface or at the interface with the reinforcing steel. This may result in cracks at the surface that are slightly in excess of the service crack width limit. A crack comparator or other suitable means shall be used to aid in the determination.

.2 Cracks in excess of the service crack limit shall be deemed to be defective and shall be repaired while cracks within service crack limit tolerances shall be deemed to be acceptable. In making their determination, the Engineer shall also consider the time-history of loading on the pipe. Full long term loading conditions shall not be deemed to have occurred until after 1 year after completion of backfilling. Therefore, very minor cracks can be determined to be acceptable but cracks near the limit of service crack tolerance shall be re-inspected to confirm whether they are acceptable or not after full loading is deemed to have developed on the pipe.

.3 For cracks deemed to be defective, the Engineer shall also make a determination as to whether the nature of the cracks compromises the structural integrity of the pipe. Cracks that are deemed to compromise the structural integrity of the pipe shall be taken out and replaced while non-structural cracks may be reviewed for alternate repair methods. Where alternate repair methods are proposed, the Contractor shall make a specific proposal for the Engineer and City's review and approval.

.4 Under circumstances where the excavation of a pipe to resolve a structural performance deficiency is not technically feasible due to its depth or its location relative to other utilities and the nature of the deficiency is determined by the Engineer to be feasible for repair by trenchless methods, the Contractor may make special application to the Engineer to achieve resolution of the deficiency by effecting an appropriately designed trenchless point repair. Approval for the rectification of structural deficiencies will only be made in special circumstances on a case-by-case basis and will always be subject to an increased monitoring period for acceptance at the Contractor's expense. The length of the monitoring period shall be determined by EPCOR on a case-by-case basis.

.6 Joint Defects

.1 Significant joint defects, cracked or offset joints shall be cut out and replaced in a manner acceptable to EPCOR.

.2 Joint defects such as hanging or improperly installed or improperly functioning gaskets shall be reviewed on a case-by-case basis to establish the most feasible means of repair. In all cases the joint may be cut out and replaced as a suitable means of repair. For minor joint deficiencies alternate repair methods may be considered. Where alternate repair methods are considered the Contractor shall seek the approval of the Engineer and EPCOR.

.3 Under circumstances where the excavation of a pipe to resolve a joint deficiency is not technically feasible due to its depth or its location relative to other utilities and the nature of the joint deficiency is determined by the Engineer to be feasible for repair by trenchless methods, the Contractor may make special application to the Engineer to achieve resolution of the deficiency by effecting an appropriately designed trenchless point repair and by the use of an appropriately selected grouting technology. Approval for the rectification of joint deficiencies by trenchless point repair or by the use of grouting technologies will only be made in special circumstances on a case-by-case basis and will always be subject to an increased monitoring period for acceptance at the Contractor's expense. The length of the monitoring period shall be determined by EPCOR on a case-by-case basis.

13.3.13 Abandonment of Sewers

.1 Abandon existing sewers by plugging one end with as noted herein and completely filling the sewer with cement-stabilized flowable fill and then sealing it as noted herein. Confirm all active sewer services have been disconnected from sewer being abandoned and have been reconnected to new sewer before filling the sewer.

.2 Plug each end of the sewer section identified on the drawings for abandonment, as follows:

.1 For concrete pipe 375 mm to 675 mm diameter, place sandbags or other firm backing 300 mm inside the abandoned sewer and seal with concrete. Break out section of the pipe invert in front of the sandbags to allow concrete to key into the pipe to prevent shifting.

.2 For PVC pipe 375 mm to 675 mm diameter, place sandbags or other firm backing 300 mm inside the abandoned sewer and seal using manufactured compression type plug.

.3 The method for plugging each end of sewer pipes larger than 675 mm shall be detailed on the drawings or specified elsewhere.

END OF SECTION

14 SEWER SERVICES

14.1 GENERAL

14.1.1 Scope

This section specifies requirements for construction of new storm and sanitary sewer services and for abandonment of existing services.

14.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1: General
Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewers	Section ***13***	
Inspection of Sewers	Section ***23***	
Typical Single and Dual Service for New Developments	Drawing WA-005-007	Volume 4: Water
Typical Dual Service for Duplex/Semi-Detached Lots	Drawing WA-005-008	Volume 4: Water

14.1.3 Submittals

At least 15 working days prior to commencing work inform EPCOR of the proposed source of bedding material and provide access for sampling.

14.1.4 As-Built Report

Obtain service report forms from Infill Water and Sewer Servicing, EPCOR. Complete these forms strictly in accordance with Infill Water and Sewer Servicing's instructions including the following information:

- Invert elevation and location at sewer main.
- Invert elevation and location at property line.
- Alignment of the service.
- Length and type of material used.
- Location of a plug in abandoned service connection.

14.2 PRODUCTS

14.2.1 Sewer Pipe

.1 PVC (PSM Type) Pipe:

.1 PVC pipe products and fittings shall conform to Sections 4 and 5 of CSA Standard B182.2 for all basic material requirements and manufactured quality and dimensional tolerance.

.2 Materials used for pipe shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM Standard D1784. Materials used for moulded fittings shall come from a single compound manufacturer and shall have a cell classification of 12454- B, 12454-C, or 13343-C as defined in ASTM Standard D1784.

.2 Notwithstanding the requirements of Section 4 of CSA Standard B182.2, compounds with different cell classifications than that noted above shall not be used without the prior approval of EPCOR.

.3 Standard Dimension Ratio (SDR) 35 unless otherwise approved by EPCOR.

.4 Minimum wall thickness for pipe diameter up to 375 mm shall be SDR 35.

.5 Pipe shall be installed within 2 years from the production date indicated on the pipe.

14.2.2 Sewer Connections

Connections to main line sewers shall be made with full tees, “strap-on” tee or wye saddles, or “insert-a- tee” type connectors. All clamps, straps, bands, nuts and bolts to be stainless steel in accordance with ASTM A320, ANSI Type 316.

14.2.3 Sewer Adapter

Sewer adapters for connecting to existing building service connections shall conform to ASTM D5926 Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems, ASTM C1173 Standard Specification for Flexible Transition Couplings for Underground Piping Systems, and CSA Standard B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

14.2.4 Pipe Embedment Zone Materials

Pipe embedment zone materials shall conform to Clause ***13.2.3*** of Section ***13*** – Sewers for sand and washed gravel materials.

14.2.5 Concrete

Concrete mixes and materials for bedding, cradles, encasements and supports to be in accordance with Section ***29*** - Concrete for Water and Drainage Structures.

14.2.6 Quality Control for Pipe Material

PVC (PSM) Pipe

.1 The manufacturer of PVC (PSM Type) pipe shall perform quality control and quality assurance testing in accordance with CSA-B182.2.

.2 At EPCOR’s discretion, PVC pipes shall be tested for joint leakage in accordance with CSA-B182.2.

14.3 EXECUTION

14.3.1 Preparation

Clean pipes and fittings of debris, dirt, mud, ice and snow before installation. Inspect materials for defects before installing. Remove defective materials from site.

14.3.2 Trench and Final Backfill

.1 Trenching and backfill work to Section 3.1 – Trench Backfill, Volume 2: Complete Streets.

.2 Do not allow the contents of any sewer or sewer connection to flow into the trench.

14.3.3 Pipe Embedment Zone Classification and Construction

.1 Pipe embedment classification and construction shall conform to Clause ***13.3.2*** (Pipe Embedment Zone and Construction) of Section ***13*** - Sewers.

.2 Minimum Installation type for the construction of sewer services shall be a Type 2 Installation.

.3 Foundation Zone requirements, Bedding and Haunch construction and Initial Backfill shall conform to Clauses ***13.3.3***, ***13.3.5***, and ***13.3.6*** of Section ***13*** - Sewers, respectively.

14.3.4 Installation

Install service lines as shown on the drawings, in accordance with the standard drawings as follows:

.1 If sanitary and stormwater services are laid in common trench, there will be a minimum clearance of 150 mm between the outside walls of the lines.

.2 Install services at right angle to main, unless otherwise shown on the drawings.

.3 Bench trench when one service pipe is lower than the other pipe. If benching is not possible, support higher service pipe(s) with compacted granular backfill or washed gravel to prevent settlement or dislocation.

.4 Where bends are required, the maximum angle of bend allowed shall be the long radius type or a combination of 22.5° bends and straight pipe.

.5 The grade of a sanitary service pipe shall be minimum of 2.0% from the property line to the main sewer line. For storm services the minimum grade shall be 1.0%.

.6 Where services are required to connect to mains more than 4.25 m deep, risers shall be installed at the time of construction of the sewer mains and in accordance with the standard drawings. Risers shall be firmly supported and anchored to the trench wall in a manner that will minimize the possibility of damage to the riser by the backfilling operations. Supports and anchors shall be to the satisfaction of the Engineer.

.7 The depth of a sanitary service pipe at the property line shall be 2.75 m from invert elevation to finished curb top grade. The depth of a storm service pipe at the property line shall be 2.0 m from invert elevation to finished curb top grade. No variation shall be permitted without the written approval of the Engineer.

.8 Connect to building service line if existing. If there is no existing service, temporary PVC caps, with rubber gaskets, shall be placed on end of service connection pipes.

.9 Provide 150 mm to 100 mm diameter reducer for sanitary service to a single residential and duplex residential lot. The reducer is to be located at the property line or at the edge of the gas easement.

.10 The bell ends of the service pipes on the City side nearest to the property line and the caps or plugs shall be painted red for sanitary services and green for stormwater services.

.11 Mark the sanitary service location by placing a 50 mm by 100 mm red painted stake, 750 mm long, extending 450 mm above ground, immediately adjacent to the curb stop.

.12 When sewer services are not installed in a common trench with water service, place a marker at the centerline of the trench at the property line. The marker for the storm service shall be a 50 mm by 100 mm green painted stake, 750 mm long, extending 450 mm above ground.

.13 Do not backfill trenches until the Engineer has approved the installation.

14.3.5 Connection to Sewer Line

.1 Connections to the main sewer line shall be made using integral fittings that incorporate an in-line service tee, or other acceptable method of connection to the main line. For new construction of PVC mains and services, it is expected that service connection locations shall be known and located, and that in line tees shall be used. Only in cases where services are added to a sewer main shall cutting or tapping be considered, as outlined below.

.2 Machine tap or core hole in sewer main within 45° of the pipe crown. Remove cuttings from sewer.

.3 Connect service lines to main using approved saddle or tee. Do not project spigot into main. Make joint watertight.

.4 Adequately support the main, saddle and service, as shown on the standard drawings.

14.3.6 Abandonment of Services

.1 All services shall be abandoned at the property line unless EPCOR has approved another location.

.2 Plug the service pipe by placing sandbags or other firm backing 300 mm inside the abandoned sewer and seal the pipe using a manufactured compression type plug.

.3 Document the location of the plug on the service report form.

END OF SECTION

15 FACTORY APPLIED PIPE INSULATION

15.1 GENERAL

15.1.1 Scope

This section specifies the requirements for the application of insulation to pipes and piping systems to be used in the construction of drainage projects. Insulation specified under this section shall be applied at the factory, before delivery to site, except for Clause ***15.2.9,*** which covers the repair of damage that has occurred during delivery or installation.

15.1.2 Related Sections

Sewage Forcemains	Section ***12***
Sewers	Section ***13***
Sewer Services	Section ***14***

15.2 PRODUCTS

15.2.1 Factory Applied Insulation

.1 Pipes to be cleaned of surface dust or dirt and treated to assure positive bond of foam to entire pipe surface.

.2 Insulation thickness to be 50 mm minimum or as shown on drawings.

.3 Material to be rigid polyurethane foam factory applied.

- Density to ASTM D1622, 35 to 46 kg/m³ (*2.2 to 3.0 lbs/ft³*).
- Closed cell content: to ASTM D2856, 90% minimum.
- Water absorption to ASTM D2842, 4% by volume.
- Compressive strength to ASTM D1621, up to 206 kPa (*30 lbs/in²*)
- Thermal conductivity to ASTM C518, 0.020 to 0.026 W/m°C (*0.14 to 0.17 Btu•in/ft²•Hr•°F*)
- Service temperature to be from -45°C to +120°C
- Centering +6.35 mm to -0.0 mm *(+250/ - 0.0 mils*)

15.2.2 Protection at Ends

Protect insulation on both ends of pipe from moisture and sunlight by 0.25 mm thick (10 mils) continuous concentration of black asphalt mastic compound. Leave all mill and heat numbers accessible for audit.

15.2.3 Outer Jacket for Buried Applications

Jacket Material; polyethylene UV inhibited.

- Minimum density, 940 kg/m³ (*58 lbs/ft³*).
- Sealant to be Butyl Rubber.
- Jacket thickness 1.27 mm (*50 mils*).
- Maximum elongation to ASTM D638, 400% 6 month test.
- Service temperature range -34°C to +82°C.
- Water vapour transmission rate to ASTM D570, 3 gm/m²/24 hrs (*002g/100in²/24 hours*).
- Tensile strength to ASTM G14, 9.8 kg/cm (*55 lbs/in*).
- Impact resistance 1.36 N*m (12 *in*lbs*).

15.2.4 Outer Jacket for above Ground Applications

.1 Shall be one of the following:

.1 Factory applied galvanized lock seam, spiral steel outer jacket; U.I.P. Spiwrap®, 18 - 26 ga., or equivalent

.2 U.I.P. Spiwrap®, Locked seam aluminum O-Pipe jacket 18 ga., or equivalent.

.3 Corrugated steel pipe (CSP) jacket 1.6 mm or 2.0 mm (63 mils or 79 mils).

.2 "U.I.P." casing system shall consist of black HDPE 3.17 - 6.35 mm *(125 – 250 mil)* wall casing pipe, UV inhibited factory applied.

15.2.5 Insulated Pipe Joints for Buried Applications for Bonded, Butt Fused or Welded Joints

.1 Material to be pre-formed rigid polyurethane half shells with heat shrink sleeves to provide moisture- proof seal.

.2 Heat shrink sleeves:

.1 Adhesive coated cross-linked polyethylene sleeve.

.2 To cover entire exposed joint length plus overlap of 75 mm minimum on pipe coating on both sides.

.3 In the case of HDPE casing a double sealed heat shrinkable casing joint is required.

15.2.6 Insulated Pipe Joints for Buried Bell and Spigot Systems

"U.I.P." PVC joints (Bell and spigot joints) insulated pipe joints or approved equal shall be completed using a 150 mm wide heat shrink sleeve or Butyl Mastic Tape to seal the joint as the jacket will go over the bell end and be flush with the cutback end.

15.2.7 Insulated Pipe Joints for above Ground Applications

Insulated pipe joints shall be complete with the use of prefabricated urethane foam half shells, the joints be complete with the application of one of the following:

.1 Cut and rolled galvanized metal, c/w stainless steel bands, and band-it clips. 18 – 26 ga.

.2 Cut and rolled aluminium, c/wstainless steel bands and band-it clips, 18 ga.

.3 "U.I.P." Casing slip joints, or equivalent, Application of 3.17 - 6.35 mm (*125 – 250 mils*) wall split casing, c/w stainless steel bands and band-it clips.

15.2.8 Insulation Kits for Buried Fittings

.1 Material: rigid polyisocyanurate or urethane foam with polymer protective coating on all exterior surfaces including ends. Kits to be supplied complete with silicone caulking for seams, stainless steel attachment straps and clips, and heat shrink sleeves to seal between pipe and insulation cover.

.2 Rigid Polyisocyanurate or Urethane Foam Insulation

- Density to ASTM D1622, 27 to 32 kg/m^3 (*1.7 to 2.0 lbs/ft^3*).
- Compressive strength to ASTM D1621, 131 to 158 kPa (*19 to 23 lbs/in^2*)
- Closed cell content 90%, minimum.
- Water absorption to ASTM D2842, 4.0% by volume.
- K Factor to ASTM C518, 0.027 W/m˚C, (*0.19 Btu•in/ft^2•hr•°F*).
- Thickness to match pipe insulation thickness.

.3 Polymer coating

- Two component high density polyurethane coating, black in color.
- Density 1170 kg/m^3, (*73 lbs/ft^3*).
- Durometer D scale 60
- Tensile strength 11,100 kPa (*1610 lbs/in^2*).
- Tear strength 26.5 N/mm minimum. (*151 lbs/in*).
- Thickness 1.9 mm (*75 mils*) outside surfaces, 0.51 mm (*20 mils*) inside surfaces.

15.2.9 Insulation Foamed in Place

Where it is necessary to apply foamed in place insulation to repair field damaged pre-insulated material, or to insulate components not factory pre-insulated, use the following specification for field sprayed urethane kits.

Material: two component polyurethane Class I foam, supplied in portable, disposable, pressurized container.

- Density to ASTM D1622, 35 to 39 kg/m³ (*approx. 2.18 to 2.43 lbs/ft*).
- Closed cell content: to ASTM D2856, 90% minimum.
- Thermal conductivity: to ASTM C518, 0.020 to 0.028 W/m0 (*0.14 to 0.20 Btu•in/ft²•hr•°F*)
- Compressive strength to ASTM D1621, 103 to 172 kPa at 10% defection minimum (*15 to 25 lbs/in²*).
- Water absorption to ASTM D2842, 4.0% maximum by volume.

15.2.10 Insulation Accessories

.1 Heat-shrink tape for sealing insulation half shells against moisture adaptable to flexible installations.

.2 Asphalt mastic vapor barrier coating to waterproof exterior surfaces of half shells or sprayed in place foam.

15.2.11 Electric Heat Tracing

.1 Active electric heat tracing to prevent the liquid in the pipe from freezing requires a heat tracing conduit, electric tracing cable, power connection kits, terminal end seal kits and specified thermostatic controllers.

.2 Heat tracing conduits.

.1 To consist of extruded plastic moulding and to be applied to pipe to application of insulation.

.2 To be securely fastened to pipe and sealed to prevent ingress of foam during insulation.

.3 Each conduit to be checked after insulating to ensure they are not plugged.

.4 Ends to be sealed prior to shipping to prevent foreign material from entering conduit while in transit or during installation.

.3 Electric tracing cable.

.1 Resistive parallel circuit type: to CSA-C22.2 No. 130.2, constant watt Thermocable.

.2 Fluoropolymer polyolefin inner and outer insulation jackets and suitable for cutting to length in field.

.3 If pipe being traced is plastic, heat trace cable to have metallic grounding overbraid and secondary Fluoropolymer extruded overjacket.

.4 Manufacturer to ensure that specified electric tracing cable and heat tracing conduit size are compatible, so that cable may be pulled in with relative ease.

.4 Thermostatic controller

.1 Low temperature sensor control to be factory preset at 0.5°C.

.2 High temperature sensor control to be attached to active zone of heat tracing cable and to serve as high temperature cut-out, factory preset at 29°C, for plastic pipe only.

.5 Accessories

Thermocable accessories such as termination kits, splice kits and power feed kits shall be compatible with the cable being connected and be CSA approved.

.6 Electric Tracing System

The electric tracing system and associated controls shall be as per the manufacturer's recommendations with particular attention being paid to the watt densities applied through conduits on plastic pipes. All tracing cables and related accessories to be CSA approved and comply with CSA heat-tracing standard CSA-C22.2 No. 130.2. Standard of acceptance is Urecon's Thermocable or approved equal.

15.3 EXECUTION

Not Applicable

END OF SECTION

16 SUBDRAINS

16.1 GENERAL

16.1.1 Scope

Supply and installation of subdrain pipe and filter materials.

16.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Aggregates	Section 2.1	Volume 2: Complete Streets

16.2 PRODUCTS

16.2.1 Pipe

Pipe shall be perforated, asphalt coated, corrugated steel pipe conforming to CSA-G401; or other pipe as indicated on the drawings or as directed by the Engineer. Submit manufacturer's product data to the Engineer, 7 days prior to use.

16.2.2 Filter Aggregate

Filter aggregate shall conform to Section 2.1 - Aggregates, Volume 2: Complete Streets, Designation 6, Class 20.

16.2.3 Geotextile Fabric

.1 To be nonwoven plastic, non-biodegradable type, designed for separation of fill materials while permitting movement of ground water.

.2 Submit manufacturer's product data to the Engineer for approval, 7 days prior to use.

16.3 EXECUTION

16.3.1 Trenching

.1 Excavate trench according to Section 3.1 – Trench Backfill, Volume 2: Complete Streets.

.2 Trim and compact trench bottom to provide firm uniform support throughout length of pipe.

.3 Allow 100 mm clearance on both sides of pipe for filter aggregate.

16.3.2 Installation

.1 Install pipe materials according to manufacturer's recommended practice.

.2 Place at trench bottom the geotextile fabric of sufficient width to completely wrap around filter aggregate and pipe with minimum 300 mm overlap. Lay pipe on fabric with perforations 2/3 down.

.3 Alternatively, a sock of approved geotextile fabric may be slipped over the pipe.

.4 Place filter aggregate around pipe to a minimum depth of 150 mm above top of pipe. Level aggregate surface and overlap the fabric.

.5 Install connections to catch basin, manhole, or sewer pipe as required. Seal joints with approved sealant.

16.3.3 Tolerance

Invert grade to be ±12 mm maximum variation from designated invert grade elevations, provided positive flow is maintained.

16.3.4 Backfill

.1 Do not cover work until it has passed inspection by Engineer. Correct deficiencies as directed.

.2 Backfill according to Section 3.1 – Trench Backfill, Volume 2: Complete Streets.

END OF SECTION

17 MANHOLES AND CATCH BASINS

17.1 GENERAL

17.1.1 Scope

This section specifies requirements for constructing new manholes and catch basins, adjusting existing manholes and abandonments of manholes and catch basins.

17.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1: General
Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewers	Section ***13***	
Drainage Manhole Frames and Covers	Section ***18***	
Inspection of Sewers	Section ***23***	
Leakage Testing of Sewers	Section ***27***	
Concrete for Water and Drainage Structures	Section ***29***	

17.1.3 Product Quality Assurance and Quality Control

.1 Pre-Cast Concrete

.1 The manufacturer of pre-cast concrete items shall perform quality testing and control in accordance with CAN/CSA-A257.0.

.2 EPCOR representative may review the manufacturer's quality control during production of pre-cast units for EPCOR projects.

.2 Frames and Covers

Refer to Section ***18*** – Drainage Manhole Frames and Covers for Specifications for manholes frames, covers, grates and associates cast metal products for usage in the drainage system.

17.2 PRODUCTS

17.2.1 Concrete

Cast-in-place concrete: to Sections ***29***- Concrete for Water and Drainage Structures.

17.2.2 Pre-Cast Manhole and Catch Basin Sections

.1 Pre-cast manhole sections, catch basins, adjusting neck rings and manhole steps shall conform to CAN/CSA-A257.4 and be manufactured using Type HS High sulphate-resistant hydraulic cement. All manhole sections shall have flexible watertight joints using flexible joint sealants. All preformed flexible joint sealants shall meet ASTM C990, Section 6.2.1, Butyl rubber sealants and contain 50% min Butyl rubber (hydrocarbon blends), % by weight.

.2 Manhole joints shall meet requirements of CAN/CSA-A257.3.

.3 All pre-cast units shall be marked with manufacturer's identification, date of casting, type of cement and CSA Standard.

.4 All pipe-to-structure connections shall meet the physical property and performance requirements of ASTM C923. In addition, all mechanical devices, including castings, bolt assemblies and take up clamps shall be constructed of 300 series stainless and use no plastic or plastic parts.

17.2.3 Safety Steps

Safety steps shall be of the shape and size as shown on standard drawings and material shall be either of the following:

.1 A 25 mm diameter mild steel and deformed bar conforming to ASTM A615, hot bent at temperature of at least 870°C and galvanized in accordance with ASTM A123/A123M.

.2 Minimum 20 mm diameter aluminium forged from 6061-T6, 6351-T6 or equal alloy having minimum tensile strength of 260 MPa.

17.2.4 Frames, Gratings, Covers

Refer to Section ***18*** - Drainage Manhole Frames and Covers

17.2.5 Other Material

.1 Mortar: to requirements of CSA-A179, type S using Type HS High sulphate-resistant hydraulic cement.

.2 Washed gravel: Washed, crushed or screened stone or gravel consisting of hard and durable particles meeting the following gradation limits and free from sand, clay, cementitious, organic and other deleterious material:

Sieve Size (mm)	Percent Passing by Mass
25	100
5	maximum 10
0.08	maximum 2

.3 Granular material: Sand, free of organic matter and graded within the following limits:

Sieve Size (mm)	Percent Passing by Mass
10	100
5	70 – 100
0.16	5 – 20
0.08	0 -12

17.3 EXECUTION

17.3.1 Excavation and Backfill

.1 Excavate and backfill in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

.2 Install manholes and catch basins in accordance with the design.

17.3.2 Concrete Work

.1 Do cast-in place concrete work in accordance with Section ***29*** - Concrete for Water and Drainage Structures.

.2 Place concrete reinforcement in accordance with Section 7.12 - Reinforcing Steel, Volume 2: Complete Streets.

17.3.3 Installation

.1 Construct units plumb and true to alignments and grade.

.2 Complete units as pipe laying progresses.

.3 Pump excavation free of standing water and remove soft, frozen, and foreign material.

.4 Check all pre-cast units for required stamps. Any pre-cast unit without stamp is to be rejected.

.5 Inspect all pre-cast units for damage in shipment. Reject all damaged units and advise the supplier.

.6 Manholes shall be installed without field cutting.

.7 Standard manholes

.1 Standard manholes shall be constructed as shown on the construction drawings and in accordance with the standard drawings. As noted in the Design Standards, access manholes deeper than 40 feet on sewers 1200 mm diameter and larger shall have manhole frames and covers with a minimum of 900 mm in diameter installed.

.2 Set pre-cast, pre-benched base on minimum 100 mm to maximum 300 mm depth of washed gravel material with a minimum of 150 mm offset around the pre-cast, pre-benched base. The washed gravel shall extend under incoming connection pipes to the extent of over-excavation that occurs around manholes.

.3 As an exception, and subject to EPCOR's approval, cast -in place manhole base can be used. Place concrete directly on undisturbed ground and embed the first manhole section in the concrete. A layer of reinforcement shall be placed above the midpoint and shall have a minimum cross sectional area of 250 mm² per linear metre of concrete, in both directions. Form the channel and benching by casting the sloping manhole floor around the pipe to the spring line, cutting and trimming the pipe evenly with the concrete surface after the concrete has set sufficiently. Place additional concrete to form the upper channel sides and benching as shown on the standard drawings. Steel trowel finish required for benching. "Perched" manholes are not permitted on new construction.

.4 Install T-riser pre-cast base with Class A bedding to the elevation of spring line. Connections to T-riser manholes must be within the barrel of the manhole, above the joint with the pipe.

.5 Assemble manhole out of pre-cast sections. Make each joint watertight by using gaskets.

.6 Manholes are to be oriented to allow for safe and easy egress and frame and cover must be aligned in the center of the travelled lane to the extent possible for arterial road and freeway/express way. The safety steps shall be installed in all pre - cast manhole sections, including the neck and in the cast -in place section to form a continuous ladder, with rungs equally spaced at a maximum of 410 mm, from within 300 mm below the cover, to within 600 mm of the base or benching. The steps shall be cast firmly in place or secured with a suitable mechanical anchorage to prevent pullout and maintain water tightness. The steps must be aligned vertically and cannot be installed in manhole barrel joints. The steps cannot be impeded by catch basin leads or service connections.

.7 The neck section shall be within the height limits shown on the standard drawings. A manhole step is required in the appropriate joints within the neck section. As noted in the Design Standards, for access manholes greater than 40 feet deep on sewers of 1200 mm diameter and larger, the top-most rung shall be no closer than 750 mm from the manhole frame. The joint with a manhole rung shall be mortared. All other joints between pre-cast rings within the neck section shall have a removable gasket installed. Grout and/or bricks, concrete block, steel, wood, or any type of wedge shall not be used for height adjustment.

.8 The manholes shall be fitted with frame and cover specified on the drawings.

.9 The Contractor shall follow the manufacturer's instructions for installation of the floating frame and covers (Type 80), ensuring that the frame is supported by the paving material and not by the manhole.

.8 Catch Basins

.1 Catch basins shall be constructed as shown on the drawings and in accordance with the standard drawings.

.2 Set the pre-cast catch basin on 100 mm of compacted granular course.

.3 All joints between pre-cast components shall be sealed with the product in the Drainage Approved Product List (or Database).

.4 The neck section shall be within the height limits show on the Standards Drawings.

.5 The catch basins shall be fitted with frame and cover specified on the drawings.

.9 Connecting pipe to manholes and catch basins

.1 SDR PVC and Open-profile PVC pipes shall be connected to the new or existing pre-cast, pre-benched manhole/catch basin or manhole/catch basin wall through a cored or formed opening,

and a resilient connector installed into the manhole/catch basin wall in a manner that meets the performance requirements of ASTM C923.

A concrete pipe shall be installed through a cored or rough cut opening. The pipe shall be centered within the opening before grout is applied. To ensure grout not displaced after placement and during backfill, a short concrete collar shall be poured around the outside of the grouted joint. The maximum size of all rough cut openings shall not extend more than 50 mm greater than the OD. of the pipe. No gasket is required on the exterior of rigid pipe to MH's at connections, but as an option, a cored hole with an approved gasket which meets ASTM C923 may be used. Connections to T-riser manholes shall be within the manhole barrel. Not more than two service connections are permitted to a standard sanitary manhole. Pipe connections must be a minimum of 150 mm from a manhole barrel joint to protect the gasket and structural integrity of the barrel. No new service connections can be connected to existing drill drop manholes (DDMHs).

.2 Plug lifting holes with low-shrink grout set in cement mortar. Insure all mortar is set prior to backfilling.

.10 Place and compact backfill in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

17.3.4 Installing Units in Existing Systems

.1 Where a new manhole is to be installed in an existing run of pipe, ensure full support of existing pipe during installation and install new unit as specified and in accordance with standard drawings. Carefully saw cut and break out the portion of the existing pipe within the new manhole and remove all pieces.

.2 Make joints watertight between new unit and existing pipe.

.3 Where deemed expedient to maintain service through existing pipes and when systems constructed under this project are ready to be put in operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.

17.3.5 Adjusting Tops of Existing Manholes

.1 Remove existing grating, frames, covers, without breaking, and store for re-use at locations designated by Engineer.

.2 Raise or lower by adjusting the number of concrete neck rings. Refer to the standard drawings for neck section height limits.

.3 Where raising or lowering with neck rings exceeds the neck height limits, rebuild the top section of the manhole by adding or removing pre-cast sections as required, in accordance with the Standard Drawings.

.4 Install additional safety steps in adjusted portion of units as required.

17.3.6 Abandoning of Existing Units

.1 Abandonment of manholes

.1 Plug all pipes leading to the manhole as per Clause ***13.3.13*** of Section ***13***- Sewers.

.2 Remove and dispose of manhole portion to elevation of 1.0 m below finished grade and fill with low slump cast-in-place concrete, fillcrete as directed by the Engineer.

.2 Abandonment of catch basins

.1 Completely remove all catch basins of diameter smaller than 900 mm diameter, plug the catch basin leads and backfill the area.

.2 For 900 mm diameter units, follow the abandonment of manholes method.

END OF SECTION

18 DRAINAGE MANHOLES FRAMES AND COVERS

18.1 GENERAL

18.1.1 Scope

This section specifies requirements for the manufacture and installation of gray iron and ductile iron castings. Castings are intended for use as frames, covers, and grates for Drainage manholes, catch basins and associated structures.

18.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1	General
Sewers	Section ***13***		
Manholes and Catch Basins	Section ***17***		
Inspection of Sewers	Section ***23***		

18.1.3 Referenced Documents

ASTM A48/A48M - Standard Specification for Gray Iron Castings.

ASTM A536 - Standard Specifications for Ductile Iron Castings.

AASHTO Designation M306 – 10 - Standard Specification for Drainage Sewer Utility and Related Castings.

Where the requirements of this Specification vary from the requirements of the referenced standards, the requirements of this Specification shall govern.

18.1.4 General Requirements

.1 Product supplied shall be in new and serviceable condition.

.2 Gray Iron Castings shall conform to ASTM A48/A48M; latest edition and revision. Class is shown on individual Drawings.

.3 Ductile Iron Castings shall conform to ASTM A536, latest edition and revision. Class is shown on individual Drawings.

.4 Requirements for Manufacturing, Testing, Inspection, Certification, Marking and Records shall conform to AASHTO M306-10, (or latest edition and revision in effect), with the following exceptions or additions to the AASHTO numbered Sections below:

.1 Section 2.3 – Referenced Documents - Federal Specifications, is deleted

.2 Section 5 – Manufacture – Section 5.2 - Permissible Variations, shall be superseded by requirements noted as Manufacturing Tolerances elsewhere. Tolerances noted on the drawings shall govern. If not on drawings, then Section 1.7 of this specification shall govern, and only if otherwise not noted elsewhere, AASHTO M306 Section 5.2 shall lastly apply.

.3 Section 6 – Proof-Load Testing - Section 6.1 - First article inspection and proof-load testing is defined as a single representative test of a design being required in any of the following cases:

a) any product that EPCOR specifies that is subject to loads,

b) any revision to an original design including any those where material changes are proposed,

c) any new manufacturer who has not supplied to EPCOR previously, and

d) any manufacturer who has had their products rejected due to failures and wish to re- enter the supply market.

.4 Section 6 – Proof- Load Testing – Section 6.1 - Proof-load third party testing may also occur in Canada with certified and calibrated equipment.

.5 Section 6 – Proof-Load Testing – EPCOR will require the load test referred to in AASHTO M306 as "HS- 20" loading (178 kN) as its test load.

.6 Section 8 - Inspection – Section 8.1 – where AASHTO M306 refers to differing basis of acceptance based on whether or not the foundry is located in the United States of America, EPCOR shall include "or Canada" after "….America" in this section.

.7 Section 8 - Inspection – as an alternative to Section 8.1.3 – Acceptance on the Basis of Cast-on Test Bars, the manufacturer may gain acceptance on the basis of the following:

.8 The manufacturer shall pour separately cast test bars as outlined in Section 8.1.2 and in accordance with ASTM standards for initial samples. The pouring of these samples and corresponding test bars shall be witnessed by a professional engineer licensed to practice in Canada or the United States, and certified by the engineer's stamp that the same iron was used in the samples and test bars. Three separately cast ASTM test bars with the same serial number will be poured with each heat of the samples. One sample will be tested by the manufacturing foundry, one will be provided to EPCOR, and the third will be tested by the supplier using third party, certified Canadian or American metallurgical labs. Reports of the manufacturer's and supplier's test results shall be supplied to EPCOR, as well as in a Material Test Certificate in a form that is acceptable to EPCOR. In addition to this, the manufacturer shall supply a casting of load bearing units for destructive testing. These test casting units will have proof-load test results provided, test bars with matching serial numbers provided, and the complete metallurgical records provided as well. Correlations between material properties, test results, and load capacity for specific designs shall be derived from this.

.9 Section 9 - Certification – The second sentence, "The certification shall state… …or local unit of government." shall be deleted.

.10 Section 10 - Markings - Section 10.1.1 – The AASHTO standard shall be superseded by Clause ***18.1.9*** of this standard. "Made in …" is not required.

.11 Section 10 – Markings – Section 10.1.6 shall be deleted.

.5 Use of alternate classes or grades requires express written approval of EPCOR.

18.1.5 Submissions

.1 Shop Drawings - The supplier shall provide detailed dimensional shop drawings for review for all products. The drawings shall be stamped by a professional engineer licensed to practice in Canada or the United States of America and show compliance to the standards.

.2 Proof-Load Test Results - The supplier shall provide certified third party testing results for products that are subject to loads, to show compliance with AASHTO M306.

.3 Markings - The supplier shall provide information and examples of the system used to identify the products, and the tracing system as per Clause ***18.1.9*** of this standard.

18.1.6 Drawings

.1 EPCOR Drainage Standards Drawings form an integral part of this Specification. The Drawings are shown elsewhere on EPCOR's Standards.

.2 Drawings referenced represent dimensional information for products that have historically been produced for EPCOR. It is the intent that new products be dimensionally and functionally interchangeable with these existing products. Manufacturers may propose alternate materials, including grades of metal, structural variations or functional enhancements for review and approval.

.3 For items not identified on the Standards Drawings, the Supplier shall provide Shop Drawings in both pdf and CAD format for review and approval by EPCOR prior to production of item.

18.1.7 Dimensions and Tolerances

.1 Product supplied shall conform to dimensions and tolerances as shown on Drawings.

.2 Except as otherwise noted on Drawings, tolerances shall be:

Casting Pattern Dimension	Allowable Tolerance
Mating Parts: Less than 50 mm	±0.8 mm
Mating Parts: 300 mm to 50 mm	±1.5 mm
Mating Parts: Greater than 300 mm	±3.0 mm
Other Dimensions to 900 mm	±3.0 mm

18.1.8 Workmanship and Finish

.1 Castings shall be free of defects, cracks, porosity, flaws and excessive shrinkage.

.2 Castings shall be true to pattern.

.3 Castings shall be sandblasted or cleaned and ground to eliminate surface imperfections.

.4 Coated or painted castings will not be accepted.

.5 Manhole cover castings shall not perceptibly rock when mated with corresponding frame. Surfaces shall be machined or ground as noted on Drawings.

18.1.9 Markings

.1 Castings shall be marked with identification markings which include:

.1 Series designation (City of Edmonton standard).

.2 Foundry identification marking including month and year of production, as well as the Standard and class of material (ASTM for example), as well as an identifier such as a heat code and/or serial number that traces the product to test bar data and metallurgical composition records.

.2 Markings shall be located in such a manner that they are easily identifiable. The markings shall be located on a “non-wear” location of the product.

18.1.10 Quality Control and Quality Assurance

.1 The Manufacturer shall co-operate with EPCOR and facilitate inspection and testing activities.

.2 Plant Inspection

Prior to the acceptance of a Manufacturer’s product, EPCOR will conduct a plant inspection to examine manufacturing facilities and quality control procedures. Manufacturer shall provide the following data, as requested:

- Flow chart showing inspection and quality control functions
- Applicable standard Specifications
- Applicable production casting tolerances
- Foundry material analysis quality control reports for verification of chemical composition and material strength properties.

.3 Manufacturer shall provide a minimum of six (6) cast test bars prepared in accordance with ASTM A48/A48M or ASTM A536, as applicable. Test bars shall be provided on a minimum frequency of once per year. EPCOR may request additional test bars, at its sole discretion.

.4 Supplier shall arrange for the initial plant inspection by contacting EPCOR. Plant inspection shall be conducted at a time and date mutually acceptable to the Manufacturer and EPCOR.

.5 EPCOR may request the use of an approved third party for the purposes of conducting facility inspection. EPCOR shall have the sole right of approving the third party.

.6 Initial plant inspections shall be performed at each plant facility manufacturing product governed by this Specification. Product manufactured in a plant not inspected and approved by EPCOR will not be accepted.

.7 Initial plant inspection shall be valid for a period not to exceed three (3) years.

.8 Costs for the initial plant inspections shall be borne by the Supplier. Costs incurred for subsequent plant re-inspections due to significant non-conformances found during the initial inspection shall be borne by the Supplier.

.9 Additional plant inspections and testing may be conducted by EPCOR, at its sole discretion. Costs for additional discretionary inspections will be borne by EPCOR.

18.1.11 Product Quality Control

.1 Manufacturer shall perform quality control and testing for all product supplied. Testing shall be done in accordance with this Specification and referenced documents.

.2 Manufacturer shall retain quality control and testing documentation. Manufacturer shall make documentation available to EPCOR upon request.

.3 Castings shall be inspected by EPCOR at Supplier's premises in the greater Edmonton area. In the event the supplier does not have facilities in the greater Edmonton area, the supplier may request the inspection to occur at EPCOR's delivery location (delivery yard).

.4 Inspection shall be done in the presence of the Supplier's representative. The Supplier shall be responsible for all inspection related costs including cost of labour and equipment required for the lifting and handling of the castings during the inspection.

.5 EPCOR's inspector shall stamp each casting that conforms to Specifications. Castings delivered without an EPCOR's inspection stamp will not be accepted and shall be promptly removed at no cost to EPCOR.

.6 EPCOR inspection shall consist of:

.1 Visual inspection.

.2 Measurement of dimensions for conformance to Drawings.

.3 Trial fitting of frames and covers to "Standard" or "Proof" castings having machined bearing edges.

.7 "Proof" castings referenced in Specification Clause 18.1.11.6.3 shall be manufactured by the Manufacturer. Costs incurred shall be borne by the Manufacturer.

.8 "Proof" castings referenced in Specification Clause 18.1.11.6.3 shall be stored at the Manufacturer's premises.

.9 Costs incurred by EPCOR for additional testing due to rejected product will be borne by the Supplier.

.10 Quality assurance testing performed by EPCOR shall not relieve the Manufacturer of responsibility for producing material in accordance with Specification requirements.

.11 Repeated failure to comply with the requirements of this Specification may result in removal of the Manufacturer's name from the approved supplier list.

18.2 PRODUCTS

18.2.1 Frames, Gratings, Covers

Frames, gratings, and covers as shown on the standard drawings shall be guaranteed not to rock when installed in corresponding mating frame.

18.3 INSTALLATION

.1 Construct units plumb and true to alignments and grade.

.2 Check all units for required stamps. Any pre-cast unit without stamp is to be rejected.

.3 Inspect all units for damage in shipment. Reject all damaged units and advise the supplier.

.4 Standard manholes

.1 As required, install concrete neck rings for a final elevation adjustment of the manhole frame and cover.

.2 The manholes shall be fitted with frame and cover specified on the drawings.

.3 The Contractor shall follow the manufacturer's instructions for installation of the floating frame and covers (Type 80), ensuring that the frame is supported by the paving material and not by the manhole.

18.3.1 Catch Basins

.1 Catch basins shall be constructed as shown on the drawings and in accordance with the standard drawings.

.2 The catch basins shall be fitted with frame and cover specified on the drawings.

18.3.2 Adjusting Tops of Existing Manholes

Remove existing grating, frames, covers, without breaking, and store for re-use at locations designated by Engineer.

END OF SECTION

19 CORRUGATED STEEL PIPE CULVERT

19.1 GENERAL

19.1.1 Scope

Supply and installation of corrugated steel pipe culvert. Removal of existing culvert.

19.1.2 Related Sections

Trench Backfill.	Section 3.1	Volume 2: Complete Streets
Aggregates	Section 2.1	Volume 2: Complete Streets

19.2 PRODUCTS

.1 Corrugated Steel Pipe: To CSA-G401, plain galvanized; with helical lock seam corrugations having a profile of 68 mm by 13 mm; round, diameters 300 mm to 2000 mm; 1.6 mm thick or as shown on drawings with ends cut square or bevelled as indicated. Include all necessary couplers and fasteners. Submit manufacturer's product data to the Engineer, 7 days prior to use.

.2 Granular Bedding: To Section 2.1 - Aggregates, Volume 2: Complete Streets Designation 5, Class 80.

.3 Granular Backfill: To Section 2.1 - Aggregates, Volume 2: Complete Streets Designation 7, Class 80.

.4 Riprap

Rock: hard, durable stones that will not deteriorate with water or freeze and thaw cycles, with a minimum nominal size of 150 mm and a maximum nominal size of 400 mm.

.5 Trash Rack: Made of steel as detailed on the drawings.

.6 Geotextile Fabric: Woven polypropylene monofilament which forms a dimensionally stable construction fabric. Minimum percent open area of 10%.

19.3 EXECUTION

19.3.1 Excavation and Base Preparation

.1 Excavate down to 300 mm below intended pipe invert in accordance with Section 3.1 – Trench Backfill, Volume 2: Complete Streets. Excavate to a minimum width of three times the pipe diameter to permit pipe assembly and accommodate bedding placement and compaction equipment on both sides of the pipe.

.2 Carefully trim bottom of excavation to provide uniform support along the profile and throughout the length of pipe. Compact base to a minimum 95% Standard Proctor density. If base is too soft to compact, continue excavation to firm base and backfill with granular or other material approved by the Engineer compacted in 150 mm lifts to a minimum 95% of Standard Proctor density.

.3 Place granular bedding to a width at least 3 times the diameter of pipe in lifts of 150 mm when compacted. Compact each lift to a minimum 95% of maximum density according to ASTM D698 Method A. Loosen the top 50 mm of bedding in contact with the pipe to permit the corrugations to seat snugly.

19.3.2 Laying Pipe

.1 Roll or lift and lower pipe into position on prepared bedding. Do not drop or drag pipe.

.2 Join pipe sections with appropriate couplers and fasteners according to manufacturer's instructions.

.3 Repair damage to protective coating with two coats of galvacon, zinc oxide or bituminous paint.

.4 Ensure that pipe is laid true to line and grade with the proper camber. If necessary, shore pipe to required position. Remove shoring when backfill has progressed to adequately support the pipe without displacement.

19.3.3 Tolerances

.1 Alignment: Centreline of culvert shall not vary from the designated alignment by more than 75 mm.

.2 Invert Grade: ±12 mm maximum variation from designated invert grade elevations, provided positive flow is maintained.

19.3.4 Pipe Zone Backfilling

.1 Do not cover work until it has passed inspection by the Engineer. Correct deficiencies as directed.

.2 Backfill according to Section 3.1 – Trench Backfill, Volume 2: Complete Streets as modified below.

.3 Place granular backfill under pipe haunches on both sides of pipe in 150 mm lifts. Compact each lift thoroughly with hand tampers or hand-held power tampers.

.4 Continue placing backfill simultaneously on both sides of pipe in 150 mm lifts. Compact each lift to a minimum 95% of maximum density according to ASTM D698 Method A. Do not allow the levels of fill on the two sides to differ by more than one lift at any time.

.5 Build up backfill until reaching a minimum cover of 300 mm over pipe. After compaction, the remainder of the embankment or roadwork may proceed.

.6 Do not allow construction and other traffic over the pipe unless adequate protective fill is placed in addition to the minimum cover. Remove such protective cover before proceeding with the rest of embankment fill.

19.3.5 Riprap

.1 Install riprap at both ends of culvert as detailed.

.2 Grade and level the slopes to receive the riprap. Lay geotextile fabric on the slopes anchored at the top.

.3 Place rock in a staggered manner to form a running bond pattern on each layer and between layers. Remove foreign matter from rock surfaces during placement. Riprap face shall appear closely packed and uniform.

.4 Where required, install trash rack as detailed on the drawings.

19.3.6 Removal of Existing Culvert

.1 Where indicated or required, carefully excavate and remove existing culvert. Deliver to designated location or dispose of as directed by the Engineer.

.2 Backfill the void as directed by the Engineer.

END OF SECTION

20 PRECAST CONCRETE BOX SEWERS

20.1 GENERAL

20.1.1 Scope

This section specifies requirements for constructing new gravity concrete box sewer lines for storm, sanitary and combined sewers.

20.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1: General
Protection of the Urban Environment	Chapter 13	Volume 1: General
Trench Backfill	Section 3.1	Volume 2: Complete Streets
Inspection of Sewers	Section ***23***	
Leakage Testing of Sewers	Section ***27***	
Concrete for Water and Drainage Structures	Section ***29***	

20.1.3 Submittals

The Contractor shall submit shop drawings, not later than 10 working days prior to installation.

20.1.4 Quality Assurance

.1 The Engineer may at any time require the Contractor to produce certification by an independent testing agency that materials used conform to the specified standards.

.2 All concrete box sections shall be marked with the date of manufacture.

.3 The Contractor and supplier shall provide reasonable access to EPCOR's Quality Assurance Laboratory during and after manufacture for all testing required by EPCOR.

20.1.5 Handling of Box Sections

.1 Handle box sections and appurtenances with approved equipment to prevent damage.

.2 Store box sections in accordance with the manufacturer's recommendations.

20.2 PRODUCTS

20.2.1 Concrete Box Sections

.1 Precast reinforced concrete box sections conforming to ASTM C1433M Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers (Metric), made with Type HS High sulphate-resistant hydraulic cement, as indicated on the drawings.

.2 The box sections shall have male and female joints.

20.2.2 Cement Mortar

.1 Cement mortar for concrete box sections joints, shall conform to the following mix.

- 1 part Type HS High sulphate-resistant hydraulic cement
- 1½ parts clean sharp sand
- Water to provide workability

.2 In freezing weather heat sand, cement and apply mortar hot. Protect joints from freezing until mortar has set.

20.2.3 Bedding and Backfill around the Box Section

.1 Bedding: gravel complying with the following gradation:

Sieve Size	% Passing by Mass
50 mm	100
25 mm	50 - 90
4.75 mm	20 - 60
425 µm	5 - 35
75 µm	0 - 5

.2 Backfill: approved native material or gravel complying with the gradation in Clause ***20.2.3.1***.

20.2.4 Sewer Insulation

.1 Rigid Styrofoam HI-40 sheets, 50 mm thick of minimum size 600 mm by 2400 mm, if shown on drawings.

.2 Insulation design is required for the thickness selection and side and bottom insulation may be required depending on the depth of the sewer and geotechnical condition.

20.2.5 Concrete

Concrete for forming additional concrete box fillets if required, to be as specified in Section ***29*** - Concrete for Water and Drainage Structures.

20.3 EXECUTION

20.3.1 Trench and Backfill

.1 Do trench and backfill work in accordance with Section 3.1 - Trench Backfill, Volume 2: Complete Streets.

.2 Trench line, depth and bottom of excavation require approval by the Engineer prior to placing bedding material.

.3 Remove and replace unsuitable material from trench bottom as directed by the Engineer.

.4 Keep the excavation free of water. Dispose of water in accordance with Chapter 13 - Protection of the Urban Environment, Volume 1: General.

20.3.2 Bedding

.1 Prepare the box sewer bedding in accordance with the drawings.

.2 Place gravel bedding specified in Clause ***20.2.3.1*** as shown on the drawings and compact to 95% of Standard Proctor density across the full width of the trench.

20.3.3 Inspection of Box Sections

.1 Inspect box sections for defects, immediately before lowering into the trench.

.2 Do not install any box sections earlier than 7 days after the date of manufacture.

20.3.4 Alignment and Grade

.1 Lay box sections to the alignment and grade shown on the drawings.

.2 Laser equipment used to maintain alignment and grade shall be operated by a qualified technician.

.3 The centreline of the box sewer shall not be more than 100 mm off the given line.

.4 The invert of the sewer main shall not deviate from the grade given by an amount greater than 15 mm. Any deviations in excess of this shall be corrected by the Contractor, in a manner approved by the Engineer, at no cost to EPCOR.

.5 All box sections shall be laid sloping in the desired directions, with no reversed grades on any box section.

.6 Box sections shall be level across their width.

20.3.5 Laying and Jointing

.1 Lower box sections carefully into trench so as to prevent damage. Do not drop box sections or materials into the trench.

.2 Lay box sections in accordance with manufacturer's recommendations and proceed upgrade.

.3 Produce a smooth, uniform invert.

.4 Forming gasket joints:

.1 Place Kent Seal or equal sealing compound gasket inside the female end of the box.

.2 Gasket diameter shall be not less than 19 mm and shall be lapped at the top.

.3 Insert the male end of box and drive in.

.4 Ram the gasket solidly and tightly into the annular space using suitable caulking tools and fill the joint with cement mortar.

.5 Overfill the joint with mortar and level off to a 45° angle to the outside of the box.

.6 Set two box sections ahead of the joint, before mortaring the joint.

20.3.6 Backfilling

.1 Backfill around the box sections with selected native material or imported granular backfill deposited uniformly in the trench at both sides of the box sewer, for the full width of the excavation. Compact in layers of 150 mm maximum depth to 95% of Standard Proctor density until the compacted backfill is to the top of the box section.

.2 Frozen material shall not be used for backfill or bedding. When conditions are such that unfrozen native material is not obtainable, provide unfrozen imported granular material at no additional cost.

20.3.7 Installation of Insulation

.1 Where shown on drawings, place the rigid Styrofoam sheets on top of the box sewer, butting ends together for a uniform fit.

.2 To secure insulation to the top of the box sewer, use a light application of mastic as recommended by the Styrofoam manufacturer, or a mechanical fastening system as approved by the Engineer.

.3 Backfill carefully over the insulation using suitable equipment, selected backfill, and appropriate backfill thickness so that the insulation is not damaged.

.4 Backfill to the original ground surface as shown in the drawings.

20.3.8 Cleaning

.1 Cover open ends of box sewer using timber and plywood before leaving the unfinished work at any time.

.2 Remove all foreign material from the box sewer and take precautions to prevent debris from new sewers from entering existing systems.

.3 Flush box sewer clean by a method approved by the Engineer and dispose of all contaminated water away from existing sewers in accordance with Chapter 13 - Protection of the Urban Environment, Volume 1: General.

20.3.9 Field Leakage Testing

.1 Perform testing identified in the Contract or as specified by EPCOR.

.2 For identified testing follow Section ***27*** - Leakage Testing of Sewers.

20.3.10 Inspection

.1 Carry out television or visual inspection of the completed sewer as described in the Section ***23*** - Inspection of Sewers.

.2 Perform inspection after all mains, manholes and service connections have been installed.

.3 Repair all defects which will impair the structural integrity and the performance of the sewer system including, but not limited to improper joints, cracked, sheared or excessively deflected pipe, sags and rises which pond water in excess of 35 mm, protruding service connections and visible leaks.

.4 Precast box sections shall be rejected if cracks 0.6 mm or wider are found.

END OF SECTION

21 TEMPORARY FLOW CONTROL

21.1 GENERAL

21.1.1 Scope

This section specifies the requirements for the provision of temporary sanitary sewer service and the control of sanitary or storm sewer flows using by-pass pumping.

21.1.2 Related Sections

Cleaning Sewers	Section ***22***
Inspection of Sewers	Section ***23***
Relining Sewers	Section ***26***

21.1.3 Work Content

The work includes supplying all equipment, labour, material, and services for the following:

.1 Drainage Operations for the proposed temporary by-pass scheme.

.2 Emergency response plan if needed

.3 Mobilization and demobilization.

.4 Traffic control and maintenance of access to properties.

.5 Providing alternate sanitary servicing to residents.

.6 By-passing flow.

.7 Reinstatement of permanent sanitary services and normal flows.

21.1.4 Constraints

.1 Existing sewer services shall not be shut off for more than 48 consecutive hours.

.2 A maximum of 25 services shall be out of service at one time, unless specifically authorized by EPCOR.

21.2 PRODUCTS

None Applicable

21.3 EXECUTION

21.3.1 Flow Control

When sewer flows are too high to effectively conduct inspection or relining, one or more of the following methods of flow control or isolation shall be used.

.1 Plugging and Blocking

A sewer line plug shall be inserted into the line at a manhole upstream from the section to be isolated. The plug shall be so designed that all or a portion of the sewage flows can be released. During the isolation portion of the operation, flows shall be shut off or substantially reduced in order to execute required work. After work is completed flows shall be returned to normal.

.2 By-passing Flow in Sewer Lines

.1 When adequate flow control cannot be obtained by the plugging method, pumps or siphons shall be used to divert all or a portion of the sewage flows, as may be necessary to perform the specified inspection or relining. Excess sewage flows shall be transported through a closed pipeline or using tank trucks provided by the Contractor. Trucks shall go to the nearest or most economical approved disposal site.

.2 The Contractor shall provide a detailed scheme to deal with mainline flows for EPCOR' approval, taking into account the following:

i. Pumps and bypass lines shall be of adequate capacity to handle the peak flows, and ensure that no upstream flooding occurs during isolation period.

ii. Equipment shall conform to the applicable noise bylaws.

21.3.2 Monitoring

.1 Provide continuous monitoring of water levels in upstream and downstream manholes. Ensure that there is no contamination of basements, ditches, roadways or sidewalks with raw sewage. In the event of such contamination, immediate action shall be taken to eliminate the source of contamination. Proper clean up of the affected area shall be followed and no work shall recommence until a re-evaluation of the complete process has been carried out by EPCOR. No rehabilitation work shall be undertaken unless authorized by EPCOR.

.2 Where the Contractor has used a flow control procedure to limit flows during an inspection, the Contractor shall note on the inspection report the depth of normal flow and the duration the flow control was in affect.

21.3.3 Safety

.1 The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act, Regulation, Code, and other construction safety measures as outlined in Chapter 4 - Occupational Health and Safety Requirements, Volume 1: General and EPCOR health and safety requirements.

.2 Contractors shall provide a copy of their confined space entry code of practice and applicable procedures prior to commencing work.

21.3.4 Temporary Sanitary Service

.1 The Contractor shall provide temporary facilities as required to divert sewage from the sanitary service connections for commercial and apartment buildings affected by the work. Temporary facilities, for example portable toilet units, are not acceptable unless the residents signs a release.

.2 The Contractor shall supply residents of single family houses or duplexes affected by the work with temporary sanitary facilities inside the house for the entire duration of the work and shall ensure that they are properly maintained during operation and removed when work is completed.

.3 Inform affected residents in writing of the length of disruption to service, details of alternate services that will be provided, any traffic-related constraints, noise levels to be expected, hours of work and safety concerns.

.4 Attend meetings with residents as required.

21.3.5 Clean-up

.1 Upon completion of the work clean up and restore the affected surface areas to the condition that existed prior to commencement.

.2 Remove and haul debris to an approved disposal site.

END OF SECTION

22 CLEANING SEWERS

22.1 GENERAL

22.1.1 Scope

.1 This section specifies the requirements for cleaning of sewer mains and removing foreign materials from lines.

.2 Contractors that are cleaning sewers are required to provide information which includes detailed specifications, methodology, design and cleaning details.

22.1.2 Related Sections

Temporary Flow Control	Section ***21***
Inspection of Sewers	Section ***23***

22.1.3 Constraints

.1 The Contractor's cleaning methods shall not shut off the existing services for more than 12 hours. The Contractor shall provide acceptable alternatives to services that are temporarily disrupted.

.2 The cleaning shall be undertaken without any excavation unless approved in writing by EPCOR.

22.2 PRODUCTS

22.2.1 Materials

.1 Chemicals such as those used for root control shall be selected in accordance with current environmental protection regulations to minimise negative impacts on the environment.

.2 Contractors shall submit a material safety data sheet (SDS) for each chemical used prior to starting work.

22.2.2 Equipment

The equipment required for this work may include one or more of the following:

- Rotating Chain Cutter Tool
- Rotating Cutter Head Tool
- Service Hub Cutter Tool
- High-Velocity Jet Nozzles.
- CCTV Cameras

22.3 EXECUTION

22.3.1 Safety

.1 The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act, Regulation, Code and other construction safety measures as outlined in Chapter 4 - Occupational Health and Safety Requirements, Volume 1: General and EPCOR health and safety requirements.

.2 Contractors shall provide a copy of their confined space entry code of practice and applicable procedures prior to commencing work.

.3 Supply material safety data sheets for all chemicals to be used to EPCOR for approval.

22.3.2 Preliminary Inspection

.1 Obtain all information necessary for the planning and execution of the sewer cleaning.

.2 Review all available closed circuit TV (CCTV) videos and record drawings.

.3 If required, inspect sewer by CCTV and by other means prior to starting work. Inspect the interior of the sewer carefully to determine the existence of any conditions that may prevent proper cleaning. (e.g. if roots or solid debris is suspected)

.4 Employ personnel trained in viewing CCTV in accordance with EPCOR Closed-Circuit Television Inspection Manual and the National Association of Sewer Service Companies (NASSCO)'s Pipeline Assessment Certification Program (PACP) Reference Manual for locating breaks, obstacles, and service connections.

.5 Provide a detailed record of all breaks, severe pipe deformations, and significant changes in cross sections between manholes, obstacles and service connections.

22.3.3 Bypassing Flow in Sewer Lines:

Where high sewer flows prevent adequate cleaning or post cleaning inspection, flows shall be controlled as defined in Section ***21***– Temporary Flow Control.

22.3.4 Line Cleaning

.1 Clean the line of obstruction such as solids, roots, sediments, protruding service connections or encrustation to at least 98% of the original capacity so that any subsequent rehabilitation scheme, such as joint grouting or relining, can proceed.

.2 If sewer clearing or obstacle removal methods can not remove an obstruction, a point repair excavation shall be made to uncover and remove or repair the obstruction. EPCOR' prior approval must be obtained.

.3 The Contractor shall make every effort to identify such locations during the tender period after reviewing the available CCTV inspection videos and reports and record plans. No extra payment shall be made for removal of obstructions that in the opinion of EPCOR were adequately identified at the time of tender.

22.3.5 Inspection on Completion

.1 The Contractor will carry out inspection of the cleaned sewers by television camera or other related means, in accordance with Section ***23*** – Inspection of Sewers.

.2 The inspection shall be performed after all mains, manholes and service connections have been cleaned along a section.

22.3.6 Clean-up

.1 Upon completion of the sewer cleaning, clean up and restore externally affected areas to the condition that existed prior to commencement of the work.

.2 Remove and haul debris to an approved disposal site. Debris and water shall be disposed of in accordance with applicable bylaws and legislation. Where necessary, debris may need to be tested for compliance with environmental law. Contractor shall retain invoices of disposal and such testing, and provide them for payment, if payment terms of the contract allow.

END OF SECTION

23 INSPECTION OF SEWERS

23.1 GENERAL

23.1.1 Scope

.1 This section specifies requirements for the inspection of gravity sewer lines, including:

- Closed circuit television (CCTV)
- Sonar
- Visual (walk-through)
- Manhole Inspection
- Mandrel test (for flexible pipe)

.2 The purpose of the sewer inspection may be for the requirements of a construction completion certificate (CCC), a final acceptance certificate (FAC), or for other reasons that the City/EPCOR has specified elsewhere. (a condition assessment of older sewers, for example). The Inspection Service Levels are defined herein, and the requirements for a specific project shall be indicated in the project requirements.

.3 The work of this section includes:

- Supply of all materials, equipment, labour and supervision.
- Cleaning of sewers immediately before inspection.
- Inspection of manholes, where specified.

23.1.2 Definitions

.1 Inspection Service Levels: The description of the various levels of service required for complete CCTV inspection of sewer pipes. Levels are further defined below:

.2 Level 1: Refers to performing CCTV inspection with sewers in existing condition, with no cleaning or flushing.

.3 Level 2: Refers to performing CCTV inspection with sewers being cleaned with one pass by flushing and cleaning equipment prior to televising. Unless otherwise specified, this is the level normally associated with CCC or FAC acceptance inspection.

.4 Level 3: Refers to performing CCTV inspection with sewers cleaned to Level 2, plus removal of sediments, solids, roots, encrustations and protruding services to allow passage of CCTV equipment.

.5 Level 4: Refers to performing CCTV inspection with sewers cleaned as specified in Section ***22***. This is a level associated with preparations of sewers prior to cured-in-place pipe (CIPP) relining. It includes a Level 3 cleaning plus any requirement of the lining design and installation, including close fit of the lining, removal of grease, removal of water, etc.

23.1.3 Related Sections

Temporary Flow Control	Section ***21***
Cleaning Sewers	Section ***22***
Deflection Testing of Flexible Pipe	Section ***28***

23.1.4 Safety

.1 The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act, Regulation, Code and other construction safety measures as outlined in Chapter 4 – Occupational Health and Safety Requirements, Volume 1: General and EPCOR Health and Safety requirements.

.2 Contractors shall provide a copy of their confined space entry code of practice and applicable procedures prior to commencing work.

.3 All documents and safety equipment required shall be available for inspection on demand.

.4 Violation of any aspect of Chapter 4, Volume 1: General will be grounds for terminating the Contract.

23.2 PRODUCTS

23.2.1 Closed Circuit Television Inspection Equipment

.1 Television equipment shall consist of a self-contained camera and a monitoring unit connected by a coaxial cable. This equipment shall be specifically designed and constructed for such inspection purposes. The camera shall be mounted on adjustable skids, or wheels, or have a height adjustment to facilitate the inspection of different sizes of pipe and to allow for visual judgement of ovality, by centring the camera within the pipe. The camera shall be waterproof and shall have a remote controlled self-contained lighting system capable of producing effective illumination for all sizes of pipe. The lighting system shall be capable of lighting the entire periphery of the pipe.

.2 For inspection of existing sewers and new sewers the camera shall have pan and tilt capabilities or sidescan technology.

.3 Recorded picture quality and definition shall be to the satisfaction of EPCOR.

.4 Location measurement of defects shall be made by devices having a proven accuracy of ±1.5% or 2 m, whichever is greater. Cable markings, if used, shall not be spaced greater than 600 mm along the length of the cable. Distance measurement system used shall be regularly calibrated by the Contractor, with records to be made available to EPCOR. EPCOR may reject equipment that cannot meet the accuracy requirements. The Contractor shall promptly inform EPCOR of significant discrepancies between EPCOR record drawings and actual field observations.

.5 Equipment shall be mounted in appropriate vehicle. Electrical power for the system shall be self-contained and shall not require removal for each set-up. External power sources from public or private residences shall not be permitted. Sound dampening shall be applied to the vehicle and equipment.

.6 Stub lines and other locations where access is limited to one manhole shall be televised using a crawler equipped camera.

.7 EPCOR shall not be responsible for any loss or damage to the Contractor's equipment. The Contractor shall carry all necessary insurance to cover loss, damage, and/or retrieval during inspection. The Contractor shall be responsible for any damages due to sewer back-up or flooding that are caused by his cleaning or inspection operations. The Contractor shall promptly inform EPCOR if any such damages occur.

23.2.2 CCTV Inspection Reports

.1 A digital video shall be provided accompanied by an inspection report (pdf format). This report shall be in accordance with EPCOR Closed-Circuit Television Inspection Manual and the National Association of Sewer Service Companies (NASSCO)'s Pipeline Assessment Certification Program (PACP) Reference Manual. It shall be a record of the exact location and severity of each leak or fault discovered by the television - e.g. open joints, broken, cracked, deformed or collapsed pipe, presence of grease, roots, debris, accumulation, obstruction, infiltration, water depth variations and other points of significance. The reference location for distance measurements shall be the wall of the launch manhole (chainage 0+00). If the inspection includes an intermediate manhole, chainage shall be reset to 0+00 in the centre of the intermediate manhole.

.2 All videos shall be in digital mp4 (H.264 compression) format at a minimum resolution of 640 x 480 and a data rate of 6000 kbps. For inspections reports that are provided to EPCOR under a direct contract, the report shall be created in a current CCTV software. The latest version of the NASSCO template for the report shall be provided by CCTV software provider. CCTV reports shall be submitted in digital media as individual reports also containing the "NASSCO standard data exchange format" and shall not contain any Player software or other embedded programs

.3 The report shall include the location of all service connections together with a statement of opinion as to whether or not the service connections are subject to joint infiltration. Protrusions of service connections into the main line shall be noted with reference to the degree of protrusion.

.4 Photographs of sewer defects shall be provided in the CCTV software report. The photographs shall be co-ordinated within the written report by defect and location. A minimum of one photograph per line shall be taken to show a representative view of the workmanship.

.5 The reports shall be submitted on external hard drives. Media submitted shall become the property of EPCOR.

23.2.3 CCTV Manhole Inspection Reports

Manholes shall be inspected and reports prepared in conformance with EPCOR Closed-Circuit Television Inspection Manual and the National Association of Sewer Service Companies (NASSCO)'s Pipeline Assessment Certification Program (PACP) Reference Manual, MACP Section and shall indicate structural conditions of the cover, frame, neck rings or grade rings, barrel, benching, flow channel and steps of each manhole. The report shall also show video of both sides of the cover. The report shall also identify cross-connections between sanitary and storm systems, high water marks and degree of sedimentation.

23.3 EXECUTION

23.3.1 General

EPCOR will supply all maps and drawings required for locating the mainlines and manholes to be inspected. The Contractor will be responsible for locating and identifying the manholes and lines in the field. The Contractor shall advise EPCOR of buried or non-locatable manholes immediately through phone and email. Any discrepancies found on site should be noted and reported to EPCOR immediately.

23.3.2 Cleaning (For Sonar or CCTV Inspection)

.1 Refer also to Section ***22*** - Cleaning Sewers. Prior to inspection, other than for level 1 service, sewer lines are to be cleaned utilising low pressure flushing.

.2 If the amount of debris, roots or encrustation makes it impossible to determine the structural condition of the sewer, Contractor shall undertake high pressure flushing, as directed. Sludge, dirt, sand and other debris resulting from the cleaning operations shall be removed from the downstream manhole of the section being cleaned. Passing material from the section being cleaned to the downstream sewer section shall not be permitted.

.3 Where the initial CCTV inspection indicates the presence of sags greater than 25% of the internal diameter of the sewer, the Contractor shall high-pressure flush that section of line. The section shall then be re-televised twice, firstly with a flusher a short distance ahead of the camera and then without a flusher active. All three records shall be forwarded to EPCOR.

.4 All debris flushed from the lines shall be removed and the Contractor shall be responsible for the proper disposal of the material.

.5 Water for flushing is generally available from fire hydrants located near the job site. The Contractor shall make arrangement with EPCOR Water Services for the use and payment of water consumed. A hydrant use report shall be filled out and submitted to EPCOR Water Services.

23.3.3 Traffic Control

.1 Interference to the normal flow of traffic shall be kept to a minimum.

.2 Traffic control, barricades, guards, and other safety precautions to be as directed in Chapter 14, Volume 1: General – Vehicular Access and Parking.

23.3.4 Flow Control

When sewer flows are too high, generally more than 1/3 of the pipe diameter, to effectively conduct the inspection, flows shall be controlled as defined in Section ***21*** – Temporary Flow Control.

23.3.5 Work during Non-Peak Hours

Should the area being inspected be anticipated to have peak flow periods during normal working hours, the option to convert to night shifts for inspection procedures may be exercised by mutual agreement between the Contractor and EPCOR. The Contractor shall comply with the requirements of the City of Edmonton Community Standards Bylaw 14600.

23.3.6 Closed Circuit Television Inspection

.1 The CCTV inspection shall provide a full record of the condition of the pipes, manholes, and appurtenances along the designated section of sewer.

.2 The Contractor shall not attempt a CCTV inspection if water levels in the pipe obstruct the camera's view unless instructed by EPCOR.

.3 When required, a small diameter polyethylene rope or similar line shall be installed in the sewer in advance of the inspection in order that the camera traction cable may be drawn through the sewer. This line shall be installed on a manhole to manhole basis with the line being tied off at each individual manhole to facilitate the quick removal of the equipment should the need arise due to mainline sewer blockages or other emergency situations.

.4 Direct communication shall be established between the monitoring station and the camera towing device operator. No loudspeaker devices shall be allowed.

.5 The camera advance rate shall not exceed 9 m/min to allow adequate time for operator interpretation. A uniform rate of speed shall prevail.

.6 If, during the inspection procedures the television camera will not pass through the entire pipe section between manholes, the Contractor will reset the equipment in such a manner so that the inspection can be performed from the opposite manhole.

.7 The camera operator shall, during the inspection, pan the camera to focus on observable deficiencies in the pipe that may be located off-center to the direction of camera travel. This shall include all services, joints to the top, left or right, cracks and fractures or surface deterioration of the pipe walls.

.8 On completion the Contractor shall provide television reports and digital media as detailed in Section ***23.2.2*** above.

23.3.7 Sonar Inspection

.1 The sonar inspection shall identify all the major defects along the wetted perimeter of the pipe.

.2 Sonar imaging equipment shall consist of a self-contained monitoring unit. The unit will be specifically adapted for the sewer main inspection purposes. The float or skid used to facilitate the movement of the equipment along the sewer main must be designed to accommodate various pipe sizes.

.3 If the sewer contains debris, roots or encrustations that could impede the accuracy of the results from the sonar inspection then the sewer shall be cleaned by high pressure flushing equipment prior to undertaking the inspection.

.4 The Contractor shall not attempt inspection, if the water depth in the sewer is not sufficient to fully submerge the sonar equipment. There shall be a minimum of 75 mm of water above the equipment.

.5 The sonar equipment shall be equipped with a zoom-in feature to produce a full screen image on the computer or TV monitor.

.6 If turbulent flow conditions are expected in the sewer line due to bends, incoming flow from another sewer, or near drop manholes, the Contractor shall carry out inspection during off-peak hours (i.e., night time or weekends), to minimise distortion to the sonar image due to air bubbles and suspended particles.

.7 The Contractor shall maintain the sonar equipment at the centre of the sewer line to obtain the best image of the wetted perimeter of pipe.

.8 The following information shall be submitted to EPCOR:

Reports shall be supplied on external hard drives. Each report must be per individual asset, each report must contain a produced CCTV software report containing a photo for each defect, and one photo for the overall line condition, and must also contain an export file in the NASSCO standard data exchange format.

.9 EPCOR may accept alternative inspection method to sonar. Contractor shall submit all details of the methodology, design of supplementary equipment required for inspection and history of using the equipment for sewer inspection to EPCOR for approval.

23.3.8 Visual Walk-Through Inspection of Large Diameter Sewers

.1 Visual and video inspections will be required in lines where conditions will allow the Contractor's inspection crew to safely walk through the sewer. Visual inspections shall not be carried out for sewers less than 1200 mm diameter.

.2 Special industrial grade colour inspection cameras, either hand-held or contained in waterproof housings shall be carried manually through the sewer during inspection work. The cameras shall be operable in conditions of 100% humidity. Camera lighting shall be sufficient for use with colour inspection cameras to clearly see details of the sewer interior. The complete video system (camera, lens, lighting, cables, monitors and recorders) shall be capable of providing a picture quality acceptable to EPCOR. If the equipment does not produce an acceptable picture quality then it shall be removed. No payment will be made for unsatisfactory inspections.

.3 Safety of the inspection crew is a prime concern. There shall be a minimum of two personnel in the sewer at any time. All crew members, whether assigned to the sewer or to assist at the surface, must receive confined space entry and rescue training.

.4 The Contractor is responsible for obtaining all information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic flows and any other considerations that might affect the manner in which the inspection is undertaken. The Contractor’s tender price shall allow for completing the required inspections under existing conditions.

.5 Whenever practical the video camera shall be used to look up sewer lines and services connected to the main line being inspected. Conditions in these sewer lines and services shall be noted on the inspection reports. Accurate and continuous distance readings, the date of inspection and EPCOR’ manhole number designation for each manhole shall be superimposed on the video recording for each line inspected

.6 No maximum flow depth has been established in this specification for manual walk-through inspections. However, Contractors shall use their own judgement before attempting any inspections. Special attention shall be paid to the current weather conditions when inspecting the combined sewers or storm sewers, as there may be a sudden increase in flow depth due to rain in the service area of the sewer.

.7 The following information shall also be submitted:

Reports shall be submitted on an external hard drive with each inspection documented by the technician during the actual inspection work describing the parameters of the line being inspected, i.e. location, depth, diameter and pipe type, as well as describing direction of inspection, connections, defects and unusual conditions observed during the inspection.

23.3.9 Closed Circuit Television Manhole Inspection

.1 When specifically required for conditions assessments of existing manholes (not normally required for CCC and FAC), the CCTV inspection shall provide a full record of the designated manholes.

.2 The Contractor shall not attempt a CCTV inspection if water levels in the manhole obstruct the camera’s view unless instructed by EPCOR.

.3 The camera descent rate shall not exceed 20 m/min to allow adequate time for operator interpretation. A uniform rate of speed shall prevail.

.4 The camera operator shall, during an inspection with a normal video camera, pan the camera to focus on observable deficiencies in the manhole, sidescan technology only requires a single pass.

.5 On completion the Contractor shall provide reports as detailed in Section ***23.2.3*** above.

END OF SECTION

24 PIPE BURSTING

24.1 GENERAL

24.1.1 Scope

This section specifies the requirements for the supply and installation of sewers utilising pipe bursting.

24.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewer Services	Section ***14***	
Manholes and Catch Basins	Section ***17***	
Inspection of Sewers	Section ***23***	
Leakage Testing for Sewers	Section ***27***	

24.1.3 Pipe Bursting Method

.1 Design

Submit methodology specific to each sewer section, design and construction details for the proposed pipe bursting operation.

.2 General Description

.1 A tool whose outside diameter is greater than the maximum inside diameter of the existing sewer pipe is drawn through the existing sewer pipe, breaking it into small fragments and driving the broken pieces into the surrounding soil.

.2 The tool makes a void along the path formerly occupied by the existing sewer pipeline and simultaneously pulls the new pipe into place.

.3 The tool shall be of dimensions such that the design maximum diameter of the space created shall not exceed the maximum outside diameter of the new pipe by more than 15%.

.4 The installation procedure shall make the invert of the new pipe lower than the original invert by half the difference between the inside diameters of the old pipe and the replacement pipe.

24.1.4 Work Content

Includes all engineering services, plant, labour, material, and services for the following:

.1 Preparation of the sewers for accepting the bursting tool and new pipe. This includes CCTV inspection, flushing and cleaning sewer lines, and may include review of existing CCTV videos, service records and plans.

.2 Installation of a new sewer by the pipe bursting process.

.3 Isolation of sewer during rehabilitation and maintaining servicing to users by an approved method.

.4 CCTV inspection of the rehabilitated sewer.

24.1.5 Constraints

.1 Maintain existing flow during construction.

.2 Schedule work to minimize interruptions to existing services. Existing sewer services shall not be shut off for more than 48 consecutive hours.

24.1.6 Submittals

.1 The Contractor is required to submit the following within 10 working days of award of contract:

- Detailed specifications of proposed pipe bursting methods.
- Complete methodology specific to each sewer section requiring rehabilitation.

- Complete details about component materials, their properties and installation procedures.
- Schedule of work.
- Drawings and description of excavation locations.
- Access shaft or pit excavation shoring design stamped by a professional engineer registered in Alberta.
- Method of dealing with existing pipe sections which may be partially/fully encased in concrete bedding.
- Manufacturer's test data and certification that pipe materials meet requirements of this section.
- The proposed method of maintaining services or providing alternate facilities, for approval by EPCOR.

.2 The Contractor shall not change any material, thickness, design values or procedural matters stated or approved in the submittals without the Engineer's prior knowledge and approval.

24.2 PRODUCTS

24.2.1 High Density Polyethylene Pipe (HDPE)

.1 The pipe shall be made from polyethylene resin compound which conforms to ASTM D1248 and qualified as Type III, Class C, Category 5, Grade P34 material and with ASTM D3350 as a 345434C cell class material. This material shall be listed with the Plastic Pipe Institute (PPI) as a PE 3408 material.

.2 A Certificate of Compliance with the specifications shall be furnished by the supplier.

.3 The pipe dimension specified on the drawings is the inside diameter (ID) required for the sewer hydraulics. If the Contractor proposes alternative pipe materials or pipe diameters (ID or OD.), then the Contractor must submit details to the Engineer for approval.

.4 The pipe shall be free from visual defects such as foreign inclusions, concentrated ridges, pitting, discoloration, varying wall thickness and other deformities.

24.2.2 Clamps

.1 Where excavations for the insertion of the replacement pipe are made between two manholes, the ends of the new pipe will be cut smooth and square to the axis so that both ends meet and touch uniformly and continuously with the existing pipe. A stainless steel full circle universal clamp coupling with a 6 mm minimum thickness grid type gasket shall be used to join the new pipe to the existing pipe.

.2 Select clamps to fit the outside diameter of the replacement pipe. Minimum clamp widths shall be 750 mm for pipe outside diameters greater than 300 mm.

.3 Any alternate coupling system must be submitted to the Engineer for approval.

24.2.3 Other Pipe Materials

Where the Contractor proposes to use other pipe materials in a pipe bursting application, the Contractor shall submit details for approval.

24.3 EXECUTION

24.3.1 Inspection and Cleaning of Sewer Lines

.1 Review all available CCTV videos and record plans.

.2 Inspect the interior of the sewer carefully using CCTV or other means to determine the existence of any conditions that may prevent completion of the pipe bursting process.

.3 Obtain adequate information for designing and execution of the rehabilitation scheme.

.4 Clean the sewer to a degree that is required for the proper completion of the pipe bursting process.

.5 Dispose of debris removed from the sewer by an approved method.

24.3.2 Bypass Flow in Sewer Lines and Service Connections

.1 Provide a detailed scheme to deal with mainline flows for EPCOR' approval, taking into account the following:

.1 Pumps and bypass lines shall be of adequate capacity to handle the peak flows, and ensure that no upstream flooding occurs during construction.

.2 Equipment shall conform to the applicable noise bylaws.

.3 Allow for continuous monitoring of water levels in upstream and downstream manholes. Ensure that there is no contamination of basements, ditches, roadways, sidewalks, etc. with raw sewage. In the event of such contamination, immediate action shall be taken to close the source of contamination. Proper clean up of the affected area shall be followed and no work shall commence until a re-evaluation of the complete process has been carried out by the Engineer. No rehabilitation work shall commence unless authorized by EPCOR. No extra payment will be made for decontamination, clean up, or down time.

.2 All service connections attached to the existing sewer shall be completely disconnected and isolated from the existing sewer before pipe bursting operations commence.

.3 Provide detailed proposals for dealing with flows in existing service connections.

24.3.3 Line Obstructions

.1 Clean the line of obstructions such as solids, roots, sediments, protruding service connection, encrustation, or collapsed pipe that will prevent the completion of the pipe bursting process.

.2 If sewer cleaning or obstacle removal methods cannot remove an obstruction, a point repair excavation shall be made to uncover and remove or repair the obstruction. Written approval from EPCOR is required prior to undertaking this work.

.3 Make every effort to identify such locations during tender time after reviewing available CCTV videos and record plans. No extra payment will be made for removal of obstructions that in the opinion of the Engineer were adequately identified at tender time.

24.3.4 Sags in Line

.1 If the CCTV inspection reveals a sag in the existing sewer, the Contractor shall define the degree to which the sag may or may not be reduced by the pipe bursting process.

.2 Undertake the necessary measures to reduce existing sags by the pipe bursting process or locate the insertion/access pits such that the sag location is exposed and the bottom of the pipe trench is raised to provide a uniform grade in line with the new pipe invert.

.3 No new sags or accentuation of existing sags outside of the limits defined under Clause ***24.3.9*** will be accepted.

.4 Take all measures required to repair new sags deemed as unacceptable, including, if necessary, excavating a pit and bringing the bottom of the trench up to a uniform grade in line with the invert of the adjacent pipe.

24.3.5 Insertion or Access Pits

.1 The location and number of insertion or access pits shall be outlined by the Contractor and submitted in writing for approval by the Engineer prior to commencement of work.

.2 Unless otherwise stipulated, the pits shall be located such that their total number shall be minimized and the length of replacement pipe installed in a single pull is maximized.

.3 Locations of damaged pipe or sags shall be used for insertion/access pits if directed by the Engineer.

24.3.6 Installation of Replacement Pipe

.1 As the pipe bursting is advanced through the existing sewer pipe, the replacement pipe shall be advanced directly behind the tool to fill the void left by the shattered sewer pipe.

.2 The installation of the replacement pipe shall not damage other underground utilities in the vicinity. The Contractor shall be responsible or making good any damage incurred.

.3 Replacement pipe with gashes, nicks, abrasions, or any such physical damage which are larger/deeper than 10% of the wall thickness shall not be used and shall be removed from the construction site.

.4 The installed replacement pipe shall be continuous over the entire length, from manhole to manhole.

24.3.7 Pipe Joining

.1 Sections of HDPE replacement pipe shall be assembled and joined on the job site above the ground. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions. Joint: to AWWA C207.

.2 The butt-fusion method for pipe joining shall be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer. These joints shall have a smooth, uniform double rolled back bead made while supplying the proper melt, pressure, and alignment. It shall be the sole responsibility of the Contractor to provide an acceptable butt-fusion joint.

.3 All joints shall be made available for inspection by the Engineer before insertion.

24.3.8 Service Connections

.1 After the replacement pipe has been completely installed and tested, all services shall be reconnected to the replacement pipe.

.2 The utmost care shall be exercised in the tapping of the sewer main for the connection, in order to ensure that no damage is caused to the sewer main.

.3 The connection to the sewer main shall be by means of an approved field connection. The connection and any joints between the service and the sewer main shall be structurally sound and watertight.

.4 The service connection pipe shall not protrude into the sewer main.

24.3.9 Acceptance

.1 On completion of the replacement pipe installation, arrange for CCTV camera inspection and provide:

.2 Digital videos for the entire sewer installation.

.3 Inspection report and log sheet between each manhole.

.4 The installed pipe invert in areas where sags were not previously identified shall not deviate from the given grade by an amount greater than the total of 25 mm plus 20 mm per metre of diameter of new sewer pipe $\left(\nearrow 25\ \text{mm} + \frac{20\ \text{mm}}{1.0\ \text{m of diameter}} \times \text{m diameter}\right)$.

.5 The installed pipe shall meet the leakage requirements as specified in Section ***27*** - Leakage Testing of Sewers.

24.3.10 Benching at Manholes

.1 If the replacement pipe fails to make a tight seal at the manhole, apply a compatible sealant material between the manhole barrel and pipe.

.2 The channel in the manhole shall be a smooth continuation of the pipe(s) and shall be merged with other channels, if any exist.

END OF SECTION

25 JOINT GROUTING CONCRETE SEWERS

25.1 GENERAL

25.1.1 Scope

This section specifies the requirements for rehabilitation of sewer lines by the injection of chemical grouting material into and/or through structurally sound joints from within the pipe.

25.1.2 Related Sections

Cleaning Sewers	Section ***22***
Inspection of Sewers	Section ***23***

25.1.3 Design

Contractors proposing joint chemical grouting systems are required to submit detailed specifications, methodology, design, construction details and data complying with ASTM Standards. Contractor shall submit data supporting the non-shrink characteristics of the grout material and data that illustrates the ability of the grout to resist chemical attack.

25.1.4 Constraints

.1 The Contractor's rehabilitation scheme shall not shut off the existing services for more than 12 hours. The Contractor shall provide acceptable alternatives to any services that are temporarily interrupted.

.2 The rehabilitation scheme shall be executed without any excavation.

25.2 PRODUCTS

25.2.1 Chemical Grout - General

All chemical sealing materials used in the performance of the work specified must have the following characteristics:

.1 While being injected, the chemical sealant must be able to react and perform in the presence of groundwater.

.2 The cured material must withstand submergence in water without degradation.

.3 The resultant sealant formation must prevent the passage of water through the sewer pipe joint.

.4 The sealant material, after curing, must be flexible as opposed to brittle.

.5 In place, the sealant formation should be able to withstand freeze - thaw, and wet/dry cycles without adversely affecting the seal.

.6 The sealant formation must not be biodegradable.

.7 The cured sealant should be chemically stable and resistant to the mild concentrations of acids, alkalis, and organic material found in normal sewage.

.8 Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

.9 Mixing of the component materials must be compatible with field operations and not require precise measurements of the ingredients by field personnel.

.10 Clean up must be done without inordinate use of flammable or hazardous chemicals.

.11 Residual sealing materials must be easily removable from the sewer line to prevent reduction or blockage of the sewage flow.

.12 Grout materials shall comply with ASTM C309 Type 1 and AASHO M198 Type 1 specifications.

.13 Prior to construction, provide all relevant chemical and physical properties and impacts on sewage treatment process to EPCOR for approval.

25.2.2 Acrylic Base Gel Chemical Sealing Material

The sealant material shall have:

- A minimum of 10% acrylic base material by volume in the total sealant mix. A higher concentration of acrylic base material may be used to increase strength or offset dilution during injection.
- The ability to tolerate some dilution and react in moving water during injection.
- A viscosity of approximately 2 centipoise which can be increased with additives.
- A constant viscosity during the reaction period.
- A controllable reaction time from 5 seconds to 6 hours.
- A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, flexible gel.
- The ability to increase mix viscosity, density and gel strength by the use of additives.

25.3 EXECUTION

25.3.1 Safety

.1 The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act, Regulation, Code and other construction safety measures as outlined in Chapter 4 – Occupational Health and Safety Requirements, Volume 1: General and EPCOR Health and Safety requirements.

.2 Contractors shall provide a copy of their confined space entry code of practice and applicable procedures prior to commencing work.

.3 Prior to entering access areas such as manholes and performing inspection or cleaning operations, evaluate the atmosphere to determine the presence of toxic or flammable vapours or lack of oxygen.

.4 Provide material safety data sheets (SDS) for all chemicals to be used to the Engineer for approval before usage.

.5 Workers shall wear appropriate protective clothing and equipment such as eye, respiratory and hand protection as per the Safety Data Sheet (SDS).

25.3.2 Inspection and Cleaning of Sewer Lines

The inspection and cleaning of the lines, including all bypass pumping required, shall be as detailed in Sections ***22*** – Cleaning of Sewers and ***23*** – Inspection of Sewers.

25.3.3 Joint Testing

Each sewer pipe joint which is not visibly leaking or, as indicated on drawings, shall be individually pressure tested using a test pressure of 70 kPa for liquid and 20 kPa for air, in accordance with one of the following procedures:

25.3.4 Liquid Test Procedure

.1 The testing device shall be positioned within the pipe in such a manner as to straddle the pipe joint to be tested.

.2 The testing device end elements (sleeves) shall be expanded so as to isolate the joint from the remainder of the line and create a void between the testing device and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient inflation pressure to contain the test liquid within the void without leakage past the expanded ends.

.3 Water or an equivalent liquid shall then be introduced into the void until a pressure equal to or greater than the required test pressure is observed with the void pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will have failed the test and shall be sealed as specified.

.4 The flow rate of the test liquid shall then be regulated to a rate at which the void pressure is observed to be the required test pressure. A reading of the test liquid flow meter shall then be taken. If the flow rate exceeds 1.13 litres per minute (due to joint leakage), the joint will have failed the test and shall be sealed as specified.

25.3.5 Air Test Procedure

.1 The testing device shall be positioned within the line in such a manner as to straddle the pipe joint to be tested.

.2 The testing device end elements (sleeves) shall be expanded so as to isolate the joint from the remainder of the line and create a void between the testing device and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient inflation pressure to contain the test liquid within the void without leakage past the expanded ends.

.3 Air shall then be introduced into the void until a pressure equal to or greater than the required test pressure is observed with the void pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will have failed the test and shall be sealed as specified.

.4 After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure decays by more than 15 kPa within 15 seconds (due to joint leakage), the joint will have failed the test has shall be sealed as specified.

25.3.6 Control Test

.1 Prior to starting the pipe joint testing phase of the work, a two-part control test shall be performed as follows:

.2 To ensure the accuracy, integrity, and performance capabilities of the testing equipment, a demonstration test will be performed in a test cylinder constructed in such a manner that a minimum of two known leak sizes can be simulated. This technique will establish the test equipment performance capability in relationship to the test criteria and insure that there is no leakage of the test medium from the system or other equipment defects that could affect the joint testing results. If this test cannot be performed successfully, the Contractor shall be instructed to repair or otherwise modify the equipment and perform the test until the results are satisfactory. This test may be required at any other time during the joint testing work if the Engineer suspects the testing equipment is not functioning properly.

.3 After entering each manhole section with the test equipment, but prior to the commencement of joint testing, the test equipment shall be positioned on a section of sound sewer pipe between pipe joints, and a test performed as specified. This procedure will demonstrate the reality of the test requirement, as no joint will test in excess of the pipe capability. Should it be found that the barrel of the sewer pipe will not meet the joint test requirements, the requirements will be modified as necessary.

25.3.7 Joint Grouting Procedures

.1 Joints showing visible leakage or joints that have failed the joint test specified shall be sealed as specified.

.2 Joint sealing shall be accomplished by forcing chemical sealing materials into or through faulty joints by a system of pumps, hoses, and sealing packers.

.3 The packer shall be positioned over the faulty joint by means of a measuring device and the closed-circuit television camera in the line.

.4 The packer ends (end elements, sleeves) shall be expanded using controlled pressure and shall seal against the inside periphery of the pipe to form a void area at the faulty joint, now completely isolated from the remainder of the pipe line.

.5 Sealant materials shall be pumped through the hose system at controlled pressures that are in excess of groundwater pressures.

.6 The pumping unit, metering equipment, and the packer device shall be designed so that proportions and quantities of materials can be regulated in accordance with the type and size of the leak being sealed.

25.3.8 Residual Sealing Material

.1 Residual sealing materials that extend into the pipe, shall be removed from the joint.

.2 The sealed joints shall be left "flush" with the existing pipe surface.

.3 If excessive residual sealing materials accumulate in the line (and/or if directed by the Engineer) the section shall be cleaned to remove the residual materials.

.4 No service connection shall be obstructed by residual grout material.

25.3.9 Joint Sealing Verification

.1 Upon completing the sealing of each individual joint, the packer shall be deflated until the void pressure meter reads zero pressure, then re-inflated and the joint re-tested as specified.

.2 Should the void pressure meter not read zero, the Contractor shall clean the equipment of residual grout material or make the necessary equipment repairs or adjustments to produce accurate void pressure readings.

.3 Joints that fail to meet the specified test criteria shall be resealed and re-tested.

.4 Joint sealing verification shall be completed after the removal of residual sealing material.

25.3.10 Records

.1 Complete records shall be kept of joint sealing performed in each section of sewer.

.2 The records shall identify the manholes between which the sealing was done, the location of each joint sealed, and the joint sealing verification results.

.3 Provide a colour CCTV video of the rehabilitated sewer main in accordance with Section ***23*** – Inspection of Sewers.

25.3.11 Clean-up

.1 Upon acceptance of the liner, clean up and restore the affected surface areas to the condition that existed prior to commencement of the work.

.2 Remove and haul debris to an approved disposal site.

END OF SECTION

26 RELINING SEWERS

26.1 GENERAL

26.1.1 Scope

This section specifies the requirements for lining of existing sanitary or storm sewers using a cured-in-place pipe (CIPP) lining system.

26.1.2 Related Sections

Sewers	Section ***13***
Temporary Flow Control	Section ***21***
Cleaning Sewers	Section ***22***
Inspection of Sewers	Section ***23***
Leakage Testing for Sewers	Section ***27***

26.1.3 Work Content

The work includes for the supply of all equipment, labour, material, and services for the following:

.1 Engineering services for the design of the proposed liner system.

.2 Mobilization and demobilization.

.3 Traffic control and maintenance of access to properties.

.4 Preparation of sewers for accepting the liner system. This includes preliminary inspection, line cleaning and final inspection as outlined in Section ***23*** – Inspection of Sewers.

.5 Isolation of sewer during rehabilitation; providing alternate sanitary servicing to users and bypassing flow as provide for in Section ***21***– Temporary Flow Control.

.6 Reconnecting all existing services to provide integral, structurally sound joints with the relined sewer.

.7 Providing CCTV inspection of the rehabilitated sewer, including service connections, in accordance with Section ***23*** – Inspection of Sewers

.8 Quality control during manufacture and installation.

26.1.4 Constraints

.1 Prior to commencing work the proposed method of reconnecting services is to be reviewed and approved by EPCOR.

.2 Existing sewer services shall not be shut off for more than 48 consecutive hours.

.3 The Contractor shall adhere to the work schedule.

.4 The rehabilitation scheme shall be executed with no excavation, except as specified. Any excavation required shall be as identified in the tender documents.

26.1.5 Alternative Pipe Relining Systems

.1 Alternatives proposed by Contractors shall meet the performance requirements specified in this section.

.2 Contractors shall submit with their tender; detailed specifications, details of proposed design and construction methodology and test data, all complying with ASTM Standards.

.3 Contractors shall submit independently verified material testing data to EPCOR for approval.

.4 Contractors shall submit a design, stamped by a professional engineer licensed to practice in the Province of Alberta.

.5 Alternative proposed shall have a quality of materials and workmanship warranted for a period of two years from the date of construction completion.

.6 Where relining is specified, rehabilitation methods requiring the destruction of the host pipe, for example pipe bursting, are not permitted unless otherwise indicated.

26.2 PRODUCTS

26.2.1 Cured-In-Place Pipe Liner

.1 Sewer rehabilitation products submitted for approval must provide independent test results supporting the long-term performance and structural strength of the product. Specifically, independent testing information that follows ASTM D2990 testing protocols or the Trenchless Technology Center (TTC) Technical Report #302, Long-Term Structural Behavior of Pipeline Rehabilitation Systems, shall be considered acceptable in determining the long-term performance and structural strength of the product. Test samples shall be prepared so as to simulate installation methods and trauma of the product. No product will be approved without independent testing verification.

.2 Contractors shall submit with their tender; detailed specifications, methodology, design and construction details, and data complying with ASTM Standards.

.3 Contractors are to supply all material to fabricate a CIPP liner to a size, which when installed, will provide a close-fit with the host pipe with an annulus no greater than the maximum allowable diametric shrinkage due to curing permitted in ASTM D5813.

.4 The cured-in-place liner shall have sufficient strength to bridge missing pipe and be sized correctly to allow for circumferential stretching, fitting irregular pipe section and insuring that the existing pipe is completely filled during installation.

.5 The cured-in-place liner shall consist of one or more layers of absorbent flexible needled non-woven or woven felt meeting requirements of ASTM F1216 or ASTM F1743. It shall be capable of carrying resin, withstanding installation pressures and curing temperature, be compatible with the resin system used and be able to cure in the presence or absence of water.

.6 The wet-out tube shall have a uniform thickness that, when compressed at installation pressures, will meet or exceed the design thickness.

.7 The tube shall be sewn to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance shall be made for circumferential stretching during installation. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be used.

.8 The outside layer of the tube, before wet-out, shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate monitoring of resin saturation during the resin impregnation, (wet-out) procedure.

.9 The tube shall be homogeneous across the entire wall thickness, containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP liner. No dry or unsaturated layers shall be evident.

.10 The wall colour of the interior pipe surface of the CIPP liner after installation shall be a light reflective colour to facilitate a clear, detailed examination with CCTV inspection equipment.

.11 Seams in the tube shall be stronger than the unseamed felt.

.12 The resin shall be either a corrosion resistant unsaturated polyester, epoxy vinyl ester or epoxy, that when properly cured within the tube composite, meets the requirements of ASTM F1216 and ASTM F1743. The liner material shall be resistant to the following substances at the concentrations stated:

Chemical Resistance	Concentration
Sulphuric acid	20%
Sodium hydroxide	5%
Ammonium hydroxide	5%
Nitric acid	1%
Ferric Chloride	0.1%
Soap	1%
Detergent	0.1%
Bacteriological	BOD not less than 700 ppm

.13 Furnish certified data that demonstrates the ability of the liner material to resist chemical attack as per ASTM D543 testing.

26.2.2 Liner Design

.1 The Contractor shall submit a design, stamped by a professional engineer licensed to practice in the Province of Alberta.

.2 The liner shall be designed by the Contractor in accordance with ASTM F1216 as a gravity pipe in a partially or fully deteriorated pipe condition, as specified.

.3 Non Reinforced liner thickness shall have a maximum dimensional ratio of 50 for partially deteriorated and 35 for fully deteriorated pipe condition. Non reinforced liner thickness shall be a minimum of 6 mm.

.4 The liner design shall be as detailed in ASTM F1216 and follow minimum design assumptions. The Appendices X1 Design Considerations and X2 in ASTM F1216 are mandatory.

.1 The total external pressure on the pipe shall include an allowance for an AASHTO HSS25 concentrated live load. If the liner crosses under a railway line, the minimum live load surcharge shall be calculated based on a Cooper E80 distributed load for the portion of liner affected by that loading.

.2 The minimum soil density utilized in computation of the dead load shall be 1920 kg/m³.

.3 The groundwater load shall be calculated based on the assumption that the groundwater table is 2.0 m below the existing ground surface.

.4 The ovality reduction factor shall be based on a minimum value of 2% or as specified by EPCOR.

.5 The creep retention factor (10,000-hour test) should not exceed 50% based upon resin composite. Tests shall utilize resin composite samples and not virgin resin samples.

.6 The long-term value for the flexural modulus of elasticity shall be the projected value at 50 years of a continuous application of the design load based on the specific resin and felt composite approved for use.

.7 The modulus of soil reaction (E's) shall be assumed to be 6.9 MPa unless a higher or lower value is specified.

.8 The Poisson's ratio shall be assumed to be 0.30 unless a higher or lower value is specified.

.9 An enhancement factor (K) value not to exceed seven.

.10 The minimum factor of safety (N) to be utilized shall be two.

.5 The Contractor shall be responsible for the structural design of the liner system as a self supporting liner for fully deteriorated sewer or to act in conjunction with the existing sewer for partially deteriorated sewer.

.6 The liner shall meet or exceed the following structural properties:

Property	ASTM Test	Cured Composite (per ASTM F1216)	Cured Composite (Enhanced Resin)
Flexural Strength	D790	31 MPa	27 MPa
Flexural Modulus	D790 and D2990	1 725 MPa	2 760 MPa

.7 In the case of a pipeline with invert "flats" the Contractor shall perform supplemental design checks to determine whether the wall thickness is governed by:

a) Buckling, by assuming the flat functions as a pin-ended strut.
b) Stress, by assuming the flat functions as a pinned member, subject to axial and transverse loads.
c) Deflection, by assuming that allowable defection is limited to 5% of the length of the flat.

26.3 EXECUTION

26.3.1 Installation Procedure

.1 Safety

.1 The Contractor shall strictly observe the Occupational Health and Safety Guidelines with special emphasis on its requirements for working with scaffolding and entering confined spaces.

.2 Contractors shall provide a copy of their confined space entry code of practice and applicable procedures prior to commencing work.

.3 Prior to entering confined access areas such as manholes; evaluate the atmosphere to determine the presence of toxic or flammable vapours or lack of oxygen and take appropriate action.

.4 Provide material safety data sheets (SDS) for all chemicals to be used to EPCOR for approval.

.5 Workers shall wear appropriate protective clothing and equipment such as eye, respiratory and hand protection as per the Safety Data Sheet (SDS).

.2 Inspection and Cleaning of Sewer Lines

The inspection and cleaning of the lines, including all by-pass pumping required, shall be as detailed in Sections ***21*** - Temporary Flow Control, Section ***22*** - Cleaning Sewers and Section ***23*** - Inspection of Sewers.

.3 Quality Control

.1 Contractor shall submit field prepared samples for each inversion. For each continuous section of relining, one sample shall be prepared. For spot relines, one sample for every five spot relines undertaken shall be prepared.

.2 Samples shall have a minimum length of 250 mm.

.3 Samples shall be obtained immediately after curing.

.4 CIPP liner samples shall be prepared and tested in accordance with ASTM F1216 or ASTM F1743. The flexural properties must meet or exceed the values in this section. Samples shall be tested by an independent testing laboratory approved by EPCOR. Test results shall be sent directly to EPCOR and shall be submitted within ten working days.

.5 The wall thickness of samples shall be determined as described in ASTM F1743. The minimum wall thickness at any point shall not be less than that of the design thickness.

.6 Visual inspection of the CIPP liner shall be in accordance with ASTM F1743.

26.3.2 Installation of CIPP Liner

.1 Job Commencement

Prior to commencing work, the Contractor shall submit, for EPCOR' approval, proposals for the preparation of liners, transportation, handling, installing and curing.

.2 Processing

.1 Prior to resin impregnation, each liner material shall be inspected for defects.

.2 The Contractor shall allow EPCOR to inspect the materials and resin impregnation process.

.3 Use a resin and catalyst compatible with the CIPP method.

.3 Installation

.1 Prior to installation inform affected residents in writing of the anticipated length of disruption to service, details of alternate service provided, any traffic-related constraints, noise levels to be expected, hours of work and safety concerns.

.2 The Contractor is required to attend any meetings organised with residents to discuss the work.

.3 The Contractor shall arrange for supply and pay for usage of water required. The use of fire hydrants will require a permit from EPCOR Water Services.

.4 The liner length shall be adequate to effectively span the distance to be lined. Verify lengths in the field prior to installation.

.5 Individual installations may run over one or more manhole sections if shown on the shop drawings or determined in the field and approved by EPCOR.

.6 The saturated lining material shall be inserted through an existing manhole or other approved access point by means of an inversion process, or other approved method. Sufficient force shall be applied to fully extend the lining material to the next designated manhole or termination point. The procedure shall produce an identifiable mark at the service connections.

.7 Lubricants may be used to reduce friction during inversion or insertion. Lubricants shall be approved by EPCOR.

.4 Curing and Cool Down

.1 After the liner placement is completed, supply all equipment to cure the resin.

.2 The equipment shall be capable of uniformly raising the liner temperature above that required to effectively cure the resin. Temperature shall be maintained during the curing period recommended by the resin manufacturer.

.3 Supply a temperature gauge to monitor the incoming and outgoing temperatures of the water, air, or steam.

.4 Install another temperature gauge between the impregnated CIPP liner and the pipe invert at the remote manhole to determine the temperature during curing.

.5 Maintain curing temperature until the CIPP liner becomes hard and sound.

.6 After the curing, a cool down period shall be provided prior to opening the downstream pipe system, reconnection of services, and returning normal flow back to the system.

.7 The CIPP liner shall be cooled to a suitable temperature before relieving the pressure on the liner.

.8 Release the pressure gradually to prevent development of a vacuum in the newly installed CIPP liner.

26.3.3 Sealing CIPP Liner at Manholes

.1 At manhole entrances and exits, the interface between the exterior surface of the liner and the manhole shall be made watertight. The ends of the liner shall be neatly trimmed so the liner fits flush with the manhole interior surface.

.2 If the CIPP liner fails to make a tight seal at the manhole, the Contractor shall apply a compatible resin mixture seal in accordance with ASTM F1216.

26.3.4 Reinstatement of Service Connections

.1 After the pipe system is in position, the existing services shall be re-established in accordance with ASTM F1216.

.2 Unless otherwise approved by EPCOR, reconnection of services shall be done without excavation by means of a remote control cutting device or directly where entry is possible.

.3 A CCTV camera shall be attached to the cutting device for precise location of the service connections.

.4 Prior to any sewer leads being completely opened to the newly lined sewer, a small diameter relief hole shall be cut through the liner into each lead opening to relieve any water that has accumulated in the leads during the lining process. After the relief holes have been cut for each service, the process of completely opening each lead shall commence.

.5 All service leads existing prior to CIPP liner installation shall be opened immediately following the lining installation process. The cost of any damages occurring from services that are not re-opened shall be borne by the Contractor.

.6 The service connections shall be re-established to the same condition as existed prior to the installation of the liner. Sewer connection reinstatement, including catchbasin leads, shall be restored to a minimum of 95% of the original cross sectional area of the connection.

.7 Voids between the liner and the existing sewer wall after connection reinstatement shall be filled with either a non-shrinking, watertight cement grout, an approved polyurethane grout; a resin mixture compatible with the liner system; or other approved grouting product.

26.3.5 Liner Finish and Project Completion

.1 Ensure that the CIPP liner is continuous over the entire length of installation and is free from visual defects such as foreign inclusions, dry spots, pinholes, lifts, wrinkles and delamination. If any of these conditions are present, remove and replace the CIPP liner in these areas.

.2 Provide a digital video accompanied by an inspection report showing the relined sewer with a clear view of each lateral service. Equipment used for this CCTV record shall be capable of viewing the service from the main to show at least 2 m into the service lead. The format of the report shall be in accordance with Section ***23*** - Inspection of Sewers.

.3 During the warranty period, repair at no cost to EPCOR any defects that will affect the integrity or strength of the CIPP liner to the satisfaction of EPCOR.

26.3.6 Clean-up

.1 Upon acceptance of the liner, clean up and restore the affected surface areas to the condition that existed prior to commencement of the work.

.2 Remove and haul debris to an approved disposal site.

END OF SECTION

27 LEAKAGE TESTING OF SEWERS

27.1 GENERAL

27.1.1 Scope

This section specifies requirements for leakage testing of gravity sewers and sewer forcemains.

27.1.2 Related Sections

Quality Assurance	Chapter 8	Volume 1: General
Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewage Forcemains	Section ***12***	
Sewers	Section ***13***	
Sewer Services	Section ***14***	
Manholes and Catch Basins	Section ***17***	
Precast Concrete Box Sewers	Section ***20***	
Inspection of Sewers	Section ***23***	

27.1.3 Submittals

.1 Submit reports of testing at the completion of the project. The report shall contain test forms signed by the recorder and the supervisor.

.2 In the report, each instrument used for testing shall be identified and the date of latest calibration noted.

27.1.4 Gravity Mains Testing - General

.1 All leakage tests shall be conducted after the service connections to the main have been installed. Service connections include in-line tees, wyes, saddles, etc.

.2 The testing scope is identified in the Contract. As a minimum, the leakage tests shall be conducted on 10% of all sanitary sewers.

.3 The Engineer will select the sewer sections to be tested after the construction is complete.

.4 The Engineer will select the type of leakage test to be performed for the gravity mains, and it will be either the exfiltration test or the Infiltration test. For the forcemains, it shall be the hydrostatic pressure test.

.5 Perform tests in presence of the Engineer. Notify the Engineer 48 hours in advance of proposed tests. The Contractor shall perform and record testing.

.6 If the event that the initial leakage test conducted by methods described within this section fails, then in addition to re-testing of the repaired initial 10% of the system, an additional 10% of the system shall be tested. Should this additional section fail too, the remainder of the sewer in the project shall be also tested for leakage. The Contractor shall replace or repair the section(s) of sewer and the testing and remedial work shall be repeated until leakage is within the allowance specified in this section.

.7 In the event that an exfiltration test fails, the line must be left drained and left for a period of 4 calendar days before attempting any further tests.

.8 Damage resulting from testing shall be repaired by the Contractor at the Contractor’s expense.

27.2 PRODUCTS

Not applicable

27.3 EXECUTION

27.3.1 Preparation for Testing of Gravity Mains

.1 Remove foreign material from sewers and related appurtenances by flushing with water. Do not allow debris to enter the downstream sewer system but remove in accordance with Chapter 13 - Protection of the Urban Environment, Volume 1: General.

.2 Perform inspections in accordance with Section ***23*** - Inspection of Sewers, as soon as practicable after construction is complete and service connections have been installed.

.3 Install watertight bulkheads in suitable manner to isolate test section from the rest of the pipeline.

27.3.2 Exfiltration Test

.1 Fill test section with water in such a manner as to allow displacement of air in line. Maintain pressure under nominal head for 24 hours to ensure absorption in pipe wall and manhole barrels is complete before test measurements are commenced.

.2 Immediately prior to the test period add water to pipeline until there is adequate head of water. The Engineer will determine the height, and it will be between minimum of 1 m and maximum of 3 m over the interior crown of the pipe measured at highest point of the test section.

.3 The duration of the exfiltration test shall be 2 hours.

.4 Water loss at the end of the test period is not to exceed the maximum allowable leakage of 10.0 litres per day per mm of pipe diameter per 1 km of sewer line.

27.3.3 Infiltration Test

.1 Discontinue trench dewatering operations for at least three days prior to testing.

.2 Prevent damage to pipe and bedding material due to flotation and erosion.

.3 Place 90° V-notch weir, or other measuring device approved by the Engineer in the invert of the sewer at each manhole.

.4 Measure rate of flow over a minimum of 1 hour, with recorded flows for each 5 minute interval.

.5 The maximum allowable leakage is not to exceed 10.0 litres per day per mm of pipe diameter per 1 km of sewer line.

.6 The above leakage limit shall constitute the overall leakage allowance for the test section, inclusive of leakage from manholes and other appurtenances.

.7 Where service connections exist along the test section, the allowable leakage from the service connections can be included in addition to the main sewer leakage allowance to arrive at a total allowable leakage. Service connection allowance shall be calculated by use of the above formula.

27.3.4 Hydrostatic Test - Forcemains

.1 After flushing, the main shall be subjected to a hydrostatic pressure test. The test pressure shall be one and a half times the operating pressure and not less than 350 kPa.

.2 Immediately prior to testing any section, all appurtenances shall be checked to ensure that they are prepared for the test. Air valves shall be checked to ensure that they are prepared for the test. Air valves shall be opened while the mains are filled. If all the air from the test section cannot be expelled from existing fittings and appurtenances, the Contractor shall tap the section in a manner acceptable to the Engineer to expel the air.

.3 Strut and brace caps, bends and tees to prevent movement when test pressure is applied.

.4 The main shall be filled with the test water and brought to a pressure of 10% of test pressure at the testing point. Any air valves in the test section shall than be closed so that test pressure will not cause damage. The main shall remain under the above pressure for a period of at least 24 hours before applying test pressure.

.5 Test Requirements – Steel and PVC Pipe

.1 Testing shall be conducted in accordance with AWWA C605 for PVC pipe and AWWA C604 for steel pipe, except as amended herein.

.2 The pipeline shall than be brought up to the test pressure, and it shall be maintained for a period of not less than 1 hour. Accurate means shall be provided for measuring the quantity of water required to maintain full pressure on the line for the test period

.3 No pipe installation will be accepted until the apparent leakage is less than the number of litres per hour as determined by the formula:

$$Q = \frac{LD\sqrt{P}}{795{,}000}$$

where, Q = the allowable apparent leakage (or quantity of make-up water) in litres per hour.

L = the length of pipe in the test section in m.

D = the nominal pipe diameter of pipe in mm, and

P = the average test pressure during the leakage test in kPa.

.6 Test Requirements – Polyethylene (PE) Pipe

.1 Testing for PE pipe shall be generally completed in accordance to AWWA F 2164 except as amended herein.

.2 Confirm test pressure is less than 1.5 times the design pressure rating for the pipe. Do not exceed maximum test pressure.

.3 The entire test procedure, including expansion phase and test phase, shall not exceed 8 hours. If test exceeds 8 hours, depressurize and allow pipe to relax for a minimum of 8 hours.

.4 Initial expansion phase -Slowly pressurize the main to test pressure and add makeup water to maintain test pressure for a period of 4 hours.

.5 Test Phase – Reduce test pressure by 70 kPa and monitor pressure for 1 hour. Do not increase pressure or add makeup water.

.6 If there is no visible leakage, and the test pressure during the test phase remains constant, within 5 percent of the test pressure, a passing test is indicated. There is no allowable makeup water for this test.

.7 If retesting is necessary, depressurize main and allow pipe to relax for a minimum period of 8 hours. Repeat expansion phase and test phase as specified herein.

.7 Leakage test allowance in all tests is for “apparent” leakage due to entrapped air and pipe expansion. No visible leakage is permitted as acceptance criteria irrespective of the apparent leakage determine by this acceptance test.

.8 Should the test section fail to meet the maximum allowable apparent leakage specifications or has any signs of visible leakage whatsoever, the Contractor shall take whatever steps are necessary to locate the leaks and correct them. The test procedure shall be repeated after repairs are made until satisfactory results are obtained.

END OF SECTION

28 DEFLECTION TESTING OF FLEXIBLE PIPE

28.1 GENERAL

28.1.1 Scope

This section specifies requirements for the deflection testing of sewers with a “go/no-go” mandrel and/or other suitable measuring devices. Other suitable devices may include laser profiling equipment, or other methods as approved by EPCOR. The onus shall be on the Contractor to demonstrate that the accuracy of the alternate measuring device meets the technical requirements of the specification.

28.1.2 Related Sections

Trench Backfill	Section 3.1	Volume 2: Complete Streets
Sewers	Section ***13***	
Inspection of Sewers	Section ***23***	

28.1.3 Submittals

Submit reports of testing at the completion of the project. The report shall contain test forms signed by the recorder and the supervisor.

28.1.4 Deflection Testing for Flexible Pipes - General

.1 The scope of work of the deflection testing includes cleaning, traffic control and CCTV inspection.

.2 Where closed circuit television (CCTV) or visual walk-through inspections show evidence of excessive or non-symmetrical deflection (e.g. a non-elliptical deformation pattern), formal deflection tests shall be conducted. The location and number of deflection tests shall be at the sole discretion of EPCOR.

.3 Where formal inspection tests are required, inspect pipes up to and including 900 mm diameter with a “go/no - go” mandrel device as described in this section. Other suitable measurement devices shall be approved by EPCOR. Where required, pipes larger than 1050 mm diameter shall be inspected with a suitable measurement device such as a telescoping rod in conjunction with a walk-through inspection. These tests are to confirm that the vertical deflection does not exceed the allowable deflection limit stipulated below and that the nature of deflection observed is illustrative of natural anticipated flexible-pipe soil interaction.

.4 Deflection tests for acceptance purposes shall be conducted not sooner than 30 days after all backfill has been completed.

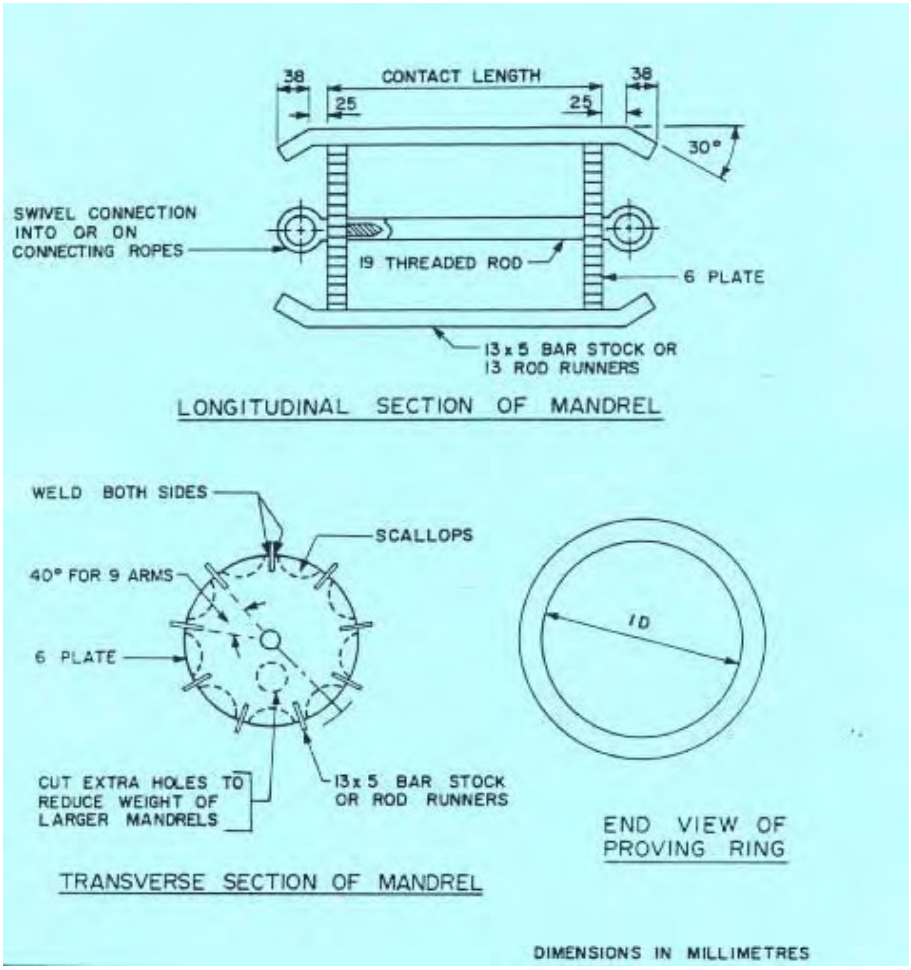
.5 Short term deflection shall be deemed to be any deflection measured not sooner than 30 days after backfilling.

.6 Long term deflection shall be deemed to be any deflection measured after one year of backfilling.

28.2 PRODUCTS

28.2.1 Mandrel

.1 The mandrel shall be cylindrical in shape, constructed with nine evenly spaced arms and shall conform to the following schematic:



.2 Mandrels larger than 450 mm in diameter shall be constructed with special breakdown devices to facilitate entry through standard access manholes.

.3 The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the values indicated below for each specific pipe material, within a tolerance of +/- 0.25 mm. The contact length of the mandrel shall be at least 75% of the inside diameter of the pipe. The outside diameter of the mandrel arms shall be checked for conformance with proving rings.

.4 Either an oversize or undersize proving ring shall be used to confirm the acceptability of mandrel dimensions. An oversize proving ring shall be of a diameter equal to the required outside mandrel size plus 1 mm. An undersize proving ring shall be of a diameter equal to the required outside mandrel size minus 0.30 mm. Both proving rings shall be manufactured to within 0.25 mm of the specified size. The proving rings shall be fabricated from 6 mm minimum thickness stainless steel.

.5 Dimensions for mandrels for acceptance purposes shall conform to the table below.

Nominal Pipe Size (mm)	Radius of Test Mandrel (mm)			
	Solid Wall PVC Pipe SDR 35		Open Profile Wall PVC Pipe	
	Short Term	Long Term	Short Term	Long Term
100	47	45.9	47.1	45.9
150	70	68.3	70	68.3
200	93.7	91.4	93.7	91.4
250	117.1	114.3	117.1	114.3
300	139.4	136	139.3	136
375	170.6	166.5	170.6	166.5
450	208.5	203.5	209.5	204.5
525	245.8	239.9	246.3	240.4
600	276.6	269.9	279	272.3
675	311.7	304.2	314.9	307.4
750	357.1	348.5	350.6	342.1
900	427.3	417	421.9	411.7
1,050	496.4	484.5	493.2	481.3
1,200	566.7	553	564.5	550.9

.6 An acceptable mandrel will pass through the oversize ring, but not through the undersize ring.

.7 The allowed vertical deflection shall be as follows:

.1 For testing done after 30 days, short term deflection, maximum allowable deflection is 5% of the CSA Base Inside Diameter (BID).

.2 For testing done after one year, long term deflection, maximum allowable deflection is 7.5% of the CSA BID.

END OF SECTION

29 CONCRETE FOR WATER AND DRAINAGE STRUCTURES

29.1 GENERAL

29.1.1 Scope

Supply and installation of cement concrete for water and drainage structures, excluding precast concrete.

29.1.2 Related Sections

Concrete Forms and Accessories	Section 7.10	Volume 2: Complete Streets
Reinforcing Steel	Section 7.12	Volume 2: Complete Streets

29.1.3 Quality Control

.1 The Contractor shall retain and pay for the services of a testing laboratory to perform field tests on the concrete produced and installed. The minimum test requirements shall be:

.1 Air content: Every batch delivered until air content is established to within specifications, minimum once per day. Every third batch thereafter, unless specifications are not met.

.2 Slump: Every batch delivered until specifications are met, minimum once per day. Every third batch thereafter.

.3 Strength: In accordance with CSA-A23.2, standard tests for strength will be conducted at a frequency of not less than one strength test for each 50 m^3 poured, or portion thereof, with minimum of one test per project. The standard strength test shall consist of three cylinders, laboratory moist cured, except when temperature is below 5o C, when cylinders shall be field cured. Slump and air content taken with cylinders. One cylinder shall be broken at 7 days, and two cylinders at 28 days.

.4 Field cured cylinders: Two additional cylinders shall be cast when the ambient temperature is 5° C, or lower. Field cured cylinders shall be cured on the job site under the same conditions as the concrete they represent. One cylinder shall be broken at 7 days, and one cylinder at 28 days.

.2 Failure to meet specifications shall result in the Engineer requesting, at the Contractor's cost:

- a change in mix design or supplier.
- additional testing (coring, etc.)
- remedial work or replacement.
- other work as deemed necessary.

29.2 PRODUCTS

29.2.1 Materials

.1 Cement: to CSA-A3000, Type HS High sulphate-resistant hydraulic

.2 Aggregates: to CSA-A23.1

.3 Water: to CSA-A23.1

.4 Air Entraining Admixture: to ASTM C260

.5 Chemical Admixture: to ASTM C494. Engineer to approve accelerating or set retarding admixtures during cold and hot weather placing.

29.2.2 Non-Shrink Grout

Premixed compound consisting of non-ferrous aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 16.5 MPa at 2 days and 48 MPa at 28 days.

29.2.3 Curing Compound

Non-membrane, colourless, non-yellowing chemical liquid curing compound conforming to CSA-A23.1 and to ASTM C309.

29.2.4 Floor Hardener

Non-metallic, natural aggregate surface hardener.

29.2.5 Bonding Agent

Two component, epoxy resin.

29.2.6 Waterstops

PVC Waterstop: Extruded PVC of sizes as indicated in the drawings, to conform to CGSB 41-GP-35M. Waterstop type and profile to be pre-approved by the Engineer. Chemical resistant hydrophilic waterstops or approved equal.

29.2.7 Dampproofing for Drainage Structures

Emulsified asphalt, mineral colloid type, unfilled to CAN/CGSB-37.2.

29.2.8 Waterproofing for Drainage Structures

Cementitious waterproofing such as Xypex, Vandex, or approved equal.

29.2.9 Joint Sealant

Control and expansion joints, on the interior and exterior of concrete walls as shown on drawings. Sealant to CAN/CGSB-19.13 - one component, elastomeric, chemical curing sealing compound. Refer to drawings for joint details and sealants for other joint types.

29.2.10 Other Materials

All other materials, not specifically described but required for a complete and proper installation of all cast-in-place concrete, shall be as selected by the Contractor subject to the approval of the Engineer.

29.2.11 Mix Design

.1 Submittals: In accordance with CSA-A23.1, Table 5, it is the intent that EPCOR follows Alternative 1 method of specifying concrete. The concrete supplier assumes responsibility for the concrete mix proportions, and in conjunction with the Contractor, shall submit a design to the Engineer for review that will comply with the requirements of EPCOR.

.2 As a minimum, and unless specified by the Engineer elsewhere, for concrete used in water and sewage facilities, the properties of the concrete shall be:

- .1 The minimum 28-day compressive strength requirement is 30 MPa.
- .2 The maximum water/cementing material ratio is 0.50.
- .3 Air content to be 5 % to 7%.
- .4 The slump for concrete shall be 80 mm, ± 30 mm, unless specified elsewhere by the Engineer. The specified slump for pumping of concrete may be increased with the use of superplasticizing admixtures, upon approval of the mix design by the Engineer.
- .5 Maximum aggregate size of 20 mm, unless specified otherwise elsewhere. Concrete density shall be normal.

.3 Accelerating admixtures may be used in cold weather subject to approval of the Engineer. If approved, the use of admixture will not relax the cold weather placement requirements. Use of calcium chloride shall not be permitted.

.4 Set retarding admixtures may be used during hot weather to allow for proper finishing of concrete, subject to approval of the Engineer.

.5 The ratio of supplementary cementitious materials to total cementitious materials shall not exceed 0.20.

29.3 EXECUTION

29.3.1 Delivery of Concrete

.1 Concrete shall be delivered to the job site according to CSA-23.1 as supplemented or modified below.

.2 The drum shall be rotated on the job site at mixing speed for three minutes just before discharge.

.3 Water shall not be added after initial introduction of mixing water at the plant except when the slump at initial discharge is less than specified. If water is added, it is the responsibility of the supplier to ensure that the specified slump is not exceeded, and the specified strength is attained. Slumps exceeding the specified slump will be a cause for rejection.

.4 Re-tempering with Air-Entraining Admixtures is only permitted under the following conditions:

.1 Re-tempering on site with an approved air-entraining admixture shall only be performed by a quality control technician working for the concrete supplier. Dry, powdered, bagged or pre-measured liquid air-entraining admixtures may be added by the concrete truck operator under the direction of the supplier's quality control technician. For re-tempering purposes the concrete supplier shall use a comparable air-entraining admixture to what was originally approved for use in the mix design. Rotate the drum for 3 to 5 minutes or until the mix is uniform, after the addition of the air entraining admixture.

.2 The quality assurance technician shall perform an air content test on each load of concrete re-tempered with air-entraining admixtures and shall immediately provide the test results to the Engineer.

.3 Guidelines for re-tempering with air-entraining admixtures

Measured Air Content (%)	Action
5.0 – 5.4	Addition of water or air-entraining admixtures as deemed necessary by the supplier to meet specifications
4.0 – 4.9	Air-entraining admixtures or air-entraining admixtures and water must be added as deemed necessary by the supplier to meet specifications
< 3.9	No re-tempering with air-entraining admixtures or water is permitted; load will be rejected

.4 When re-tempering with air-entraining admixtures, the supplier will be given one opportunity to meet the specified air content.

.5 When initial load requires re-tempering, the quality assurance technician shall perform an air content test to verify air content on subsequent loads until such time air content is acceptable.

.6 If the need for re-tempering with air-entraining admixtures becomes persistent or continuous, the Engineer or his representative may refuse to accept concrete loads that have been re-tempered with air-entraining admixtures.

.7 The use of de-air-entraining admixtures is not permitted.

.8 A load of concrete will be rejected if it is re-tempered with air-entraining admixtures and the resulting air content exceeds the specified maximum air content.

.9 A load of concrete that is rejected at the jobsite may not be re-tempered at the concrete plant with cement, aggregate, sand or admixtures and subsequently returned to the jobsite.

.10 On site mix adjustments with cementitious materials, sand aggregate or any chemical admixtures other than air-entraining admixtures and superplasticizers will not be permitted.

.5 The slump shall be measured in accordance with CSA-A23.2-5C.

.6 The total air content shall be measured in accordance with CSA-A23.2-4C.

.7 Concrete shall arrive at the work site with a temperature of not less than 10°C and not greater than 30°C.

.8 Concrete shall be delivered to the site and discharged within two hours after introduction of the mixing water to the cement and aggregates.

.9 The delivery ticket shall show batch plant location, supplier's name, ticket and truck numbers, mechanically punched date and time of initial plant mixing, mix design designation, water added, volume of concrete, site arrival and discharge time and any other information requested by the Engineer. Non compliance of any of the requirements above shall be reasons for rejection of concrete by the Engineer.

29.3.2 Preparation

.1 Obtain the Engineer's approval before placing concrete. Provide 24 hours notice prior to placing concrete.

.2 Pumping of concrete is permitted only after approval of equipment and mix.

.3 Ensure reinforcement and inserts are not disturbed during concrete placement.

.4 Prior to placing of concrete obtain Engineer's approval of proposed method for protection of concrete during placing and curing.

.5 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.6 Do not place load upon new concrete until authorized by the Engineer.

29.3.3 Construction

.1 Do cast-in-place concrete work in accordance with CSA-A23.1.

.2 Sleeves and Inserts

.1 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by the Engineer.

.2 Where approved by the Engineer, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 mm x 100 mm not indicated shall be approved by the Engineer.

.3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from the Engineer before placing of concrete.

.4 Check locations and sizes of sleeves and openings shown on drawings.

.5 Set special inserts for strength testing as indicated and if required by non-destructive method of testing concrete. Refer to 1.3 - Quality Control above.

.3 Anchor Bolts

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 With approval of the Engineer grout anchor bolts in pre-formed holes or holes drilled after concrete has set.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

.4 Set bolts and fill holes with shrinkage compensating grout.

.5 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.

.4 Waterstops

.1 Install waterstops in all construction joints as shown on detailed drawings, or located below finished grade. Install them to provide a continuous water seal. Do not distort or pierce waterstop in such a way as to hamper performance. Do not displace reinforcement when installing waterstops.

.2 Use only straight heat sealed butt joints in field. Use factory welded corners and intersections unless otherwise approved by the Engineer.

.3 All field splices to be inspected by the Engineer.

.4 Hydrophilic waterstops shall be kept dry until the fresh concrete is poured.

.5 Joints

.1 Locate and form all isolation or expansion joints as indicated on the Drawings. Install joint filler, sealer and primer to manufacturer's instructions.

.2 Install a polyethylene strip over joint filler to prevent bonding to joint sealer.

.3 The Contractor shall submit a plan that shows the proposed location of joints and pour breaks to the Engineer for approval.

.4 Do not allow reinforcing steel to run through expansion joints or isolation joints unless otherwise indicated.

.6 Finishing

.1 Finish concrete in accordance with CSA-A23.1.

.2 Use procedures acceptable to the Engineer or those noted in CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged.

.7 Floor Finishes

Finish and protect the top surface of all concrete as indicated on the Drawings or as specified below:

.1 Plain Floor Finish (all covered floors and roof)

i. Finish concrete floors to CSA-A23.1 as specified below.

ii. Use two passes of steel trowelling to produce smooth burnished surface to within 5 mm tolerance when measured in any direction using 3 m. straight edge.

iii. At areas with floor drains, maintain floors level at walls, pitch floor uniformly to drains at a minimum rate of one half of one percent (5 mm per m) or as shown on the Drawings.

.2 Hardened Floor Finish (all exposed floors)

Finish concrete floors as per 3.3.7.1 above, and apply hardener at a rate specified by the manufacturer.

.3 Textured Non-Slip Finish (all exterior flatwork)

Immediately after first trowelling of the "Plain Floor Finish", swirl-trowel, brush or broom the surface to a uniformly textured non-slip finish, as described in CSA-A23.1.

.8 Wall Finishes

.1 In accordance with CSA-A23.1, leave concrete with a rough form finish for use on surfaces not exposed to view in the structure. Chip off fins and irregular projections, and patch form tie holes.

.2 For walls and surfaces exposed to view, the Contractor shall provide a sack rubbed finish as described in CSA-A23.1

.9 Protection and Curing

.1 Cure all concrete in accordance with CSA-A23.1, Section 7.

.2 Loosen wall forms within 24 hours as outlined in Section 7.10 - Concrete Forms and Accessories, Volume 2: Complete Streets.

.3 Initial curing: ensure the concrete surface is kept continuously moist until the temperature produced by the heat of hydration of the cement has peaked and dropped at least 8°C.

.4 Final Curing: immediately after initial curing, additional curing shall be applied and maintained for a period of 7 days, to ensure that the specified concrete strength and quality has been obtained.

.10 Damp-proofing and Waterproofing of Drainage Structures

.1 Apply damp-proofing compound to exterior of structural wall below grade where shown on drawings, according to manufacturer's recommendations.

.2 Apply waterproofing material onto interior surfaces of structural base and wall as indicated on drawings, within 72 hours of stripping forms, and as recommended by the manufacture of the waterproofing materials. Cure the waterproofing compound as recommended by the manufacturer.

.11 Repairing Concrete

.1 Cut back metal form ties and voids not less than 20 mm from surface and fill with non-shrink grout.

.2 Cut back honeycombed or defective areas perpendicular to the surface to a depth of 20 mm. Brush on 1:1 cement sand grout over a saturated surface then patch with a 1:2 cement sand mortar with 10% hydrated lime.

.3 Where honeycombing or defective areas require cut backs deeper than 50 mm, use non-shrink grout.

.12 Bonding New Concrete to Old

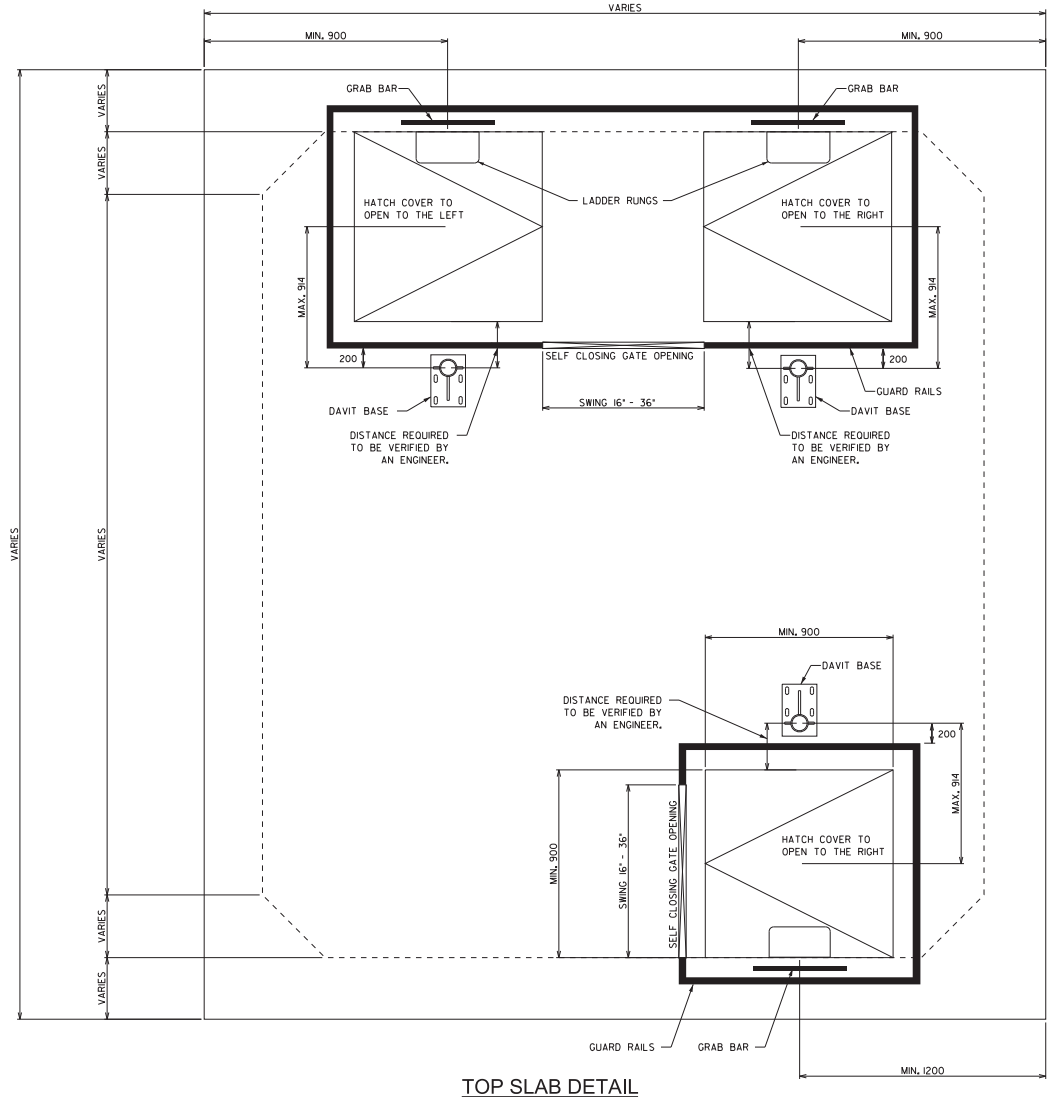
.1 Clean old concrete surface and protruding reinforcing steel concrete for a distance shown on detailed drawings.

.2 Roughen cleaned surfaces to expose the coarse aggregate of the existing concrete.

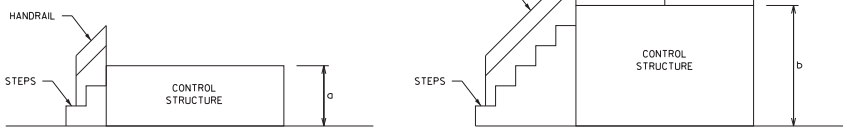
.3 Immediately prior to placing new concrete, apply a coating of bonding agent to the existing surface, in strict accordance with the manufacturer's recommendation.

.4 In locations where new concrete is doweled to existing work, drill holes in existing concrete and insert steel dowels and pack solidly with non-shrink grout to positively position and anchor dowels, or as indicated on the drawings.

END OF SECTION



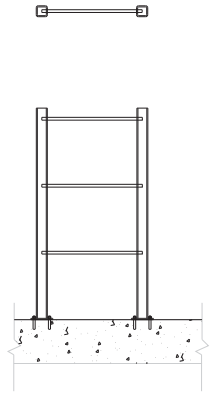
TOP SLAB DETAIL



DETAIL A

DETAIL B

1. IF a ≥ 500 MM, STEPS AND HANDRAILS ARE REQUIRED. PERIMETER GUARDRAILS ARE NOT REQUIRED.
2. IF b ≥ 1200 MM, STEPS, HANDRAILS, AND PERIMETER GUARDRAILS ARE REQUIRED.



NOTES:
1. ALUMINIUM GRAB BARS FOR ABOVE GRADE NORMAL ENVIRONMENTS.
2. 316 SS GRAB BARS FOR ABOVE GRADE CORROSIVE ENVIRONMENTS AND ALL BELOW GRADE APPLICATIONS.

TYPICAL DETAIL OF GRAB BAR INSTALLATION

NOTES:
1. CONTROL PANELS SHALL HAVE UNOBSTRUCTED ACCESS FOR OPERATION AND MAINTENANCE WORK. PANELS THAT ARE AT THE OUTER EDGES AND OPEN TO THE OUTSIDE SHALL HAVE AN ENGINEERED PLATFORM AND GUARD RAILS.
2. ANCHORAGE CONNECTORS SHALL HAVE A MINIMUM CLEARANCE OF 230 MM FROM THE EDGE OF THE CONCRETE.
3. IF THE CONTROL STRUCTURE IS HIGHER THAN 0.5 M FROM THE GROUND, STEPS AND GUARD RAILS SHALL BE INSTALLED OR SOIL RAMPS ARE REQUIRED. SOIL RAMPS SHALL HAVE A 50% OR LESS SLOPE AND BE COVERED WITH GRASS. SEE DETAILS A AND B FOR REQUIREMENTS.
4. DAVIT BASE SHALL BE DESIGNED PER OH&S CODE AND ASSOCIATED CSA CODES CONSIDERING RESCUE AND INSPECTION OF THE FACILITY.
5. CONTACT DRENG@EPCOR.COM FOR ANCHOR BOLT PROOF LOAD TEST VALUES PER SECTION 2.13.2 (III) - VOL. 3-04: PUMP STATION AND FORCEMAIN DESIGN GUIDELINES.
6. GUARD RAIL SHALL NOT INTERFERE WITH DAVIT BASE AND OPERATION OF THE DAVIT ARM SYSTEM.
7. FOR OPEN HATCHES: SELF-CLOSING GATE, GUARD RAIL AND 6" HIGH KICK PLATE SHALL BE INSTALLED.
8. IF GUARD RAILS AREN'T A VIABLE OPTION, ANCHORAGE CONNECTORS SHOULD BE INSTALLED ON ALL FOUR CORNERS OF THE CONTROL STRUCTURE.
9. INSTALL A GRAB BAR AT ALL LADDER ACCESS LOCATIONS. DEPENDING ON THE SPACE AVAILABILITY, FOLLOW THE ORDER BELOW:
   a. INSTALL A GRAB BAR, SEE TYPICAL DETAIL OF GRAB BAR INSTALLATION FOR GUIDELINE.
   b. GUARD RAIL CAN BE DESIGNED TO ACT AS A GRAB BAR (EPCOR'S REVIEW AND APPROVAL IS REQUIRED)

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

TYPICAL DAVIT BASE, GUARD RAIL AND HATCH LAYOUT ON CONTROL STRUCTURE

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
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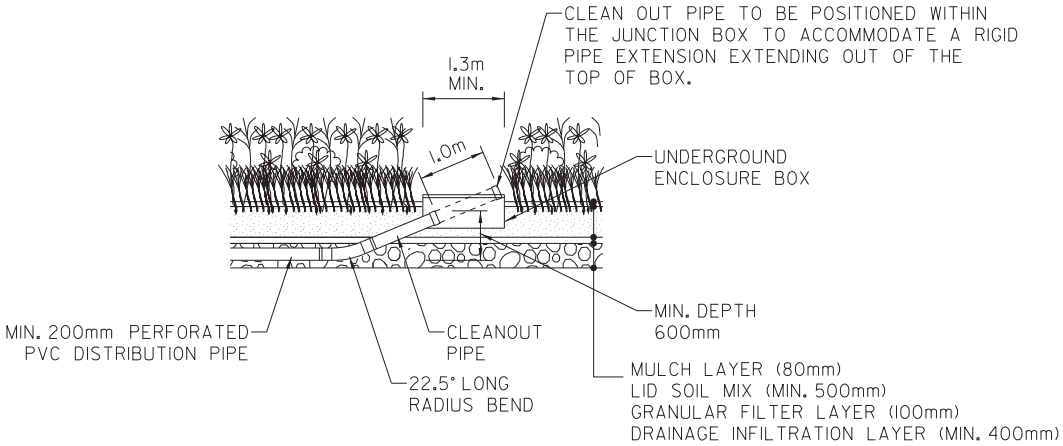
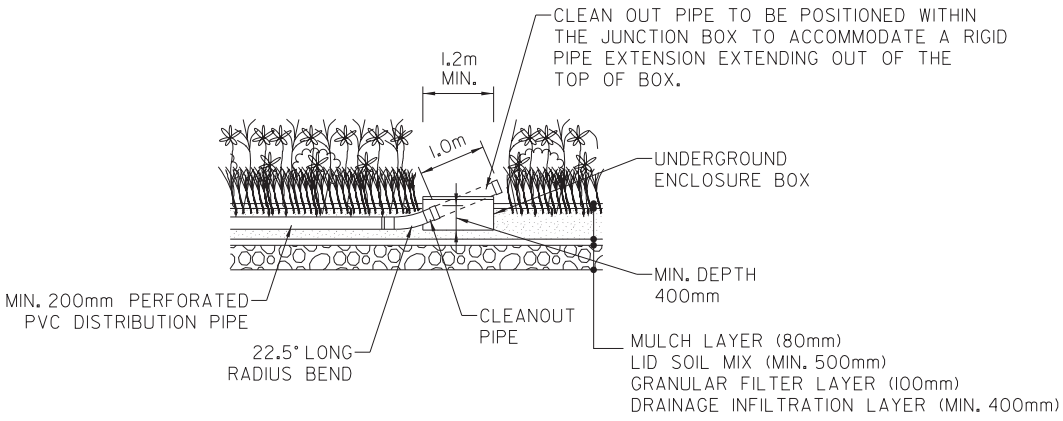
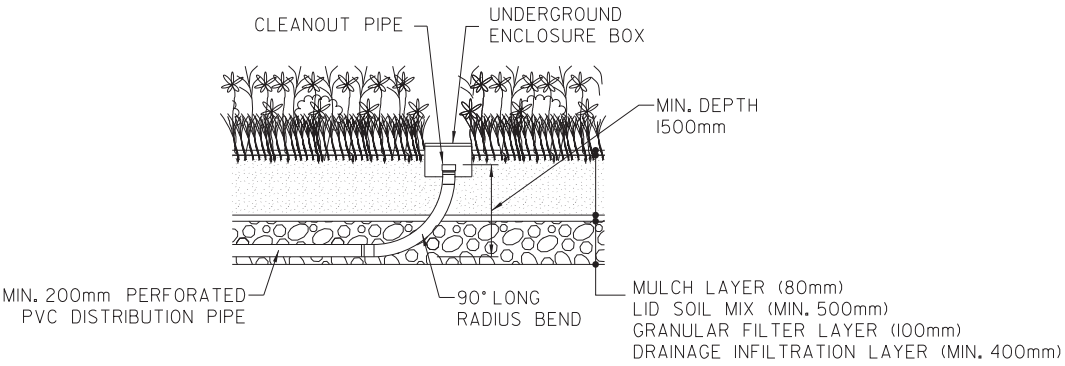
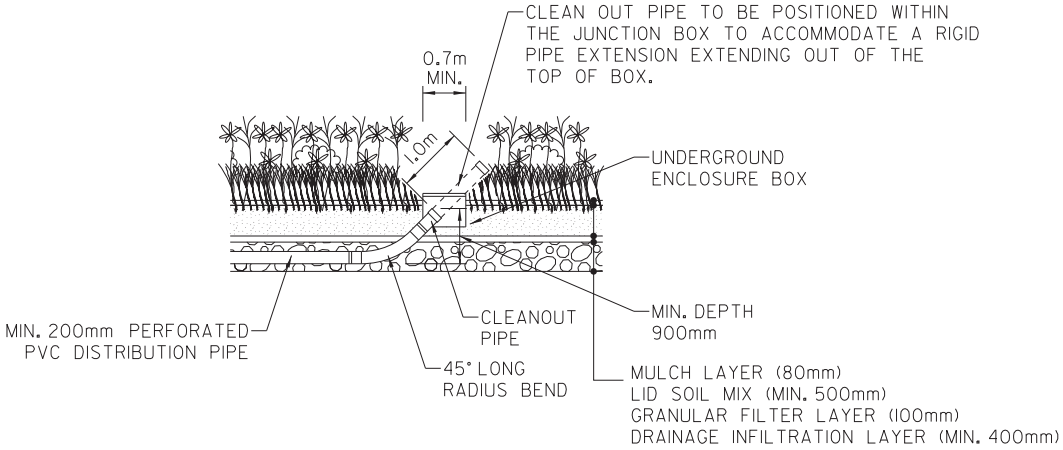
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		-





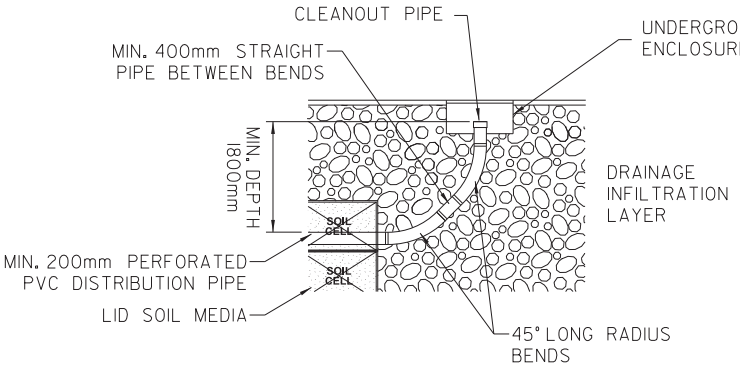


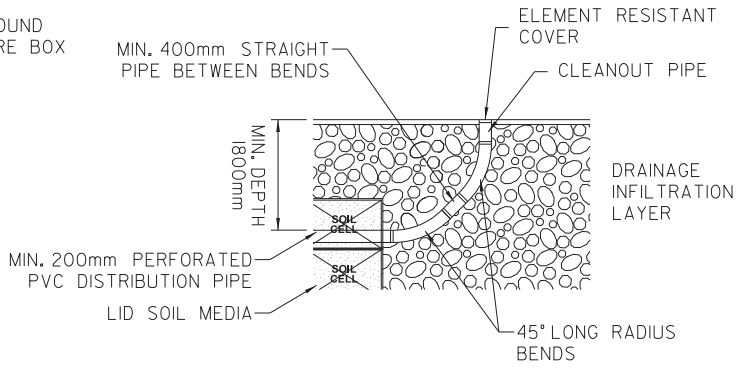


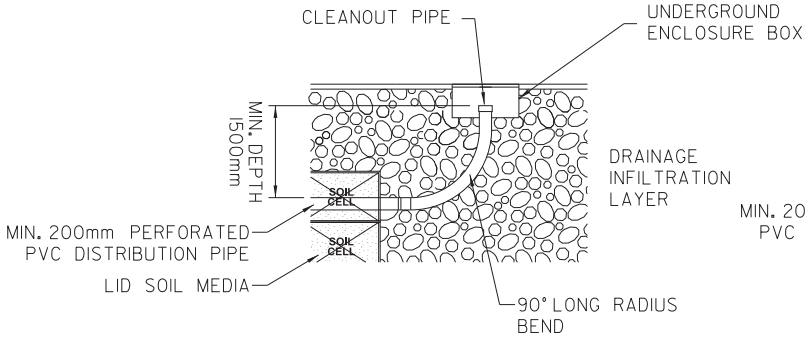
EPCOR

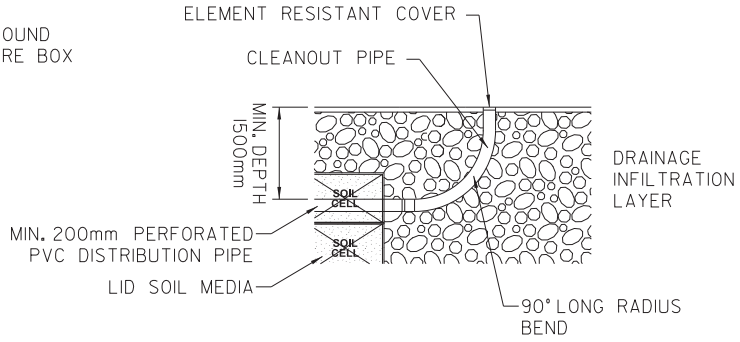
BIORETENTION CLEANOUTS

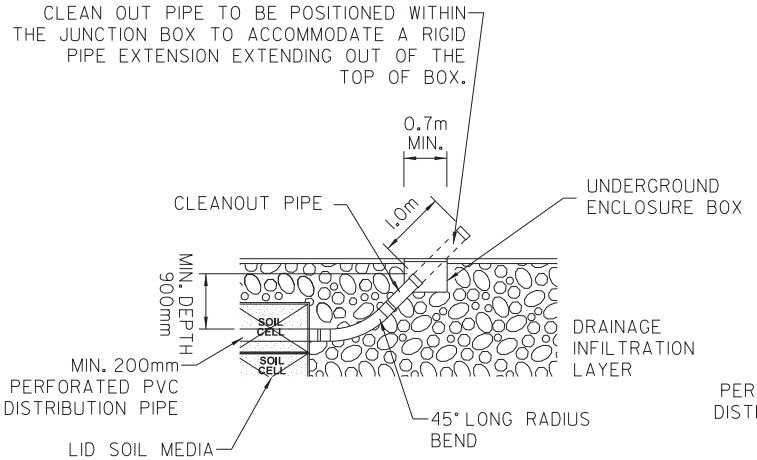
APPROVED OCTOBER 2021	DRAWN BY LW	APPROVED	DRAWING NUMBER DR-02-05-01
SCALE 1:8	CHECKED BY AL		OLD DRAWING NUMBER 7001

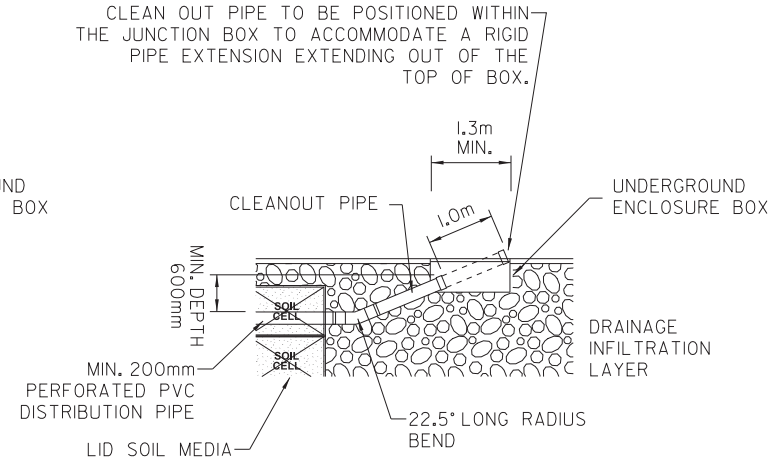












EPCOR

SOIL CELL CLEANOUTS

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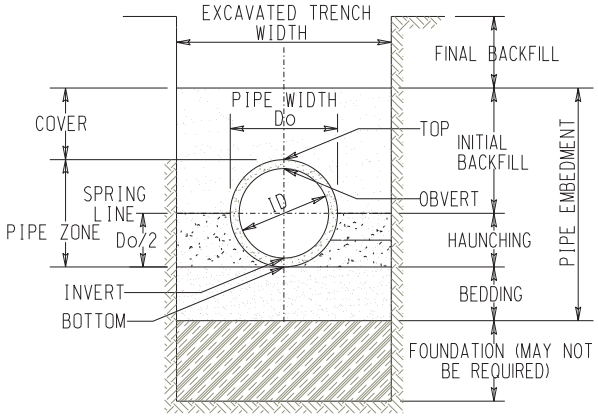
SCALE	CHECKED BY		OLD DRAWING NUMBER
1:8	AL		7003



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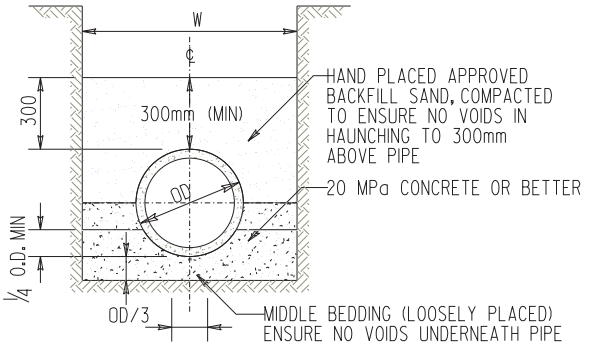
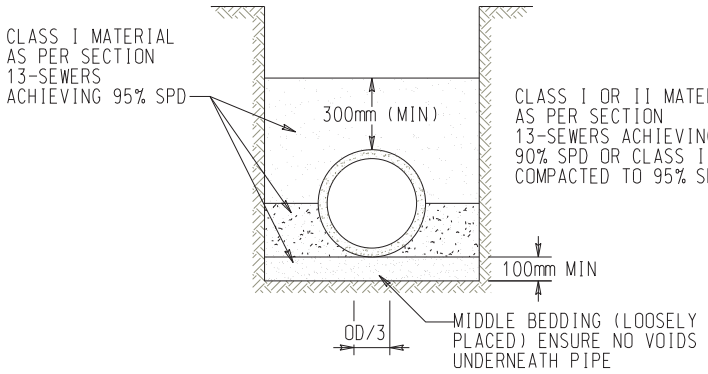
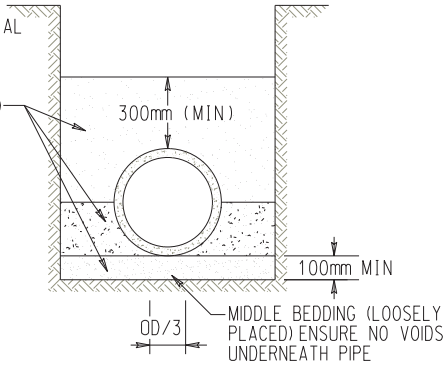


CLASS A BACKFILL (CONCRETE CRADLE)

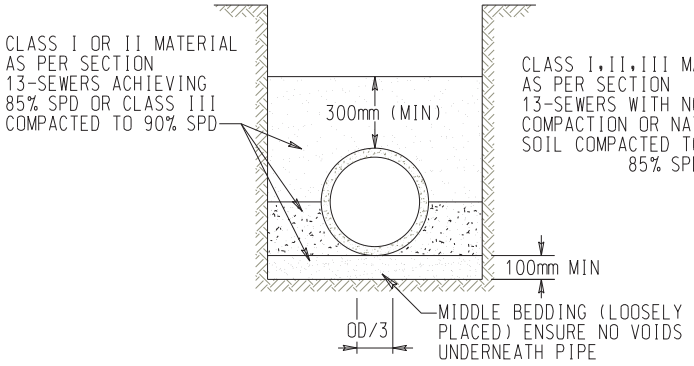


TYPE 1 INSTALLATION

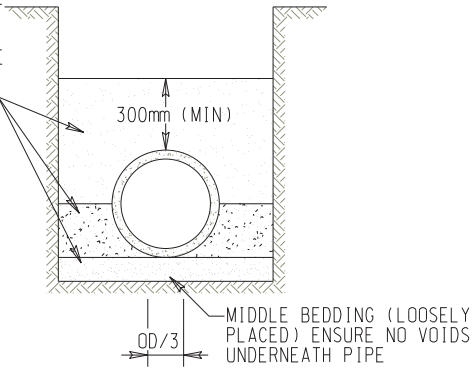
TYPE 1 INSTALLATION REQUIRES THAT THE MATERIAL DENSITY & METHOD OF INSTALLATION BE CERTIFIED BY A PROFESSIONAL ENGINEER



TYPE 2 INSTALLATION



TYPE 3 INSTALLATION



TYPE 4 INSTALLATION

TYPE 4 INSTALLATION ONLY APPROVED FOR USE WITH RIGID (CONCRETE PIPE)

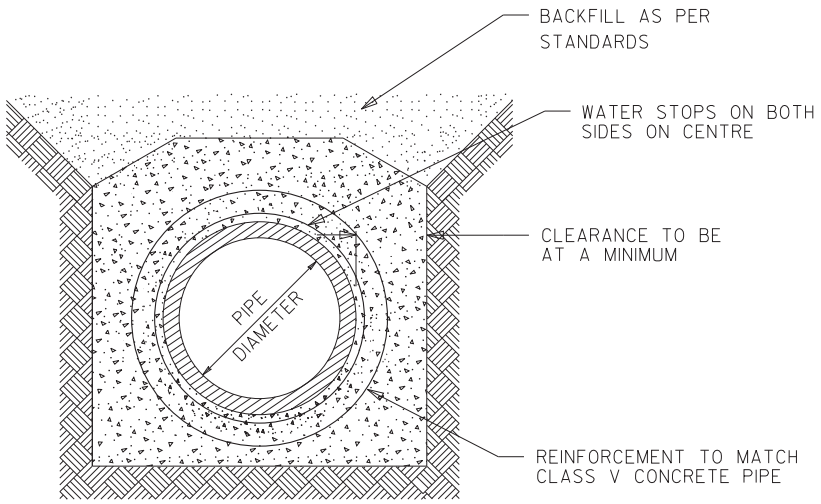
NOTES

1. W (TRENCH WIDTH) = OD + 450mm (MINIMUM), OD = OUTSIDE DIAMETER
2. d = DEPTH OF BEDDING BELOW PIPE;
   ID = 675mm OR SMALLER, d MIN = 75mm
   ID = 750mm TO 1500mm, d MIN = 100mm
   ID = 1650mm AND LARGER, d MIN = 150mm
   ID = INSIDE PIPE DIAMETER
3. BEDDING UNDER THE MIDDLE THIRD OF THE PIPE SHALL BE LOOSE, UNCOMPACTED MATERIAL.
4. IF A ROCK FOUNDATION, THEN MINIMUM BEDDING THICKNESS IS Do/24.

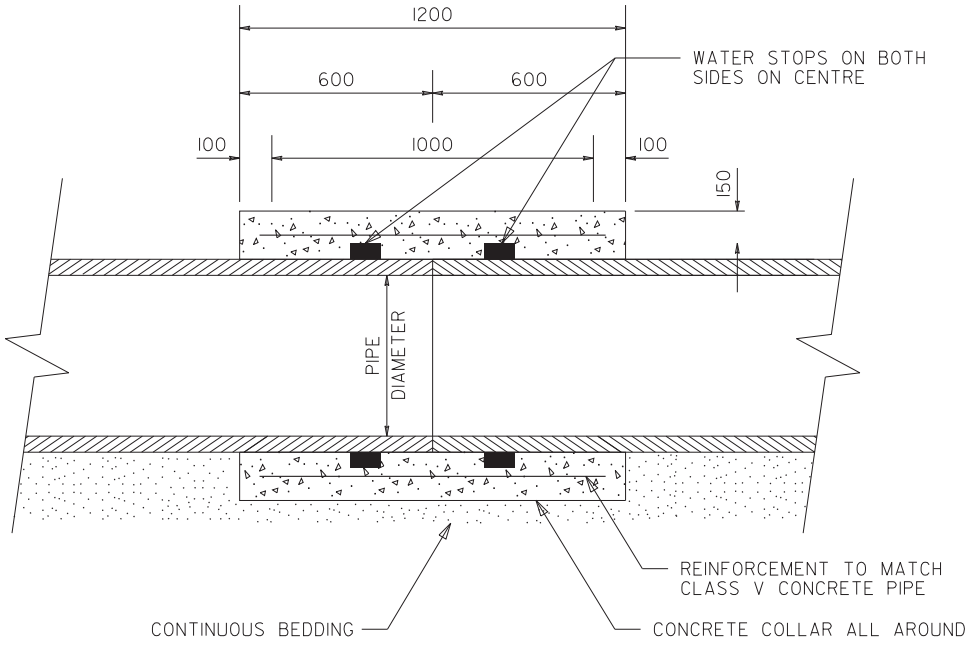
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

TRENCH BEDDING TYPES

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-13-01
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7980



END VIEW

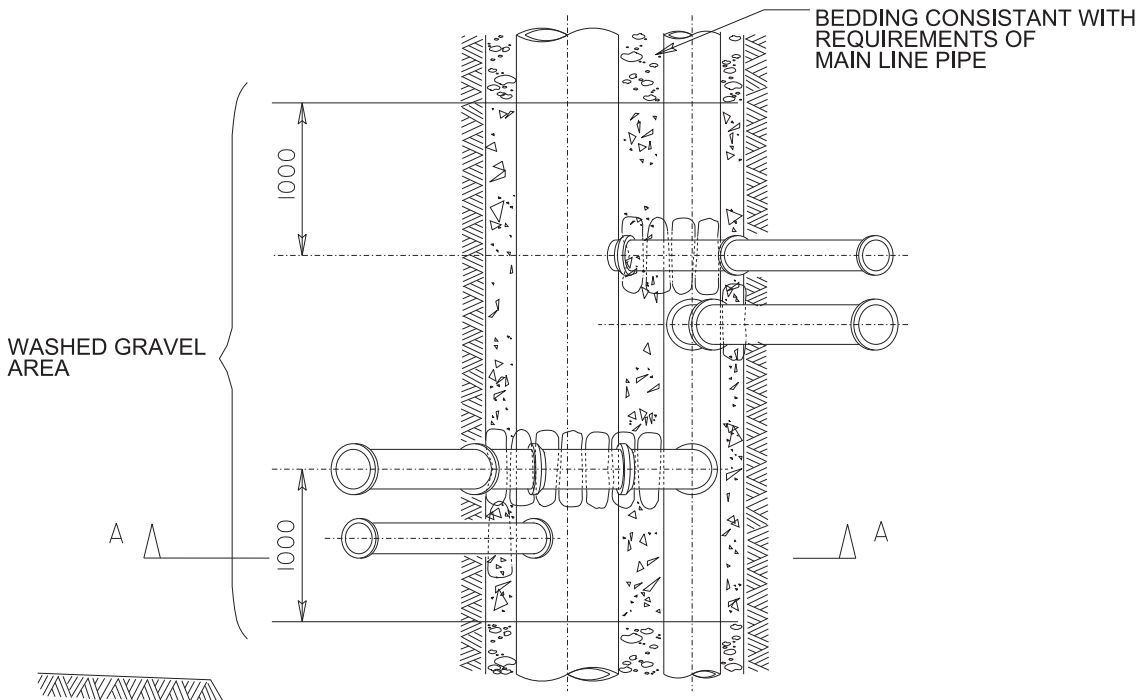


SIDE VIEW

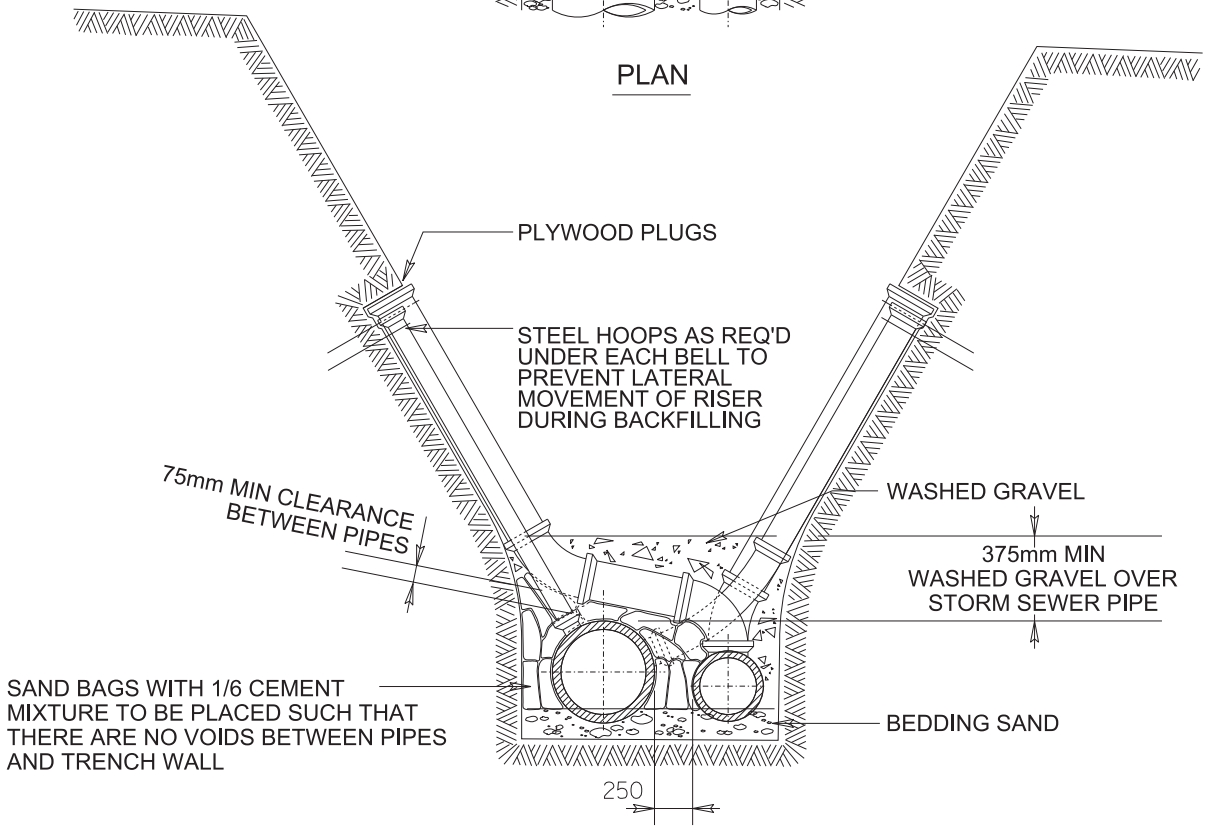
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

CONCRETE PIPE BUTT JOINT DETAIL

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	DJ		DR-06-13-02
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7981



PLAN



SECTION A - A

NOTES:

1. THIS DETAIL APPLIES IN PRINCIPLE TO ALL RISER CONNECTIONS IN V-CUT TRENCH.
2. VERTICAL RISER INSTALLATION IS ACCEPTABLE IN NEAR VERTICAL WALL TRENCH.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

STANDARD RISER CONNECTIONS TO STORM AND SANITARY SEWERS IN COMMON TRENCH

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-14-01
SCALE	CHECKED BY		OLD DRAWING NUMBER
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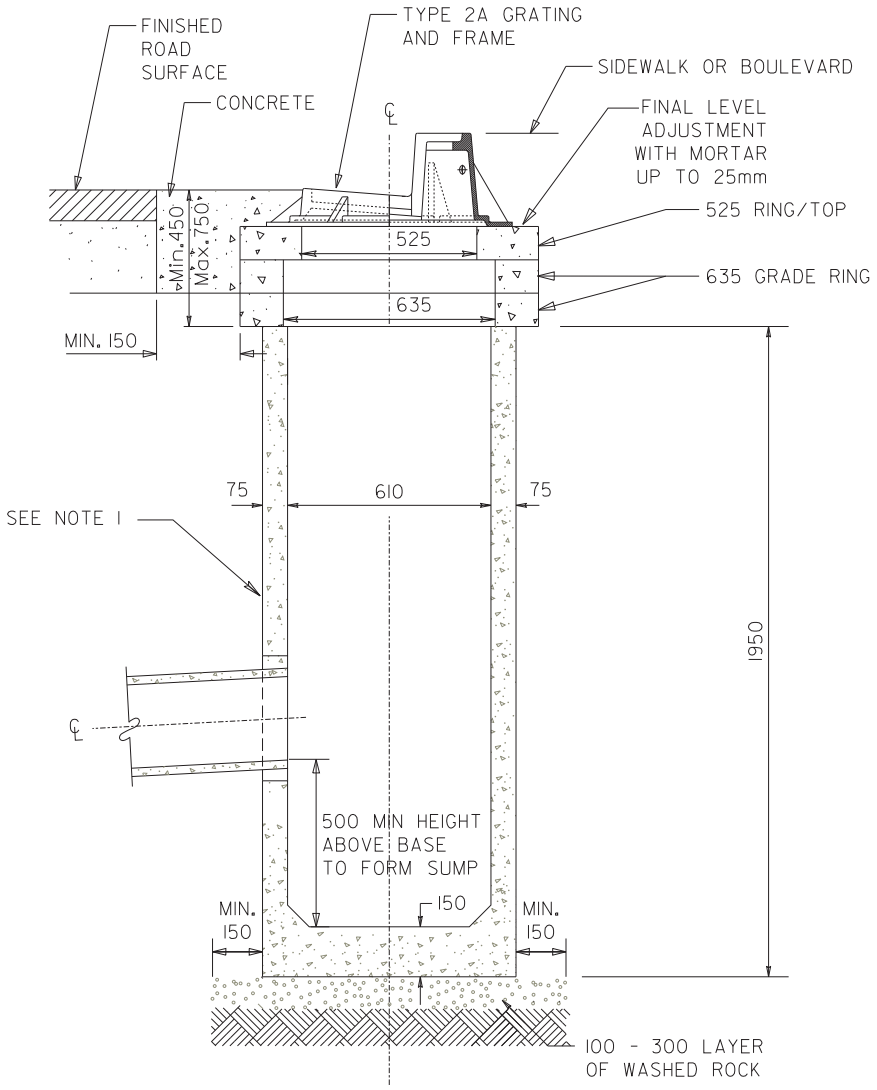


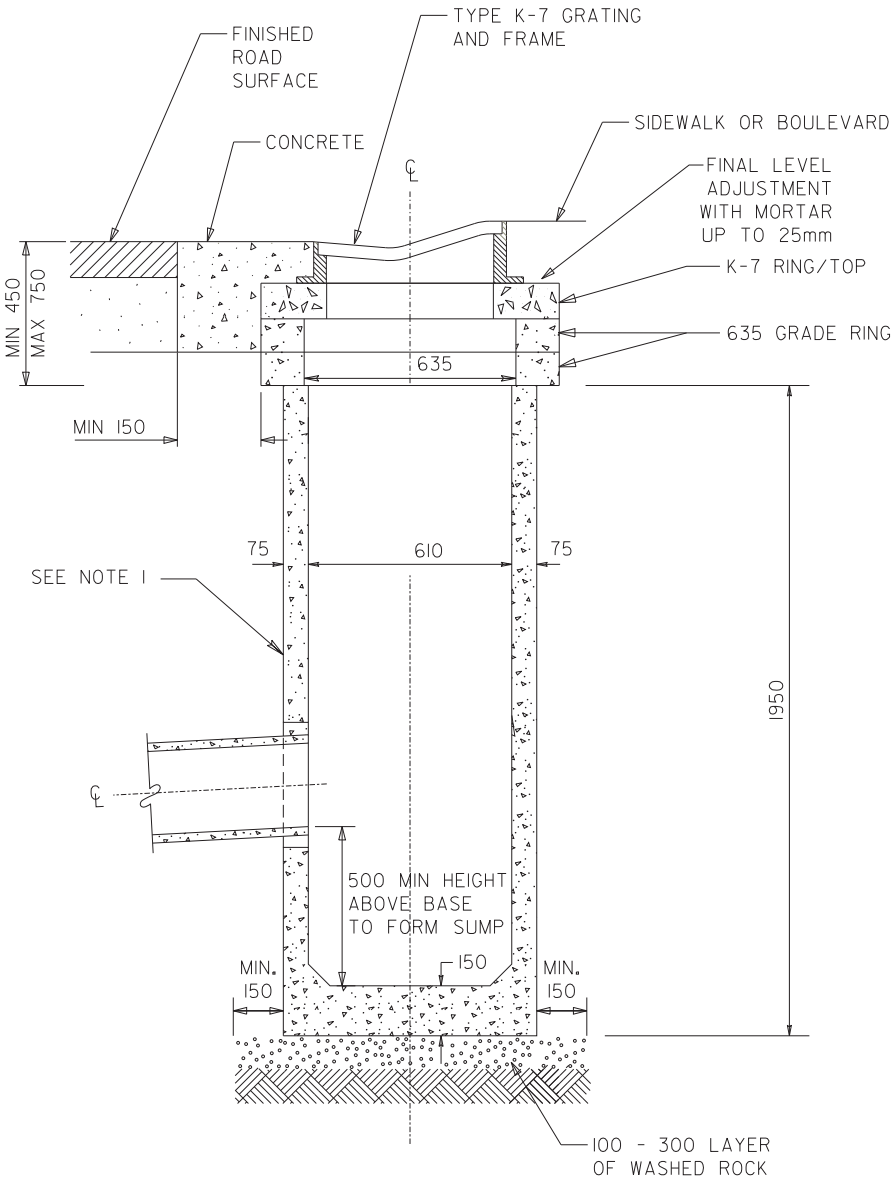
NOTE:

1. UNIT COULD BE MADE UP FROM TWO ITEMS (SHOULDER RING SLAB AND BARREL).

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 600 CATCH BASIN WITH TYPE 2A GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL,DJ		DR-06-17-01
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7005



NOTE:

1. UNIT COULD BE MADE UP FROM TWO ITEMS (SHOULDER RING SLAB AND BARREL).

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 600 CATCH BASIN WITH TYPE K-7 GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL,DJ		DR-06-17-02
SCALE	CHECKED BY		OLD DRAWING NUMBER
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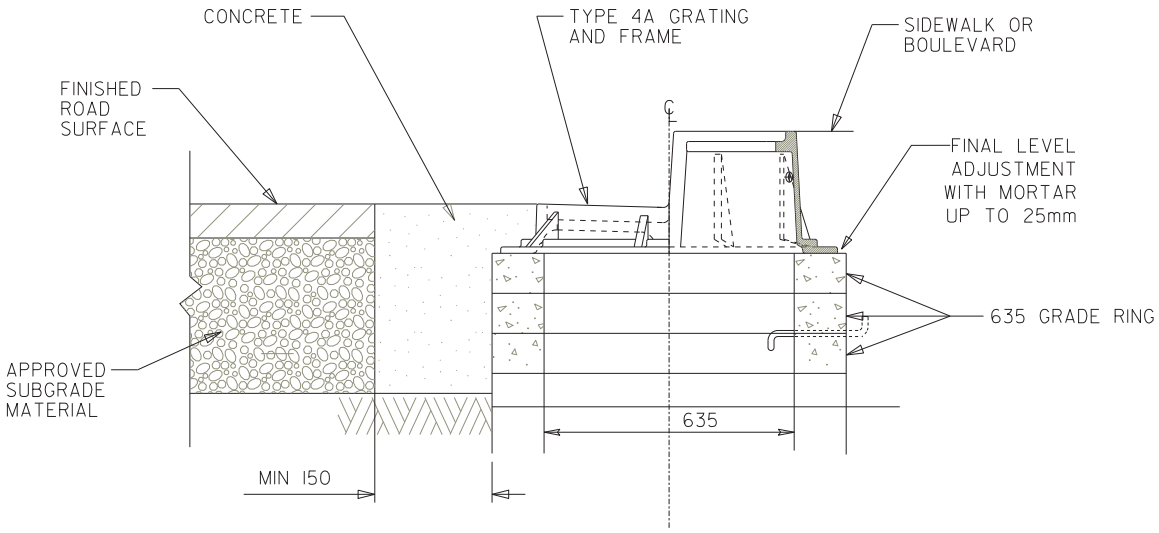

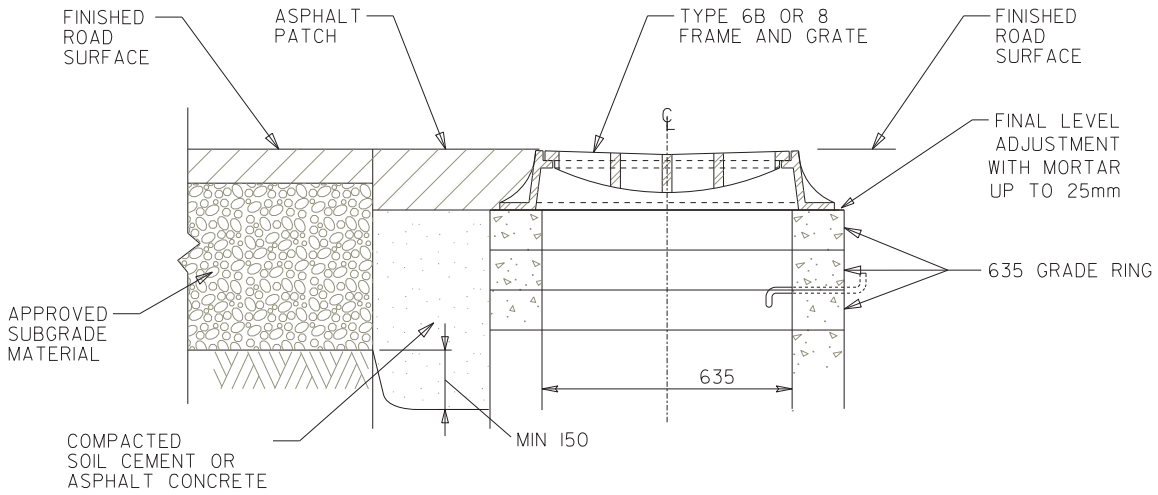

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

NECK SECTION DETAILS FOR TYPE 4A, 6B AND 8 GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
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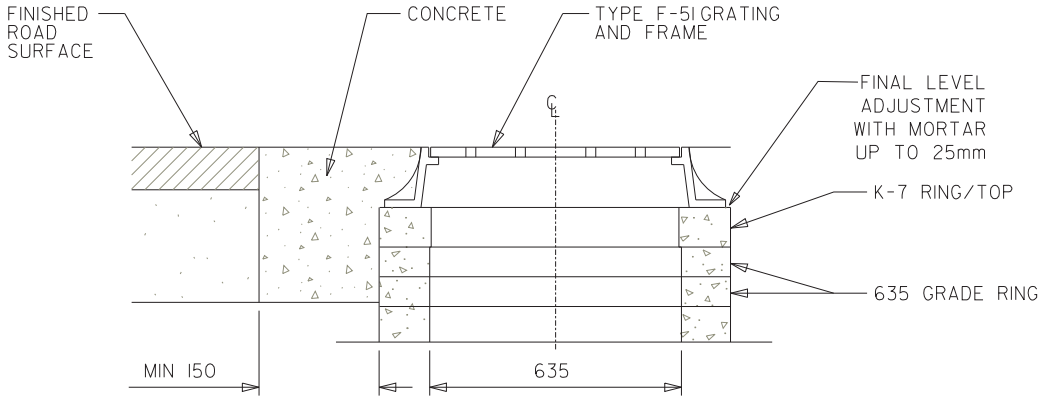
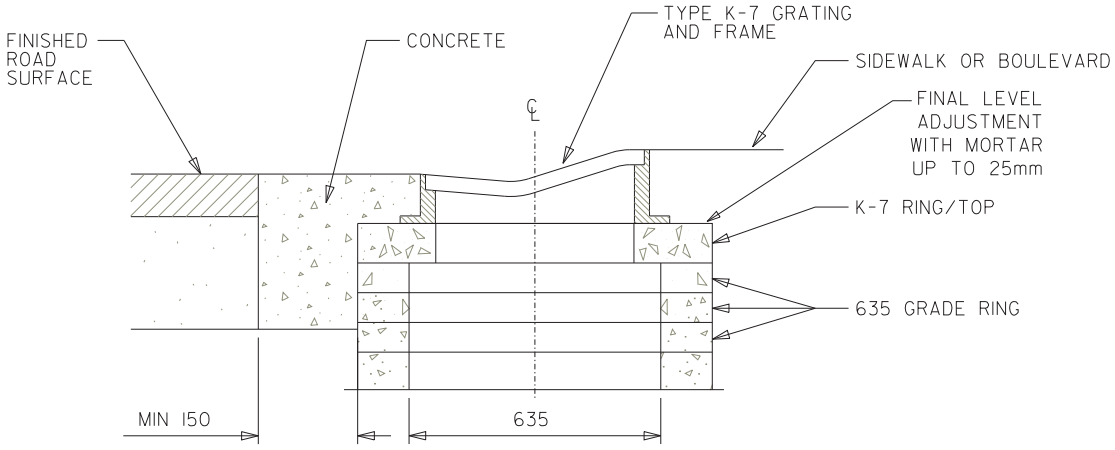
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7007





ALL DIMENSIONS ARE IN MILLIMETERS
UNLESS OTHERWISE NOTED.

EPCOR

NECK SECTION DETAILS FOR TYPE F-51 AND K-7 GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-04
SCALE	CHECKED BY		OLD DRAWING NUMBER
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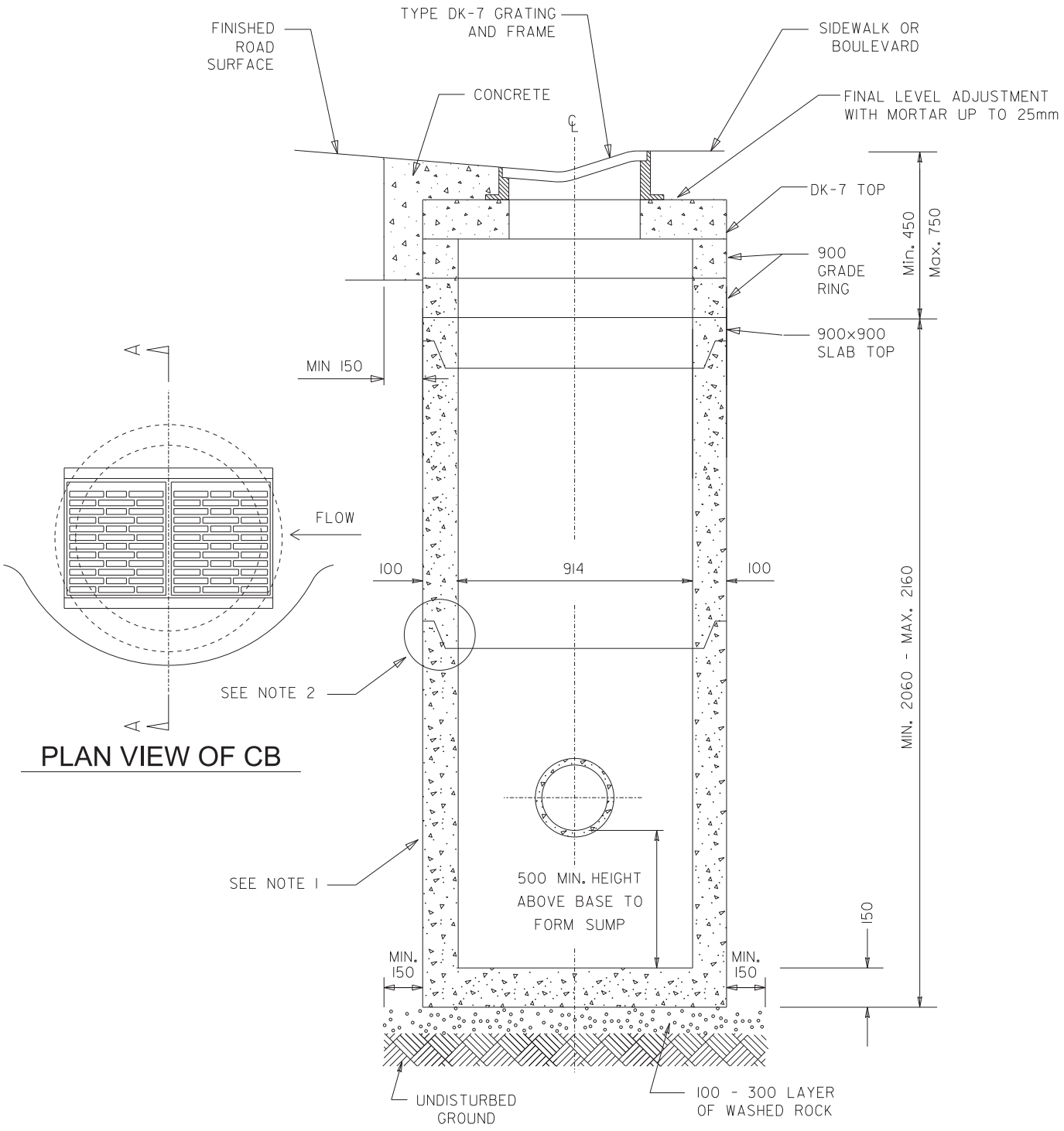


PLAN VIEW OF CB

SECTION A-A

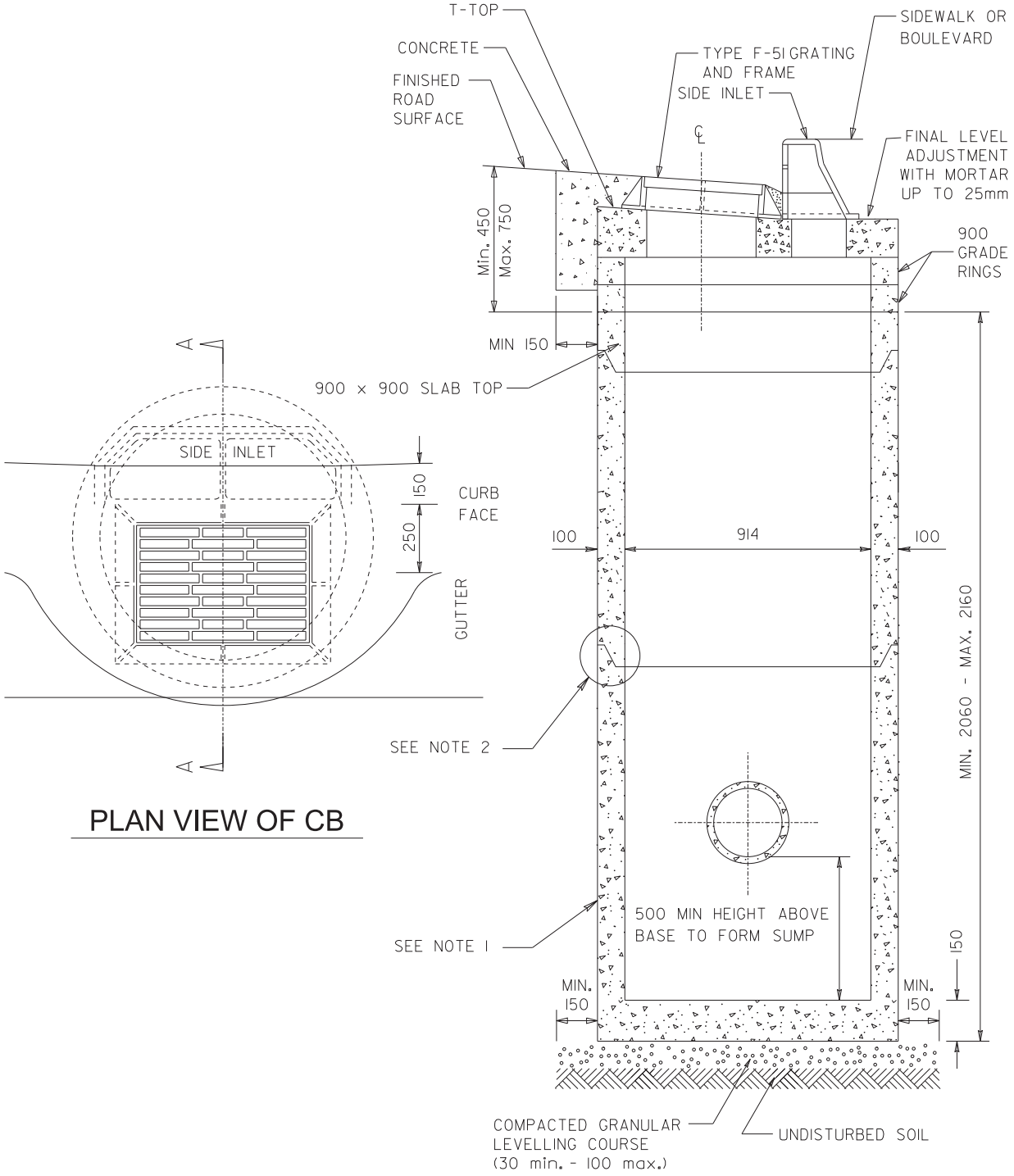
NOTES:
1. UNIT COULD BE MADE UP FROM TWO ITEMS (BASE AND BARREL).
2. OPPOSITE ORIENTATION OF JOINTS IS ACCEPTABLE.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

EPCOR

STANDARD 900 CATCH BASIN WITH TYPE DK-7 GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-05
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7009



PLAN VIEW OF CB

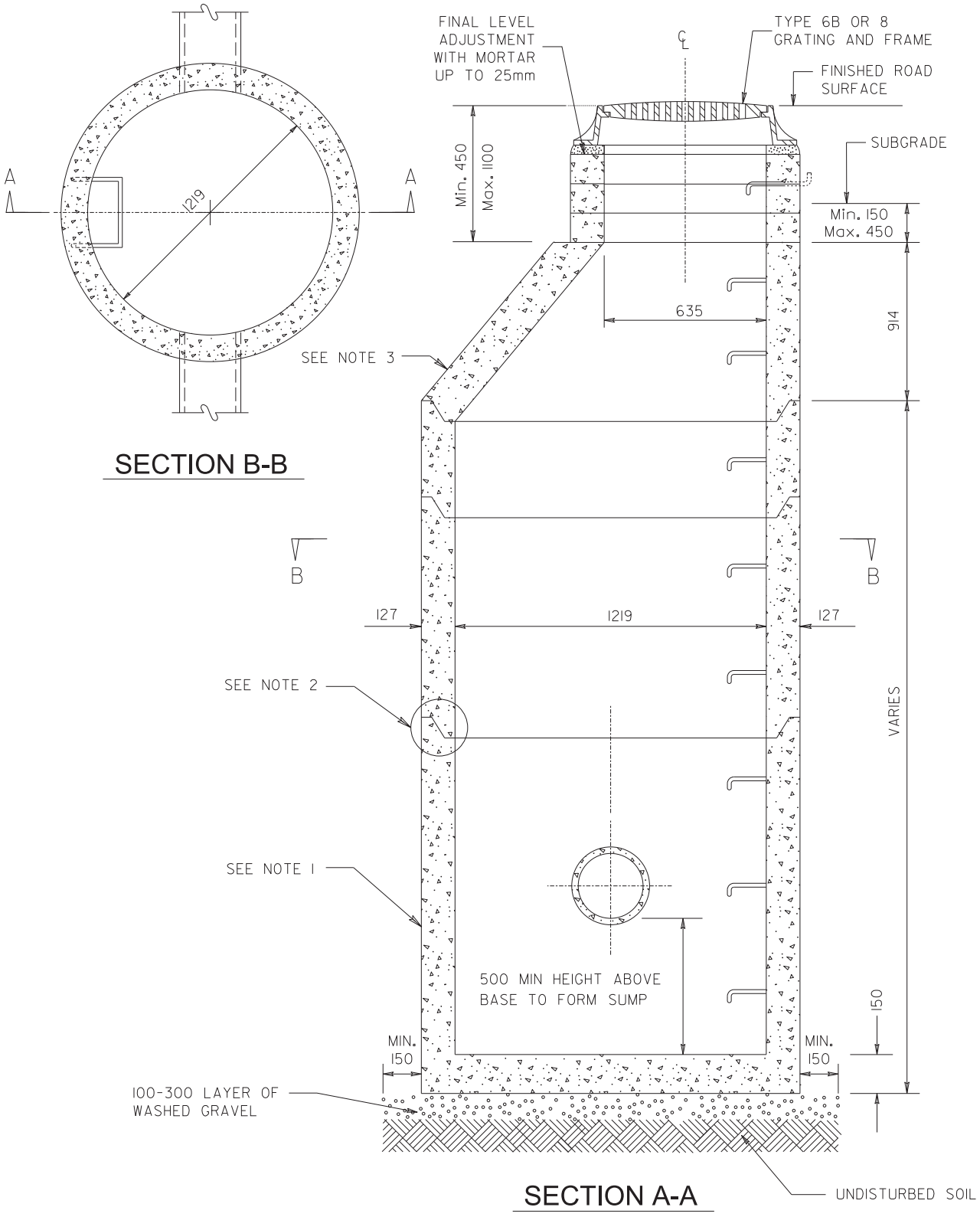
SECTION A-A

NOTES:
1. UNIT COULD BE MADE UP FROM TWO ITEMS (BASE AND BARREL).
2. OPPOSITE ORIENTATION OF JOINTS IS ACCEPTABLE.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 900 CATCH BASIN WITH TYPE F-51 GRATING AND FRAME WITH SIDE INLET

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-06
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7010



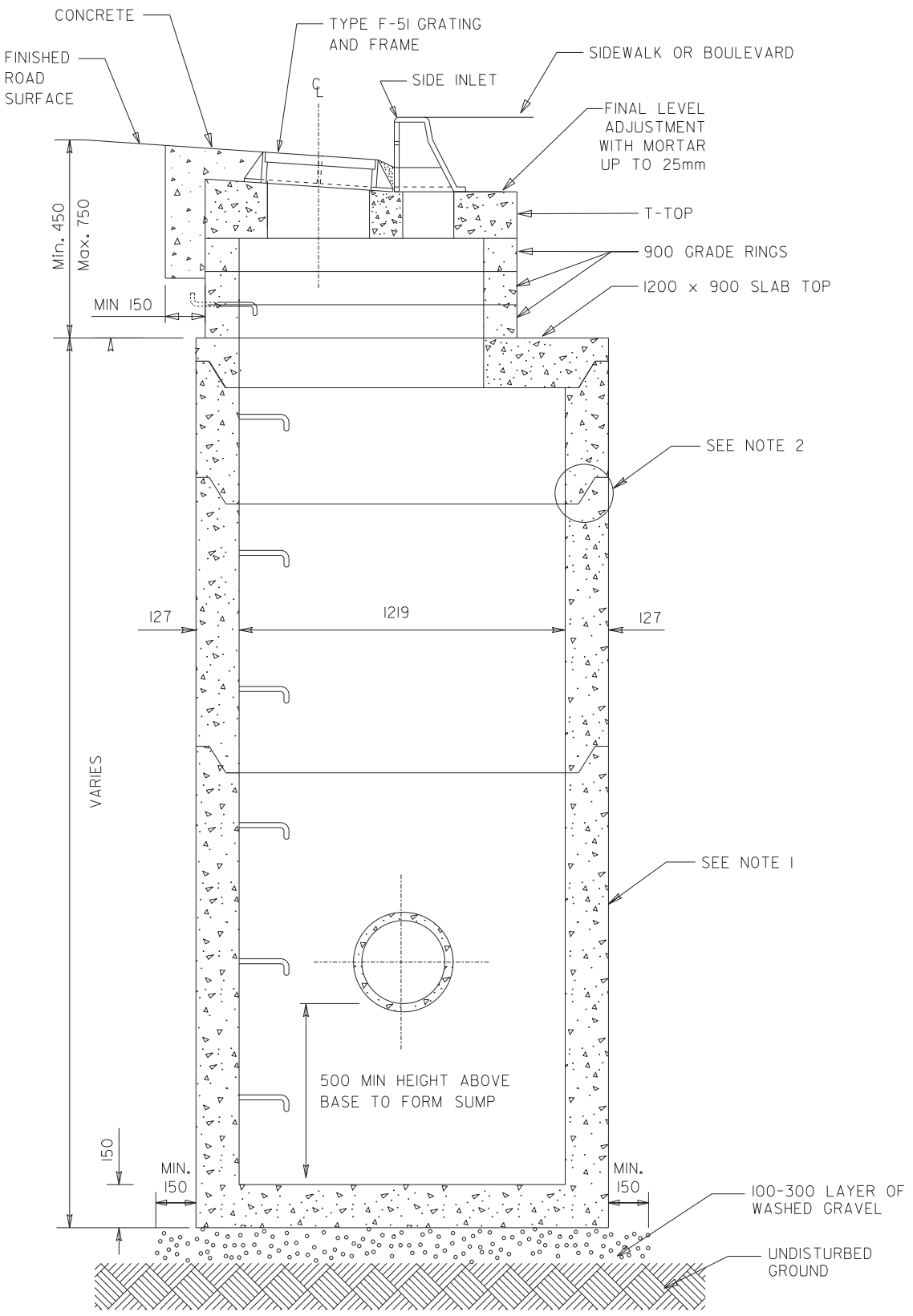
NOTES:

1. UNIT COULD BE MADE UP FROM TWO ITEMS (BASE AND BARREL).
2. OPPOSITE ORIENTATION OF JOINTS IS ACCEPTABLE.
3. 1200 x 635 SLAB TOP COULD BE USED INSTEAD OF CONE IN SHALLOW BURY INSTALLATION.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 1200 CB MANHOLE WITH TYPE 6B OR 8 GRATING AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-07
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7011



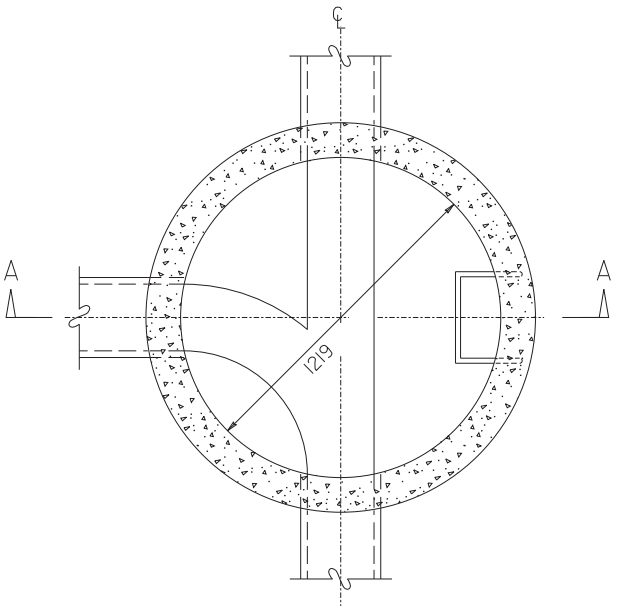
NOTES:

1. UNIT COULD BE MADE UP FROM TWO ITEMS (BASE AND BARREL).
2. OPPOSITE ORIENTATION OF JOINTS IS ACCEPTABLE.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 1200 CB MANHOLE WITH TYPE F-51 GRATING AND FRAME WITH SIDE INLET

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-08
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7012



SECTION B-B

SECTION A-A

NOTES:

1. THIS STANDARD APPLIES TO MANHOLES ON PIPING OF MAXIMUM DIAMETER 600mm AND MINIMUM DEFLECTION ANGLE OF 120°.
2. 1500mm MANHOLE SHALL BE USED ON PIPING DIAMETER 750mm, 900mm AND 1050mm. FOR PIPES DIAMETER 1200mm AND LARGER, MANHOLE TEE RISERS SHALL BE USED.
3. PREBENCHED MANHOLE BASE UNITS WITH INTEGRAL GASKETS SHALL BE USED.
4. THE SEWER PIPING IS AN EXAMPLE ONLY. REFER TO PROJECT DRAWINGS FOR LAYOUT AND ELEVATIONS.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

STANDARD 1200 MANHOLE FOR PIPING UP TO 600mm DIAMETER WITH TYPE 6A COVER AND FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
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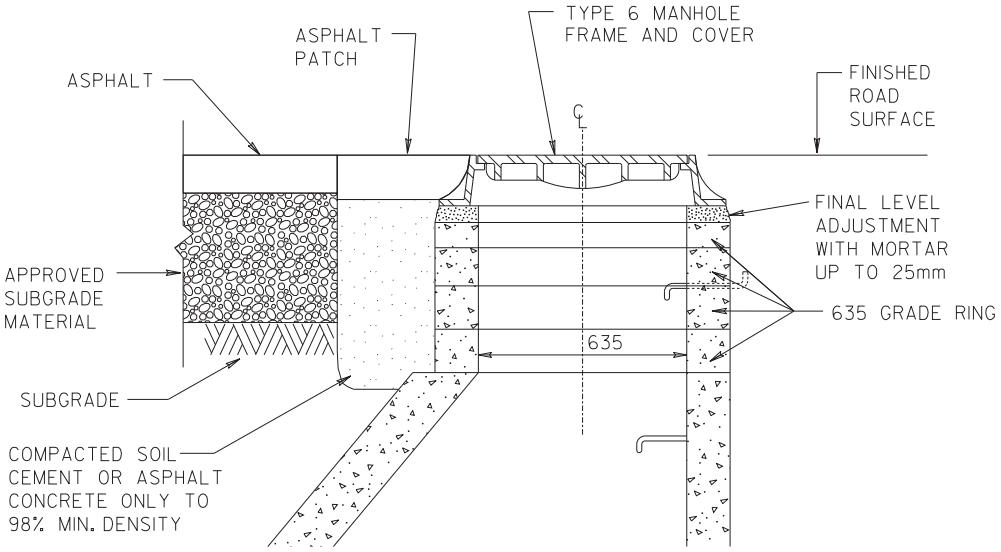
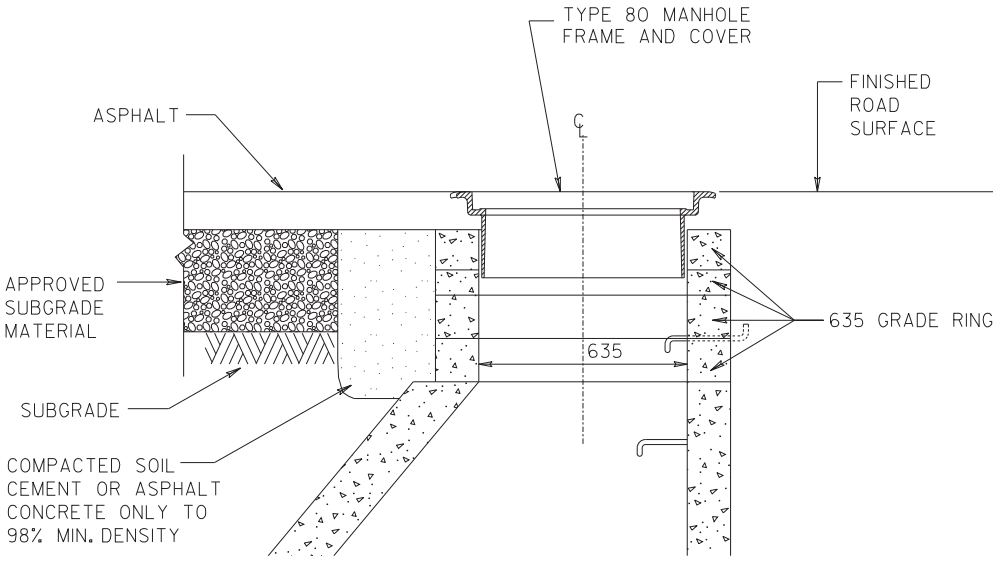
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7013



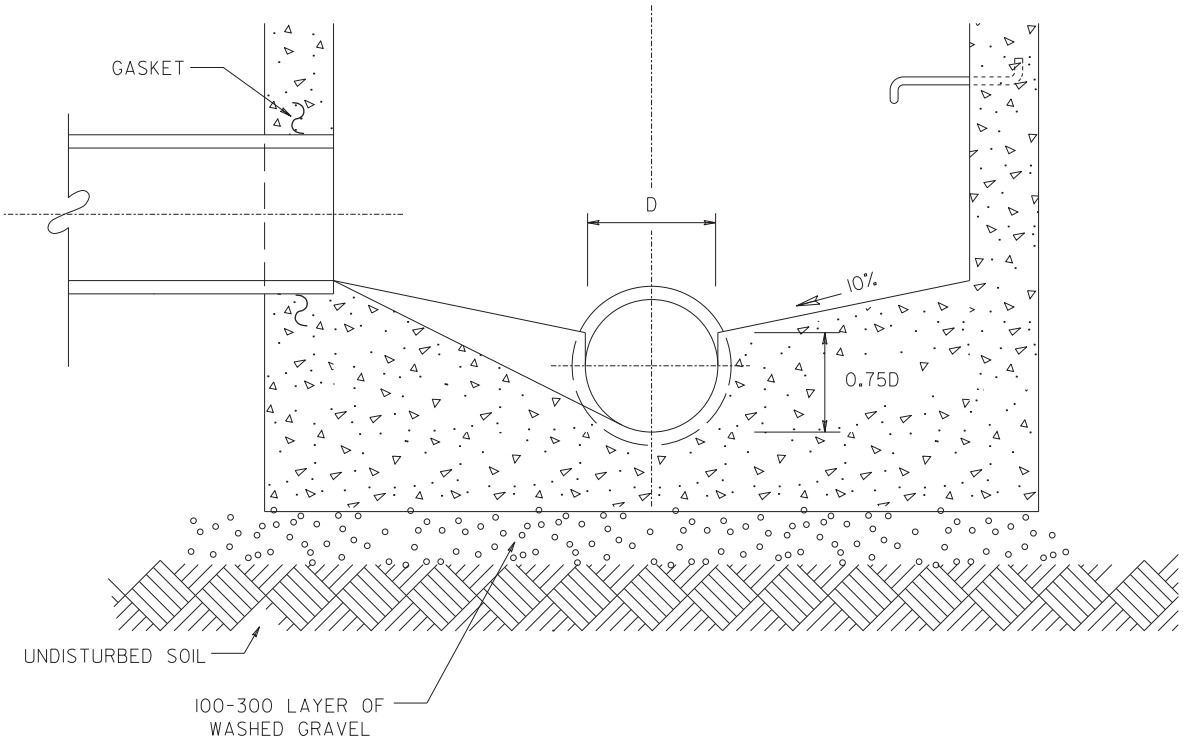


ALL DIMENSIONS ARE IN MILLIMETERS
UNLESS OTHERWISE NOTED.

EPCOR

NECK SECTION DETAILS FOR STANDARD 1200 MANHOLE

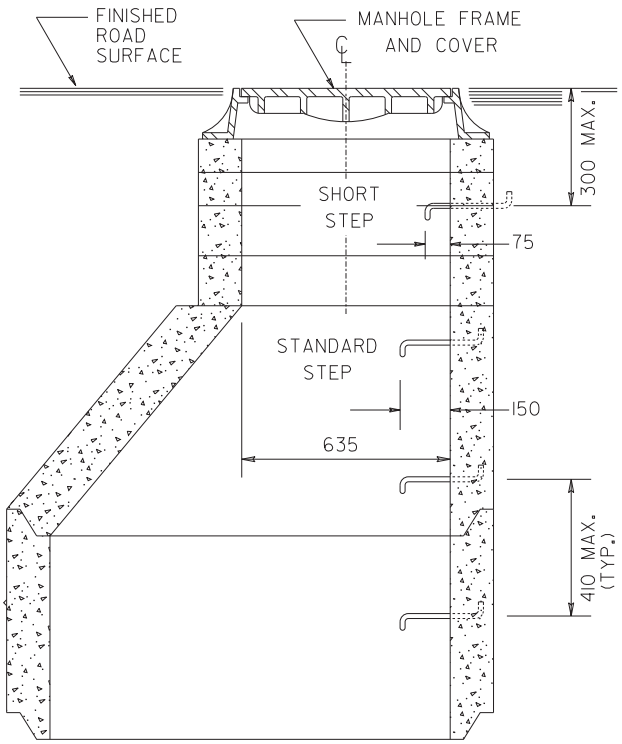
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL, DJ		DR-06-17-10
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7014



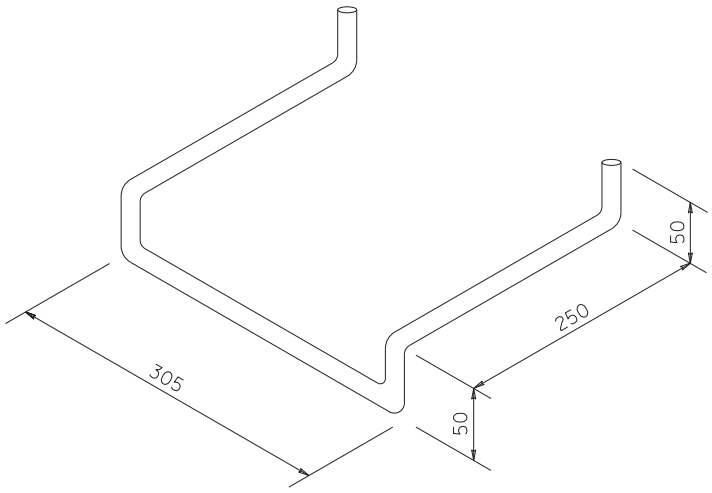
ALL DIMENSIONS ARE IN MILLIMETERS
UNLESS OTHERWISE NOTED.

BENCHING DETAIL FOR STANDARD 1200 MANHOLE

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-11
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7020



TYPICAL MANHOLE SECTION



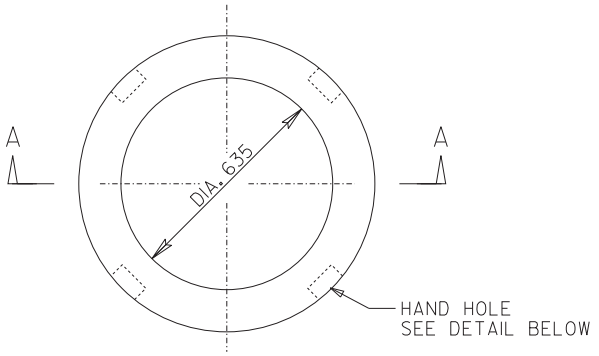
SAFETY STEP ISOMETRIC VIEW
(CAST IN PLACE OPTION)

ALL DIMENSIONS ARE IN MILLIMETERS
UNLESS OTHERWISE NOTED.

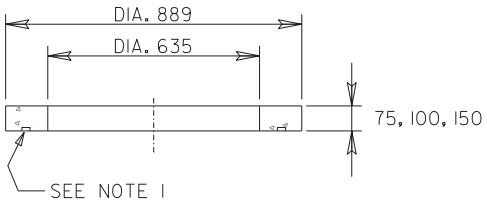
EPCOR

SAFETY STEPS FOR MANHOLES

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-12
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7021

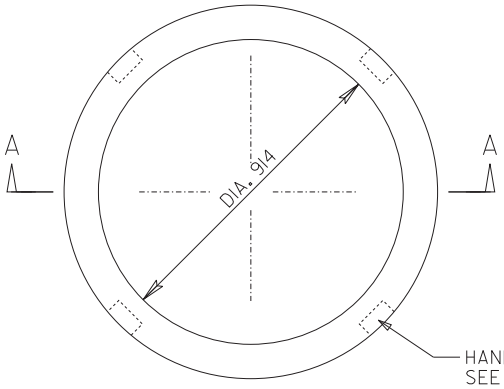


PLAN VIEW

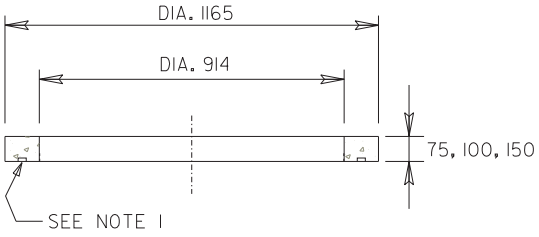


SECTION A-A

635 GRADE RING

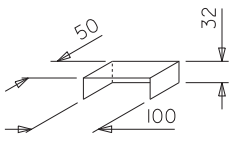


PLAN VIEW



SECTION A-A

900 GRADE RING



HAND HOLE DETAIL

NOTES:

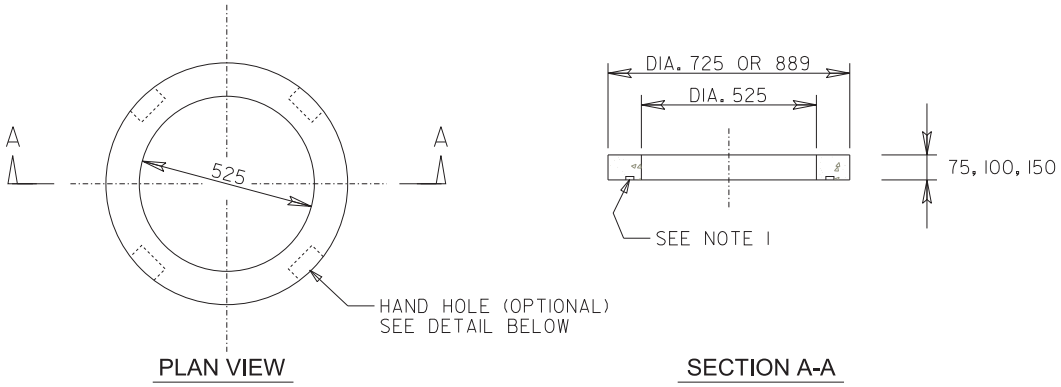
1. A CONCENTRIC GROOVE (SUITABLE FOR SEALANT) LOCATED AT MID CROSS SECTION

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

EPCOR

GRADE RINGS

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-13
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7030

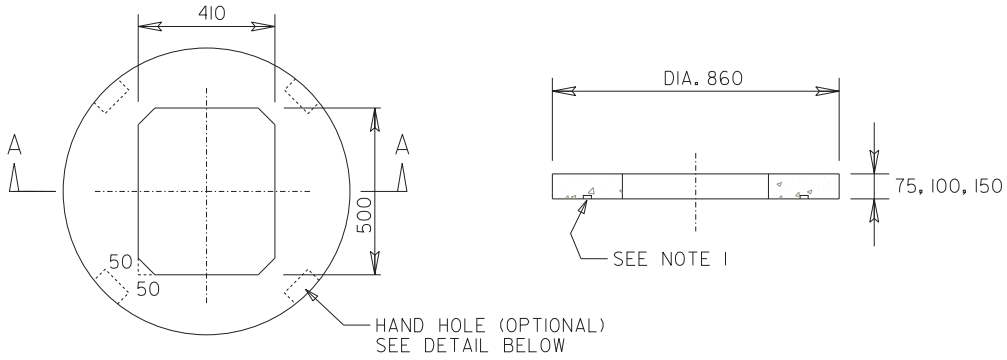


PLAN VIEW

SECTION A-A

525 RING/TOP

FOR USE WITH TYPE 2A FRAME AND GRATING

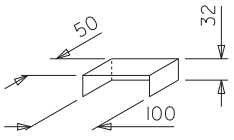


PLAN VIEW

SECTION A-A

K-7 RING/TOP

FOR USE WITH TYPE K-7 OR F-51 WITHOUT SIDE INLET FRAMES AND GRATINGS



HAND HOLE DETAIL

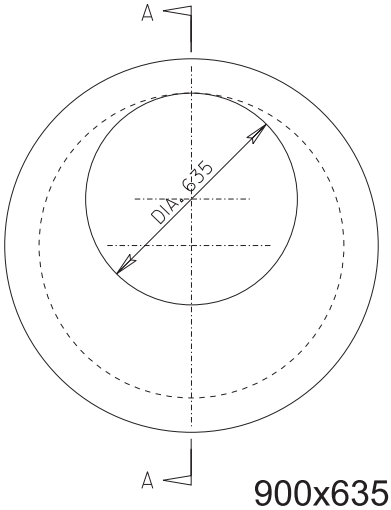
NOTES:

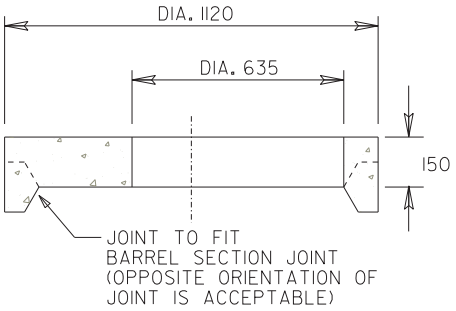
1. A CONCENTRIC GROOVE (SUITABLE FOR SEALANT) LOCATED AT MID CROSS SECTION OR 50mm FROM THE EDGE

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

RINGS/TOPS

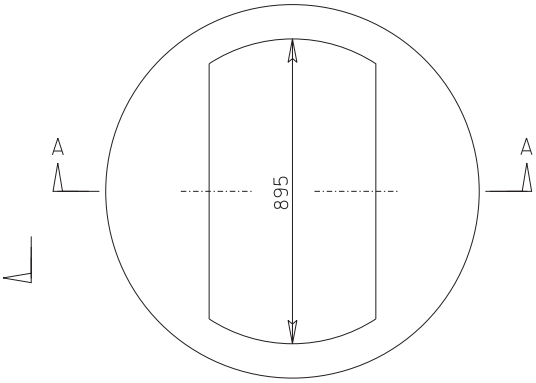
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-14
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7031

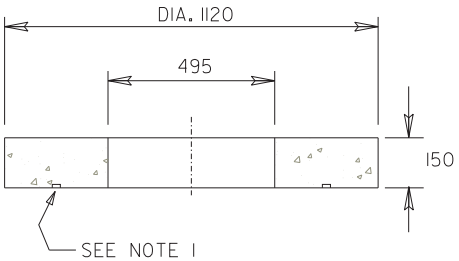




SECTION A-A

900x635 SLAB TOP

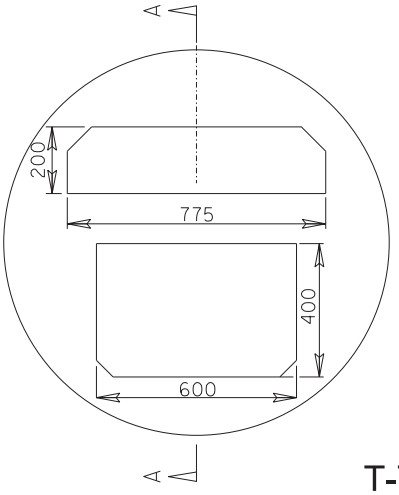


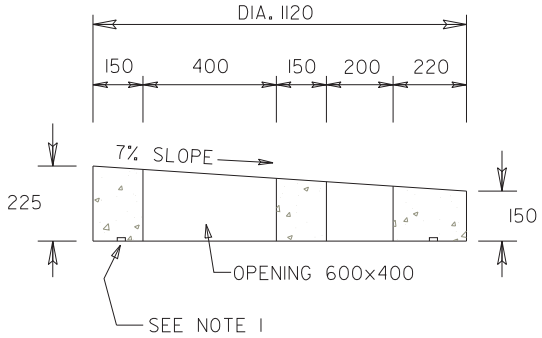


SECTION A-A

DK-7 TOP

(FOR USE WITH TYPE DK-7 FRAME AND GRATING)





SECTION A-A

T-TOP

(FOR USE WITH TYPE F-51 WITH SIDE INLET FRAME AND GRATING)

NOTES:

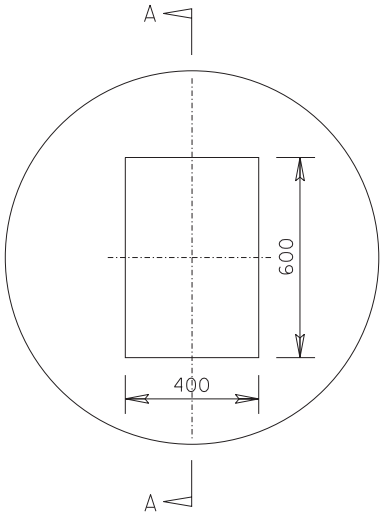
1. A CONCENTRIC GROOVE (SUITABLE FOR SEALANT) LOCATED AT 50mm FROM THE EDGE
2. SLAB THICKNESS MAY VARY, DEPENDING ON MANUFACTURERS PROOF OF DESIGN

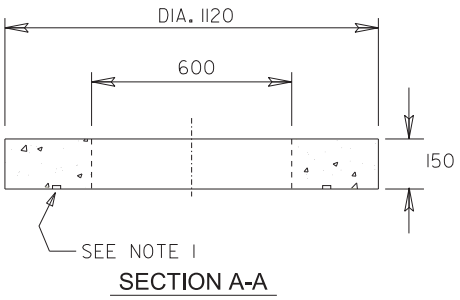
ALL DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE NOTED.

EPCOR

SLAB TOPS FOR STANDARD 900 CATCH BASIN

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-17-15
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7032





SECTION A-A

K-3/E-TOP

(FOR USE WITH TYPE F-51 WITHOUT SIDE INLET)

NOTE:

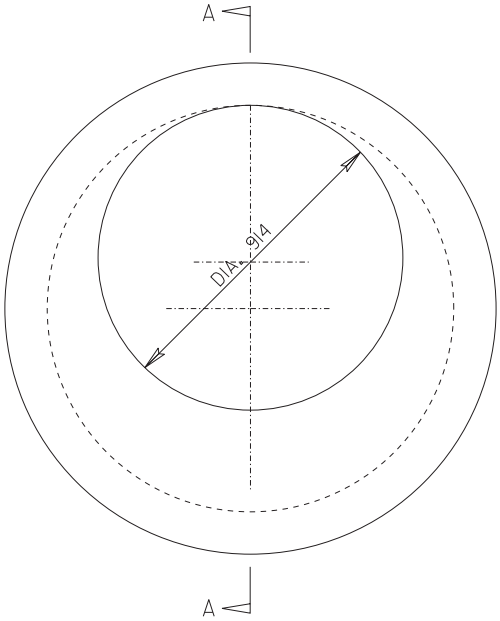
1. A CONCENTRIC GROOVE (SUITABLE FOR SEALANT) LOCATED AT 50mm FROM THE EDGE

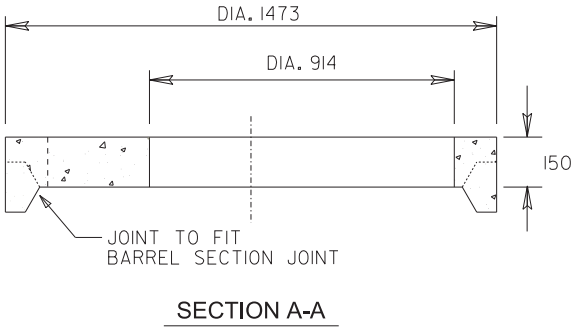
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

SLAB TOP FOR STANDARD 900 CATCH BASIN

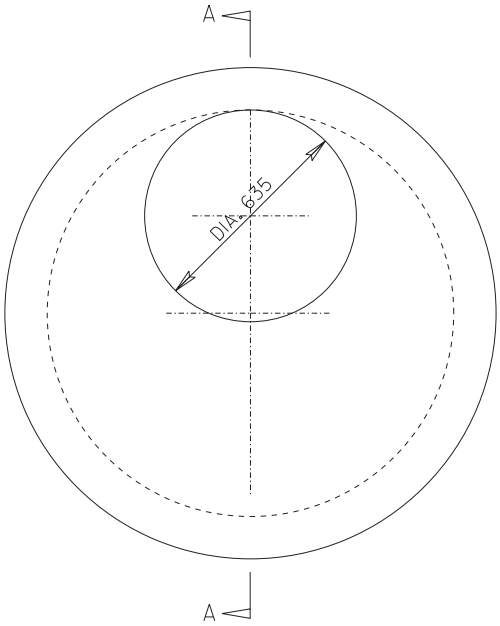
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	DJ		DR-06-17-16
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7033

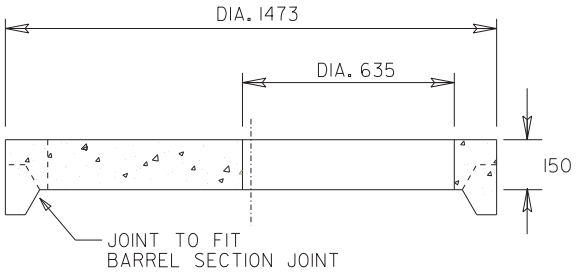




SECTION A-A

1200x900 SLAB TOP





SECTION A-A

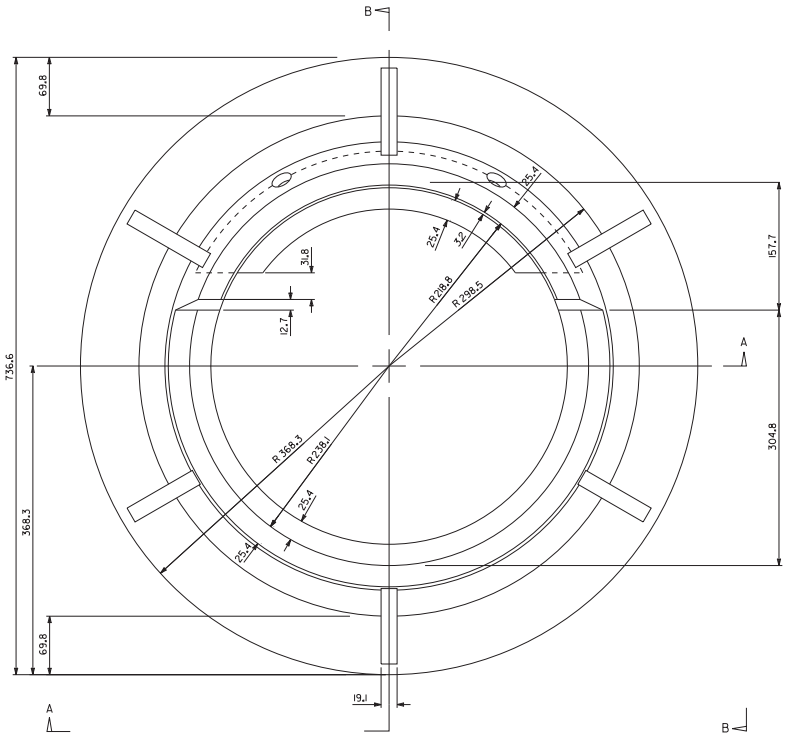
1200x635 SLAB TOP

ALL DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE NOTED.

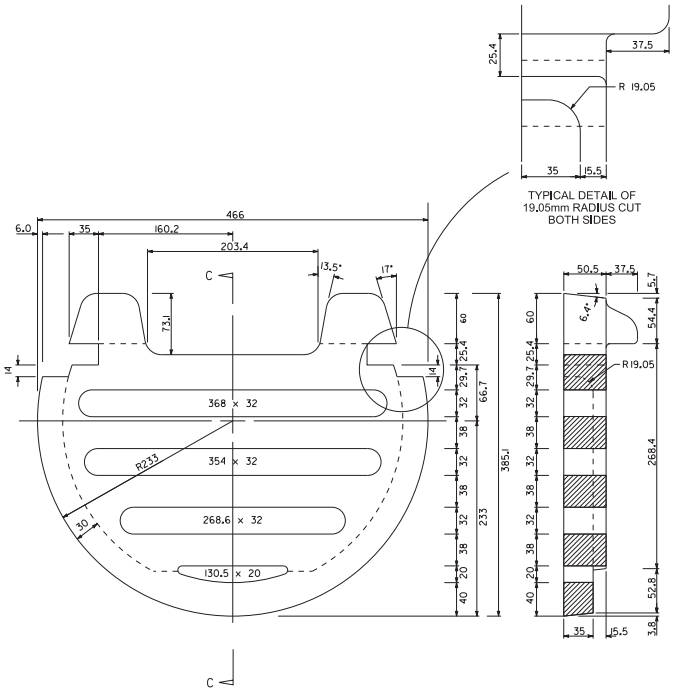
EPCOR

SLAB TOPS FOR STANDARD 1200 MANHOLE

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	DJ		DR-06-17-17
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7034



TOP VIEW (FRAME)

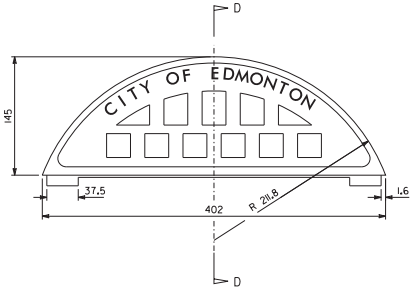


TOP VIEW COVER (PART A)

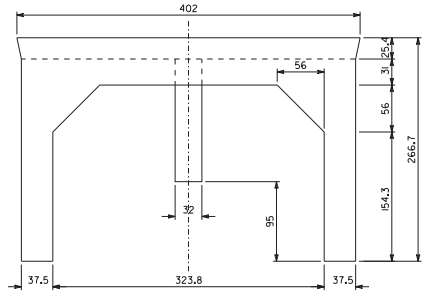
NOTE: CAST IRON MATERIAL

TYPICAL DETAIL OF
19.05mm RADIUS CUT
BOTH SIDES

SECTION C - C

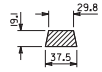


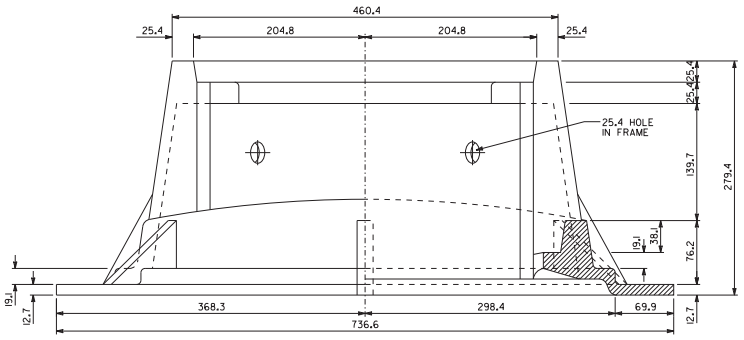
TOP VIEW



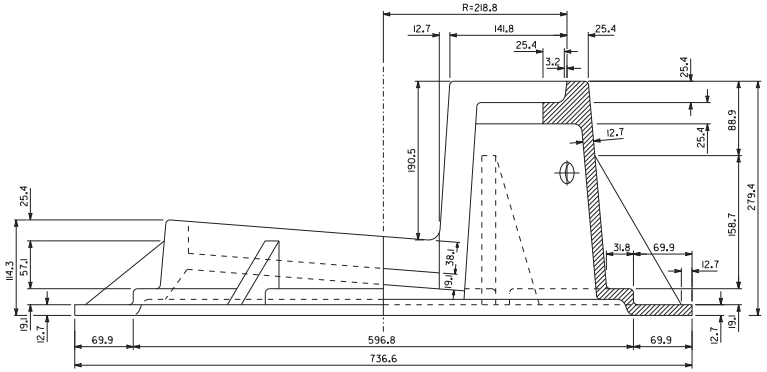
FRONT VIEW COVER (PART B)

NOTE: DUCTILE IRON MATERIAL

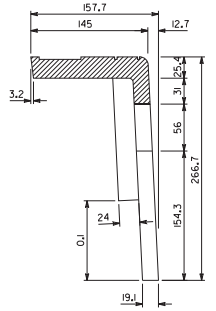




SECTION A - A



SECTION B - B



SECTION D- D

SPECIFICATIONS :

(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B OR ASTM DESIGNATION A536 GRADE 65-45-12 (OR APPROVED ALTERNATE) AS SPECIFIED.
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.
(6) TOLERANCE TO BE AS PER GREY IRON TENDER DOCUMENTS.

NOTE:

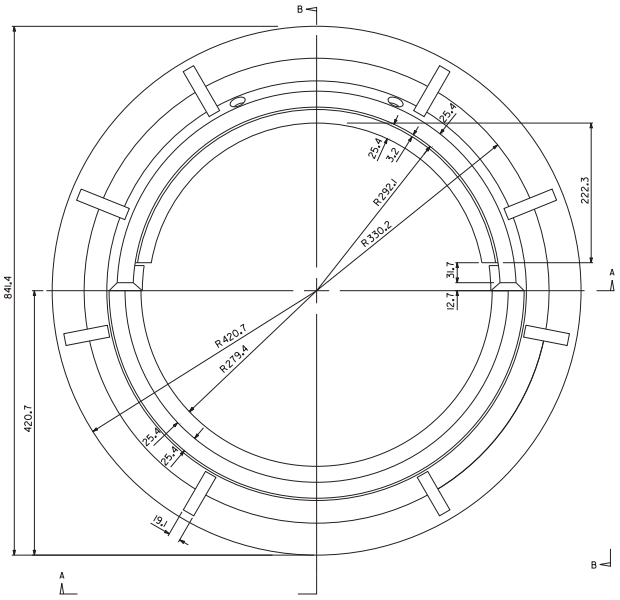
(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS: ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

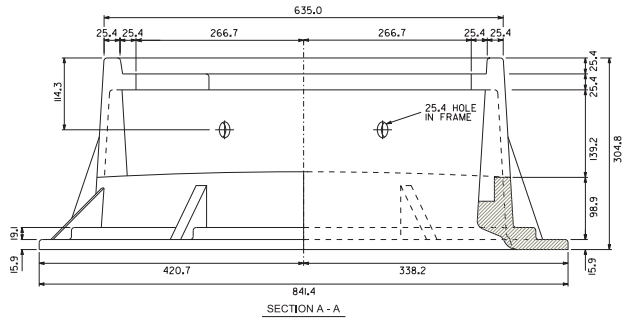
EPCOR

TYPE 2A TWO PIECE SIDE INLET CATCH BASIN GRATING AND FRAME

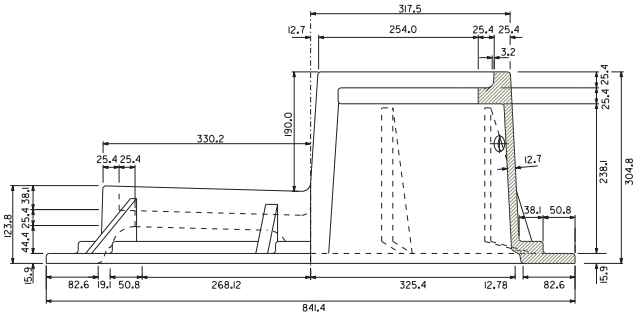
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	AM		DR-06-18-01
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7040



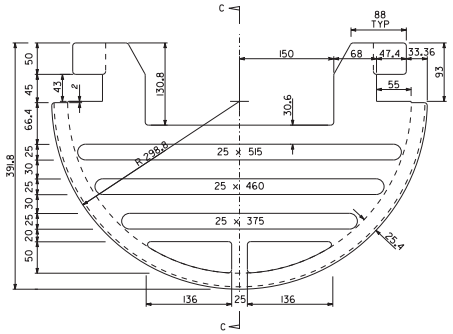
TOP VIEW (FRAME)



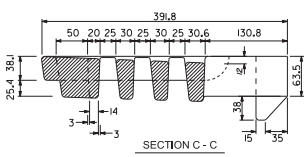
SECTION A - A



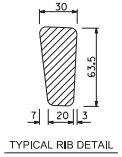
SECTION B - B



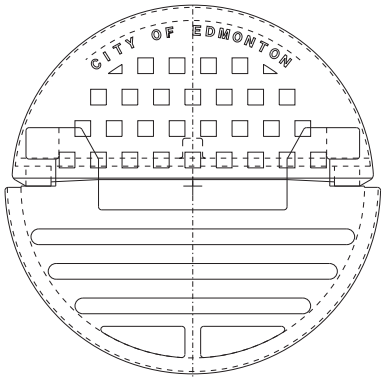
TOP VIEW - COVER (Part A)
NOTE: CAST IRON MATERIAL



SECTION C - C

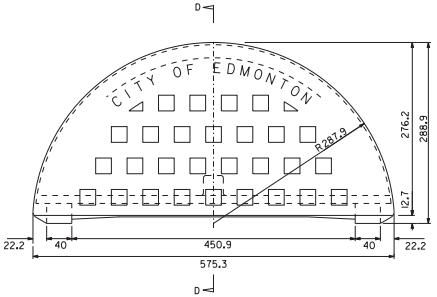


TYPICAL RIB DETAIL

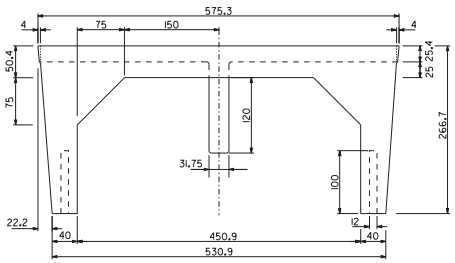


PLAN VIEW

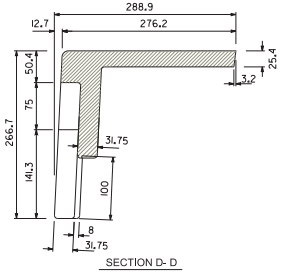
COVER COMPONENTS ASSEMBLED



TOP VIEW - COVER (Part B)



FRONT VIEW COVER (PART B)
NOTE: DUCTILE IRON MATERIAL



SECTION D- D

NOTE:

(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

SPECIFICATIONS :

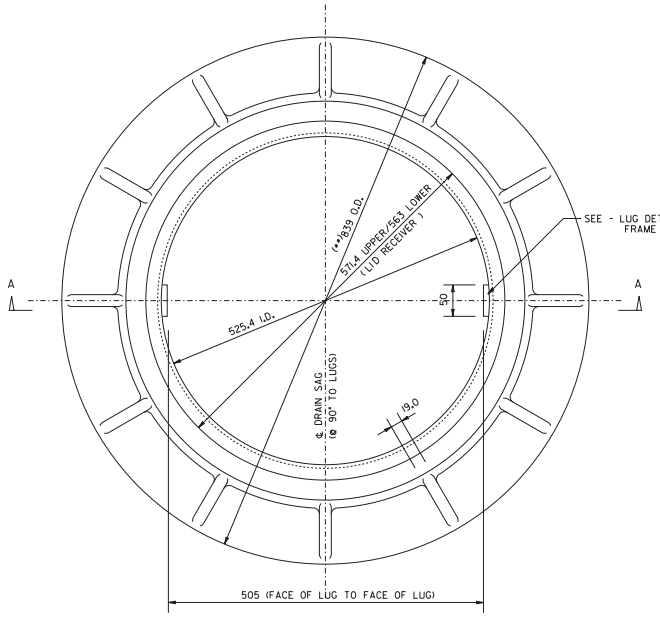
(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B OR ASTM DESIGNATION A536 GRADE 65-45-12 (OR APPROVED ALTERNATE) AS SPECIFIED.
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING
AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.
(6) TOLERANCE TO BE AS PER GREY IRON TENDER DOCUMENTS.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

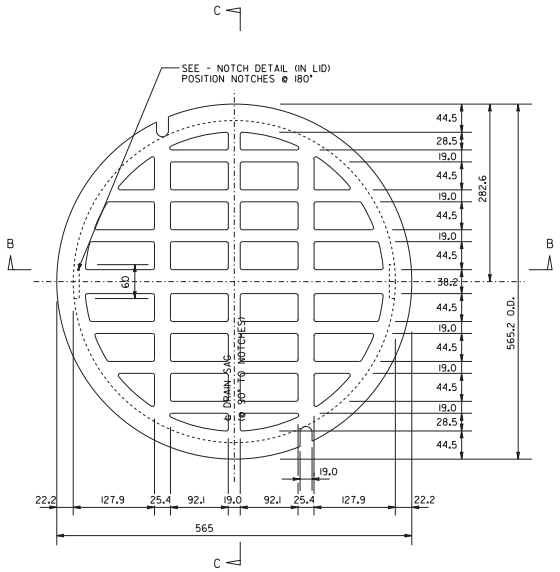
EPCOR

TYPE 4A TWO PIECE SIDE INLET CATCH BASIN MANHOLE GRATING AND FRAME

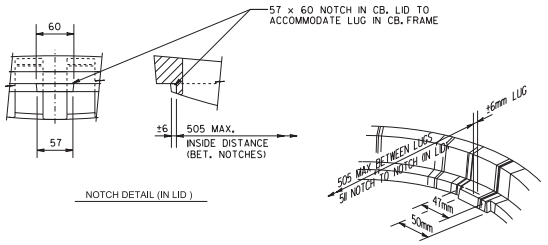
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	AM		DR-06-18-02
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7041



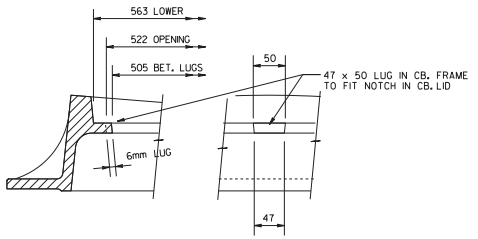
TOP VIEW



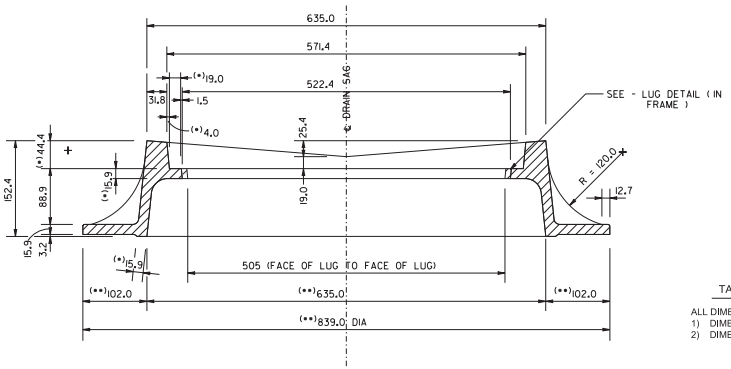
TOP VIEW



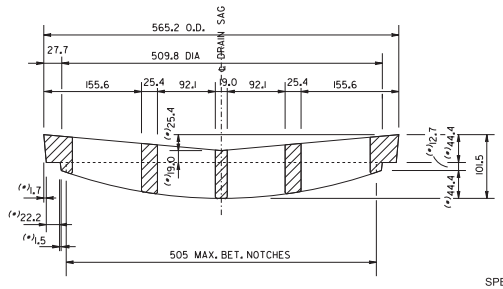
NOTCH DETAIL (IN LID)



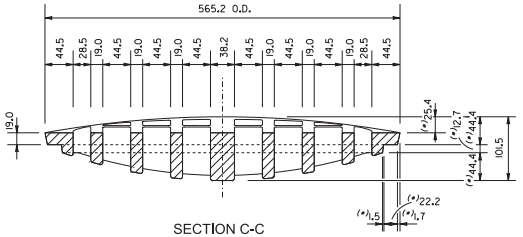
LUG DETAIL (IN FRAME)



SECTION A-A



SECTION B-B



SECTION C-C

FRAME MASS = 86 kg
COVER MASS = 59 kg

TABLE 1 - MANUFACTURING TOLERANCES

ALL DIMENSIONS SHALL CONFORM TO ±3mm TOLERANCE EXCEPT
1) DIMENSIONS MARKED (*) SHALL CONFORM TO A TOLERANCE OF 1.5mm.
2) DIMENSIONS MARKED (**) SHALL CONFORM TO A TOLERANCE OF 8mm.

SPECIFICATIONS :

(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B OR ASTM DESIGNATION A536 GRADE 65-45-12 (OR APPROVED ALTERNATE) AS SPECIFIED.
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.
(6) TOLERANCE TO BE AS PER GREY IRON TENDER DOCUMENTS.

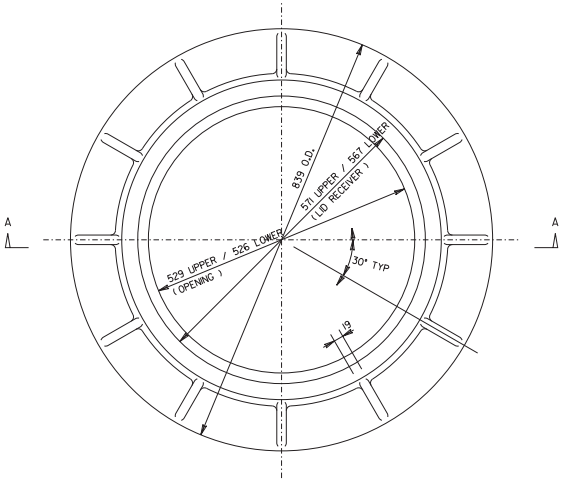
NOTE:

(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

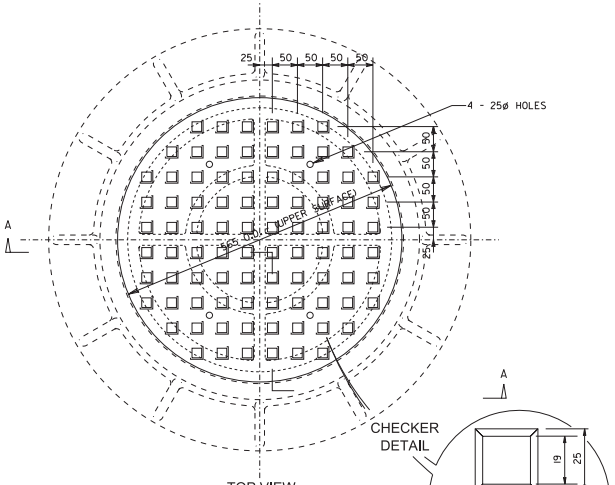
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

TYPE 8 CATCH BASIN MANHOLE GRATING AND FRAME

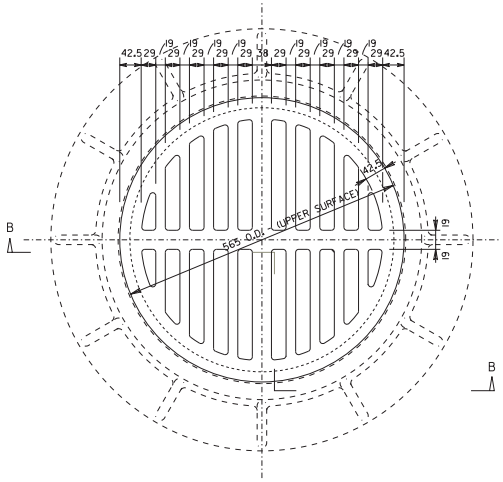
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-18-03
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7042



TOP VIEW

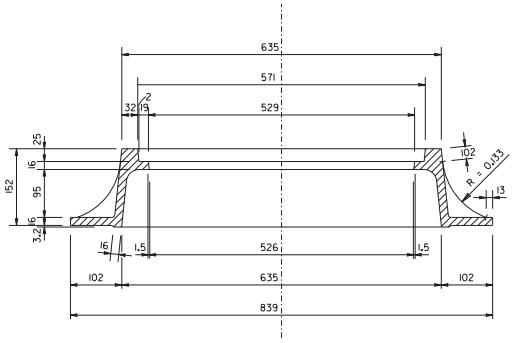


TOP VIEW



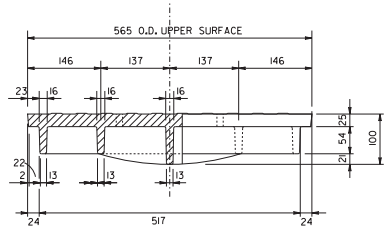
TOP VIEW

TYPE 6 STANDARD FRAME FOR MANHOLE AND ROUND CATCH BASIN COVER
(WEIGHT = 69kg)



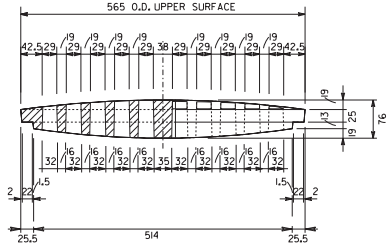
SECTION A-A

TYPE 6A STANDARD MANHOLE COVER
(WEIGHT = 54.5kg)



SECTION A-A

TYPE 6B STANDARD ROUND CATCH BASIN COVER
(WEIGHT = 50kg)



SECTION B-B

TABLE 1 - MANUFACTURING TOLERANCES

1. NO DEVIATION SHALL BE ACCEPTABLE FOR DIMENSIONS WHICH ARE LESS THAN 10mm.
2. ALL DIMENSIONS GREATER THAN 10mm SHALL CONFORM TO ±3mm TOLERANCE.

SPECIFICATIONS:

1. MATERIAL SPECIFICATIONS:
   FRAME AND COVER - GREY CAST IRON TO CONFORM TO CLASS 35B ASTM A48 (LATEST EDITION).
2. CASTINGS SHALL BE PRODUCED TO THE DIMENSIONS SHOWN AND WITHIN THE TOLERANCES NOTED IN TABLE 1 - MANUFACTURING TOLERANCES.
3. COATED CASTINGS WILL NOT BE ACCEPTED.
4. CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE:
   A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD)
   B) FOUNDARY IDENTIFICATION MARKING, AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
5. ALL CASTINGS WILL BE; FREE OF DEFECTS, TRUE TO PATTERN AND FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTING SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
6. MATING SURFACES SHALL BE MACHINED SUCH THAT CASTINGS SHALL NOT ROCK WHEN INSTALLED. THE MANUFACTURER SHALL TRIAL FIT THE CASTINGS AGAINST A TRIAL FRAME OR COVER.

NOTE:

(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

TYPE 6 STANDARD MANHOLE FRAME, COVER AND ROUND CATCH BASIN COVER

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
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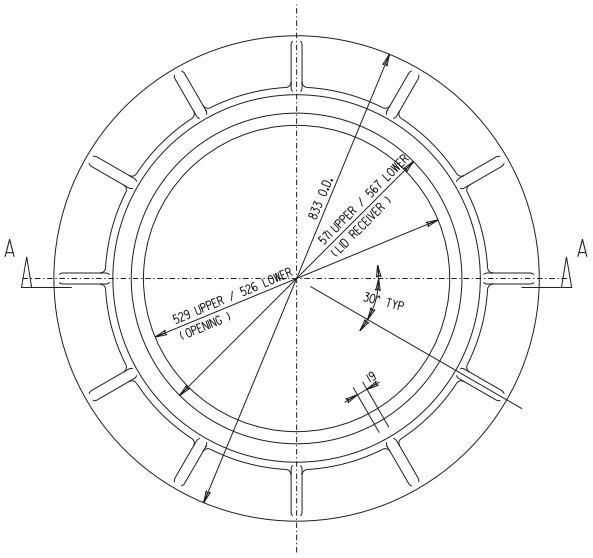
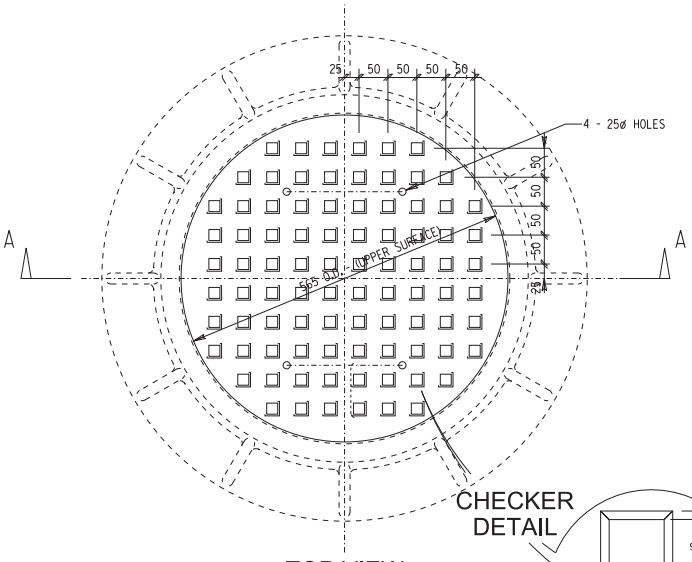
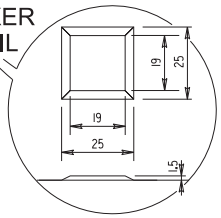
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7043A / 7043B



TOP VIEW

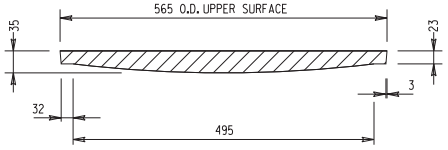


TOP VIEW



TYPE 6S MANHOLE COVER

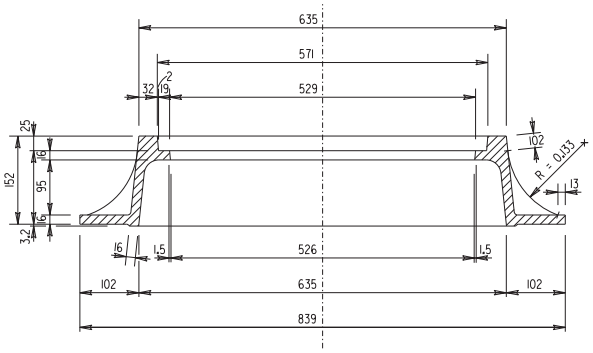
(WEIGHT = 50.0kg)



SECTION A-A

TYPE 6 STANDARD FRAME FOR MANHOLE AND ROUND CATCH BASIN COVER

(WEIGHT = 69kg)



SECTION A-A

TABLE 1 - MANUFACTURING TOLERANCES

1. NO DEVIATION SHALL BE ACCEPTABLE FOR DIMENSIONS WHICH ARE LESS THAN 10mm
2. ALL DIMENSIONS GREATER THAN 10mm SHALL CONFORM TO ±3mm TOLERANCE

NOTE:

(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS: THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN ±5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

SPECIFICATIONS

1. MATERIAL SPECIFICATIONS:
   FRAME AND COVER - GREY CAST IRON TO CONFORM TO CLASS 35B ASTM A48 (LATEST EDITION).
2. CASTINGS SHALL BE PRODUCED TO THE DIMENSIONS SHOWN AND WITHIN THE TOLERANCES NOTED IN TABLE 1 - MANUFACTURING TOLERANCES.
3. COATED CASTINGS WILL NOT BE ACCEPTED.
4. CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE:
   A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD)
   B) FOUNDARY IDENTIFICATION MARKING, AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
5. ALL CASTINGS WILL BE: FREE OF DEFECTS, TRUE TO PATTERN AND FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTING SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
6. MATING SURFACES SHALL BE MACHINED SUCH THAT CASTINGS SHALL NOT ROCK WHEN INSTALLED. THE MANUFACTURER SHALL TRIAL FIT THE CASTINGS AGAINST A TRIAL FRAME OR COVER.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

TYPE 6S MANHOLE FRAME AND COVER

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
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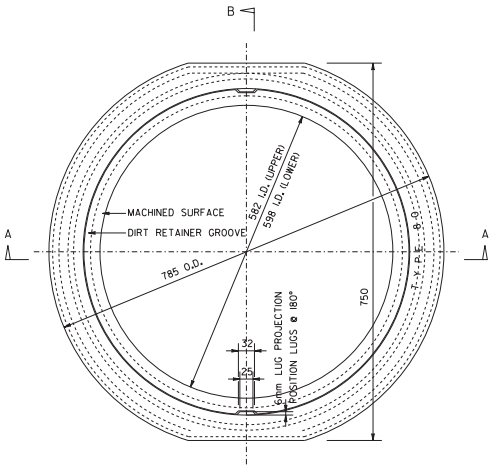
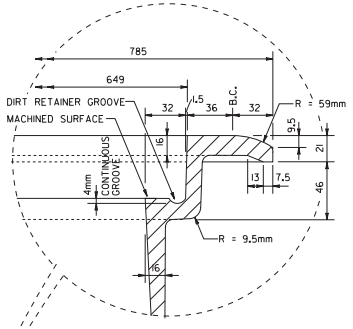
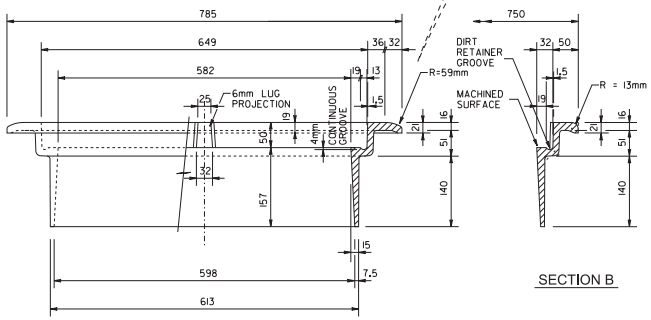
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7043C



TOP VIEW



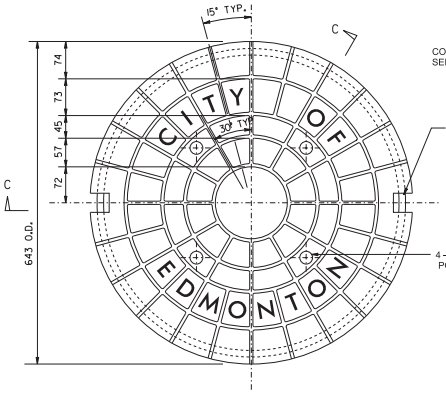
DETAIL
SCALE 1 : 2



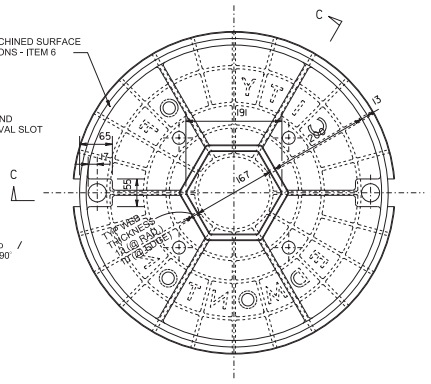
SECTION A-A

FLOATING TYPE MANHOLE FRAME

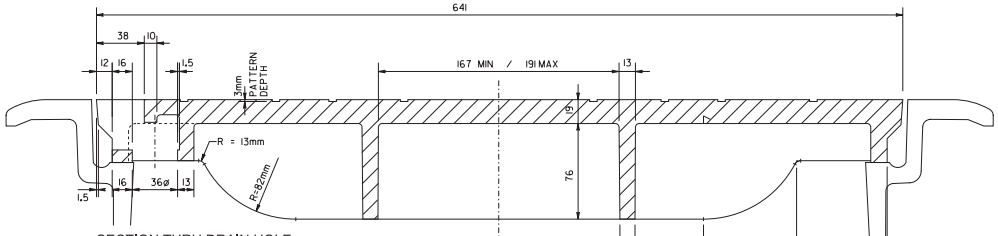
SECTION B



TOP VIEW



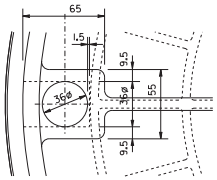
BOTTOM VIEW



SECTION THRU DRAIN HOLE

SECTION C-C

TYPE 80 MANHOLE COVER



DRAIN HOLE DETAIL
BOTTOM VIEW

TABLE 1 - MANUFACTURING TOLERANCES

1. NO DEVIATION SHALL BE ACCEPTABLE FOR DIMENSIONS WHICH ARE LESS THAN 50mm
2. ALL DIMENSIONS GREATER THAN 50mm SHALL CONFORM TO ±3mm TOLERANCE.
3. ALL FILLET RADII TO BE 6mm UNLESS SHOWN OTHERWISE.

NOTE:

(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

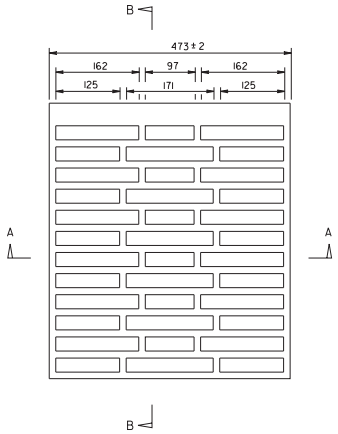
SPECIFICATIONS

1. MATERIAL SPECIFICATIONS:
   FRAME AND COVER - DUCTILE MATERIAL TO CONFORM TO ASTM A536 (LATEST EDITION) GRADE 80-55-06 COVER MASS = 50 kg ±5%
   FRAME MASS = 54.5 kg ±5%
2. CASTINGS SHALL BE PRODUCED TO THE DIMENSIONS SHOWN AND WITHIN THE TOLERANCES NOTED IN TABLE 1 - MANUFACTURING TOLERANCES.
3. COATED CASTINGS WILL NOT BE ACCEPTED.
4. CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE:
   A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD)
   B) FOUNDARY IDENTIFICATION MARKING, AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
5. ALL CASTINGS WILL BE; FREE OF DEFECTS, TRUE TO PATTERN AND FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTING SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
6. MATING SURFACES SHALL BE MACHINED SUCH THAT CASTINGS SHALL NOT ROCK WHEN INSTALLED. THE MANUFACTURER SHALL TRIAL FIT THE CASTINGS AGAINST A TRIAL FRAME OR COVER.

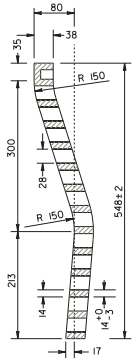
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

TYPE 80 COVER AND FLOATING TYPE MANHOLE FRAME

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-18-06
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7044

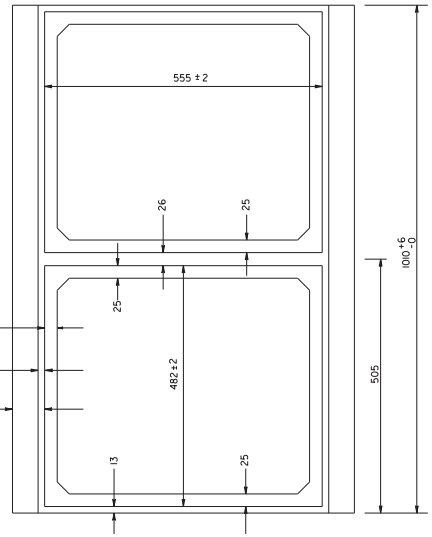


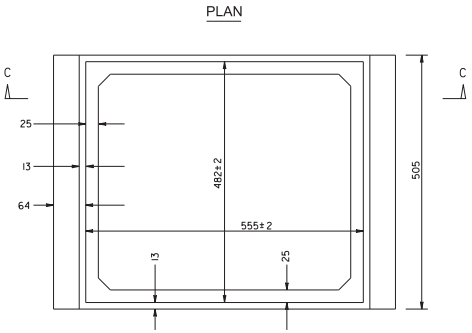
PLAN



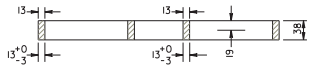
SECTION B-B

PLAN





PLAN



SECTION A-A
GRATE

FRAME AND GRATING DIMENSIONS ARE MEASURED AT THE TOP OF THE UNIT AND THE TAPER (USUALLY APROX. 2mm) IS NOT SHOWN.

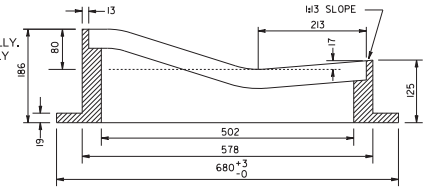
DIMENSIONAL TOLERANCES AS SHOWN.

NOTE:

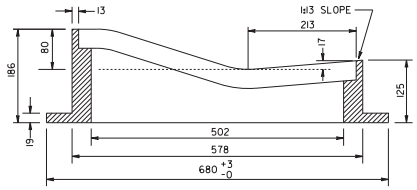
(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

SPECIFICATIONS :

(1) THE FRAME CASTING SHALL CONFORM TO CLASS 35B ASTM A48 (LATEST EDITION) - GREY CAST IRON.
(2) THE GRATE CASTING SHALL CONFORM TO ASTM A536 (LATEST EDITION) GRADE 80-55-06 - DUCTILE IRON.
(3) COATED CASTINGS WILL NOT BE ACCEPTED.
(4) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE:
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKING AND YEAR OF CASTING.
(5) ALL CASTING WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTING SHALL BE FREE FROM BURNT AN SAND AND BE REASONABLY SMOOTH.
(6) CASTING SHALL NOT ROCK WHEN INSTALLED. THE MANUFACTURER SHALL TRIAL FIT THE CASTINGS AGAINST A STANDARD FRAME.



SECTION C-C
SINGLE FRAME



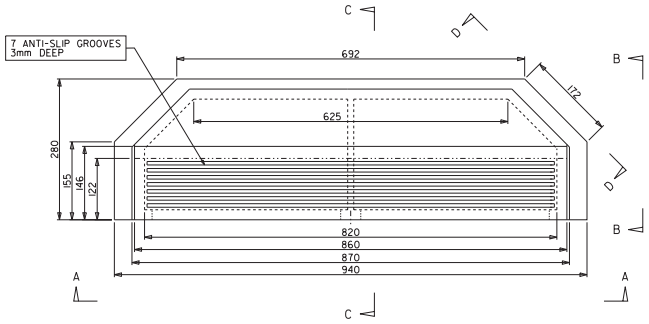
SECTION D-D
DOUBLE FRAME

GRATE MASS = 20 kg.
SINGLE FRAME MASS = 73 kg.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

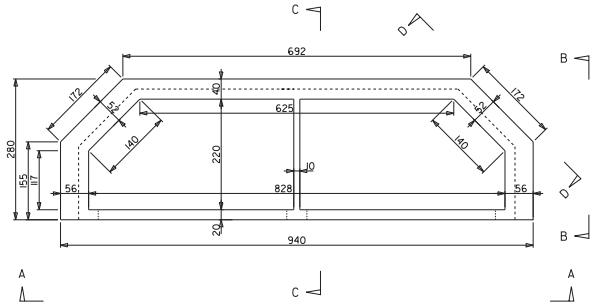
TYPE K-7 AND DK-7 CATCH BASIN FRAME AND GRATING

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL		DR-06-18-07
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7045



SIDE INLET

PLAN VIEW - TOP



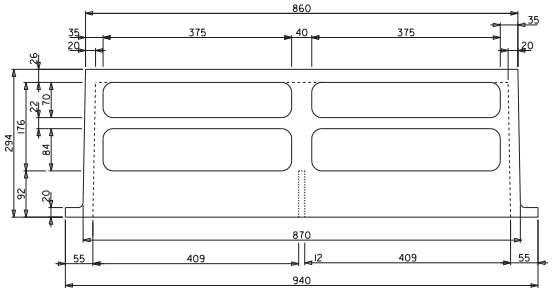
PLAN VIEW - BOTTOM

SPECIFICATIONS :

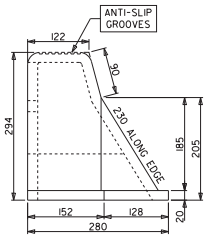
(1) COATED CASTINGS WILL NOT BE ACCEPTED.
(2) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(3) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(4) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.

NOTE:

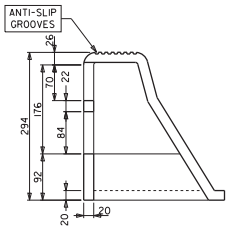
(1) THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).



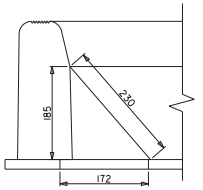
FRONT VIEW A - A



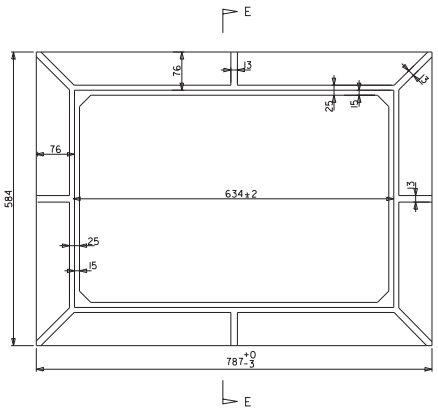
SIDE VIEW B - B



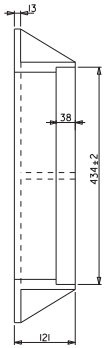
SECTION C -C



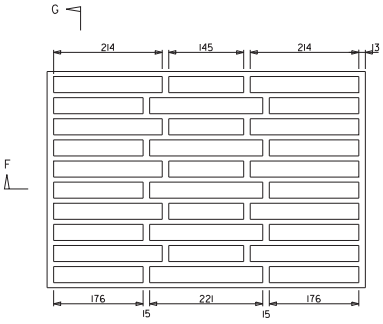
SLANT VIEW D - D



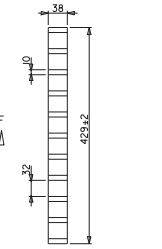
FRAME - PLAN VIEW



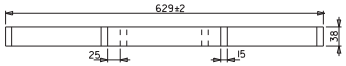
SECTION E - E



GRATE - PLAN VIEW



SECTION G - G



SECTION F - F

FRAME AND GRATING DIMENSIONS ARE MEASURED AT THE TOP OF THE UNIT AND THE TAPER (TYPICALLY 3mm TO 4mm) IS NOT SHOWN.

DIMENSIONAL TOLERANCES AS SHOWN.

MATERIAL SPECIFICATIONS

FRAME:
* GREY CAST IRON TO CONFORM TO CLASS 35B ASTM A48 (LATEST EDITION)
* MASS = 57 KILOGRAMS PLUS/MINUS 5%

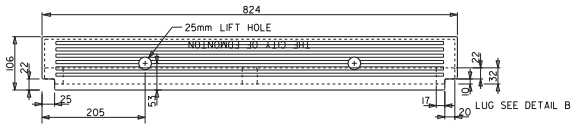
SIDE INLET:
* GREY CAST IRON TO CONFORM TO CLASS 35B ASTM A48 (LATEST EDITION)
* MASS = 86 KILOGRAMS PLUS/MINUS 5%

GRATE:
* DUCTILE IRON TO CONFORM TO A.S.T.M. A536 (LATEST EDITION) GRADE 60-40-18
* MASS = 25 KILOGRAMS PLUS/MINUS 5%

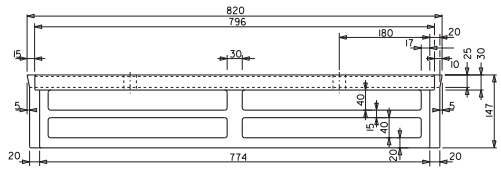
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

TYPE F-51 THREE PIECE CATCH BASIN FRAME AND GRATING WITH SIDE INLET

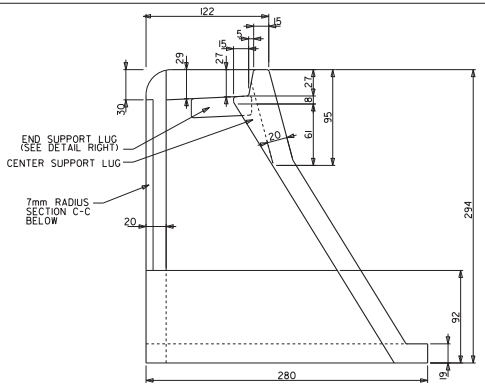
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	AM		DR-06-18-08
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7047



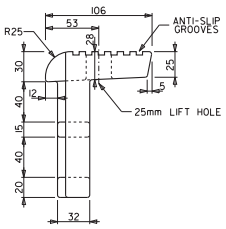
CURB COMPONENT
COVER PART A - PLAN VIEW



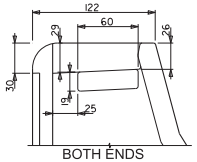
CURB COMPONENT
COVER PART A - FRONT VIEW
DUCTILE IRON (D 65 COVER STRENGTH)

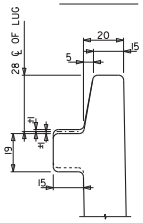


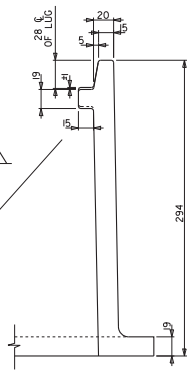
FRAME PART B



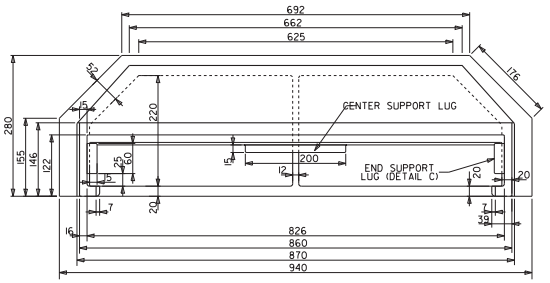
COVER PART A





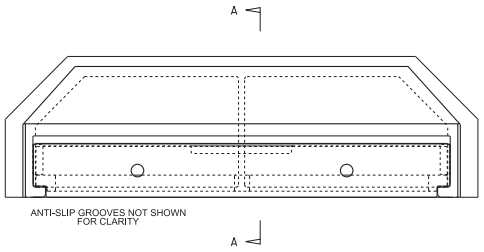


DETAIL C
PART B
END SUPPORT LUG

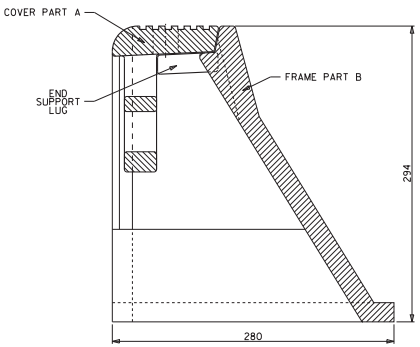


SEE DETAIL A

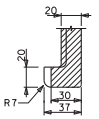
CURB COMPONENT
PART B - PLAN VIEW



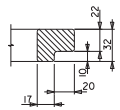
ASSEMBLED - PLAN VIEW



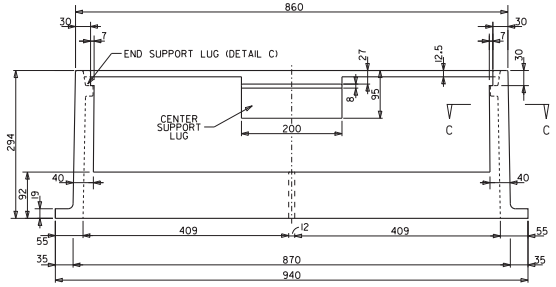
SECTION A - A



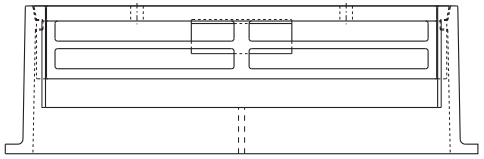
DETAIL A
FRAME PART B
SCALE 1:25



LUG DETAIL B
COVER PART A



CURB COMPONENT
FRAME PART B - FRONT VIEW
CAST IRON



ASSEMBLED - FRONT VIEW

SECTION C - C

NOTE:

THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED. PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

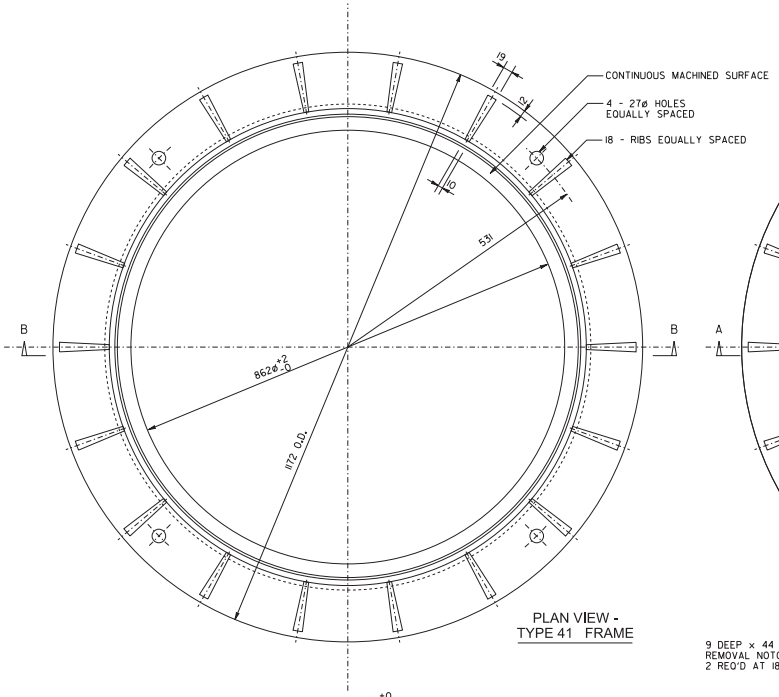
SPECIFICATIONS:

(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B OR ASTM DESIGNATION A536 GRADE 65-45-12 (OR APPROVED ALTERNATE) AS SPECIFIED.
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.
(6) TOLERANCE TO BE AS PER GREY IRON TENDER DOCUMENTS.

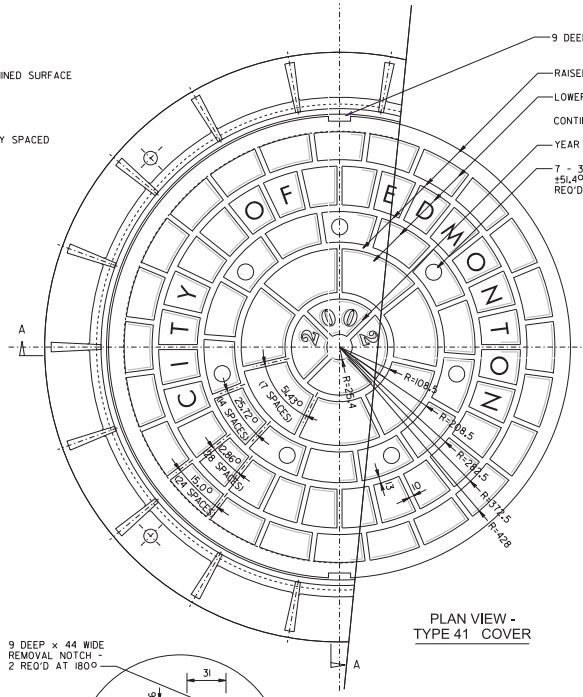
EPCOR

TYPE F-51 2 PIECE CURB COMPONENT FRAME AND GRATING

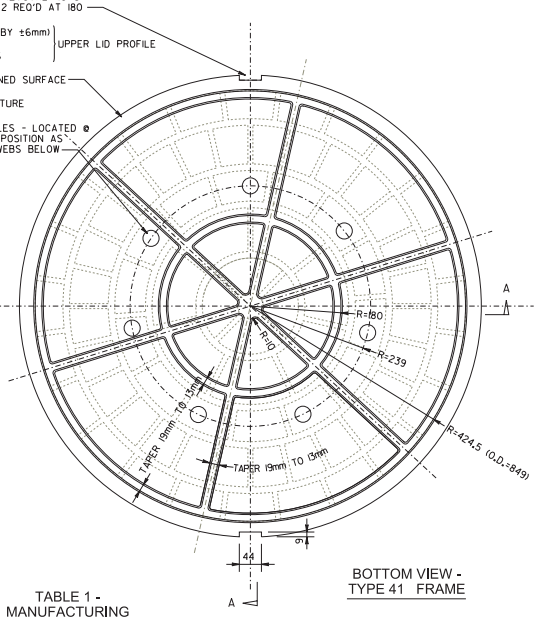
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	AM		DR-06-18-09
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7048



PLAN VIEW - TYPE 41 FRAME



PLAN VIEW - TYPE 41 COVER



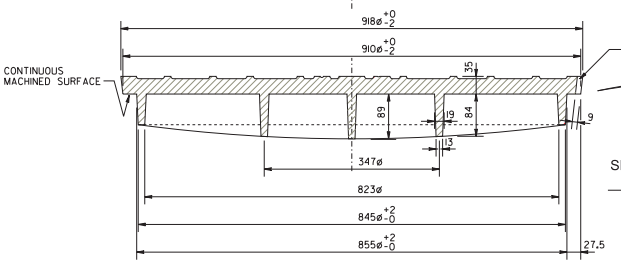
BOTTOM VIEW - TYPE 41 FRAME

TABLE 1 - MANUFACTURING TOLERANCES

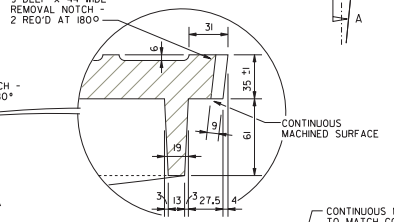
ALL DIMENSIONS SHALL CONFORM TO ±3mm TOLERANCE,

EXCEPT:

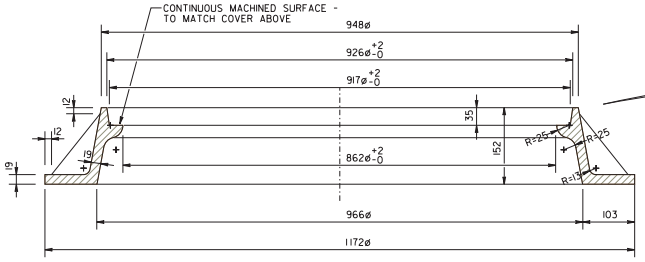
1) AS NOTED OTHERWISE.
2) NO DEVIATION SHALL BE ACCEPTABLE FOR DIMENSIONS WHICH ARE LESS THAN 10mm.



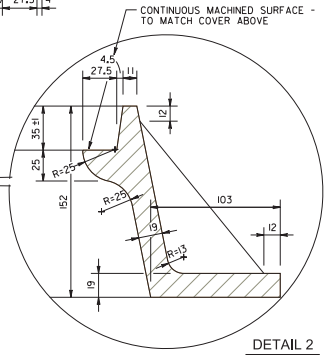
SECTION A-A COVER



DETAIL 1 SCALE 1:2



SECTION B-B FRAME



DETAIL 2

SPECIFICATIONS

(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
  (A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
  (B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.

NOTE:

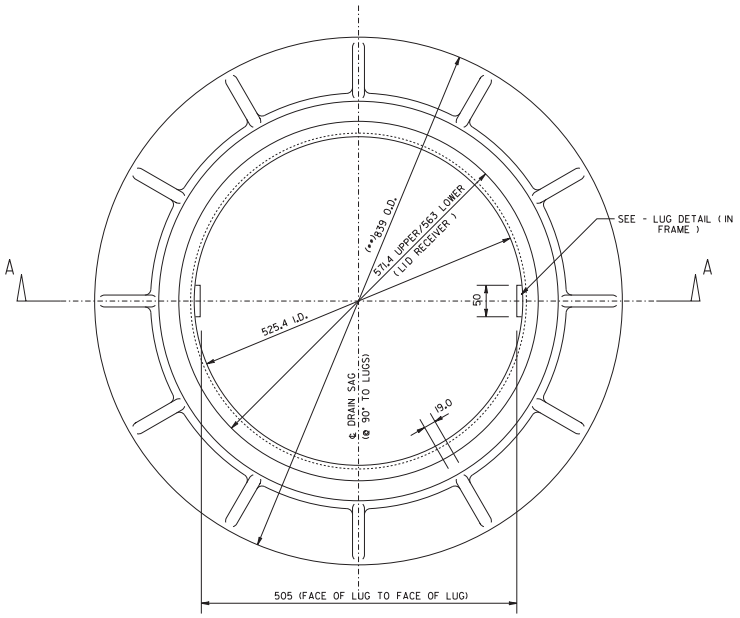
THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED, PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

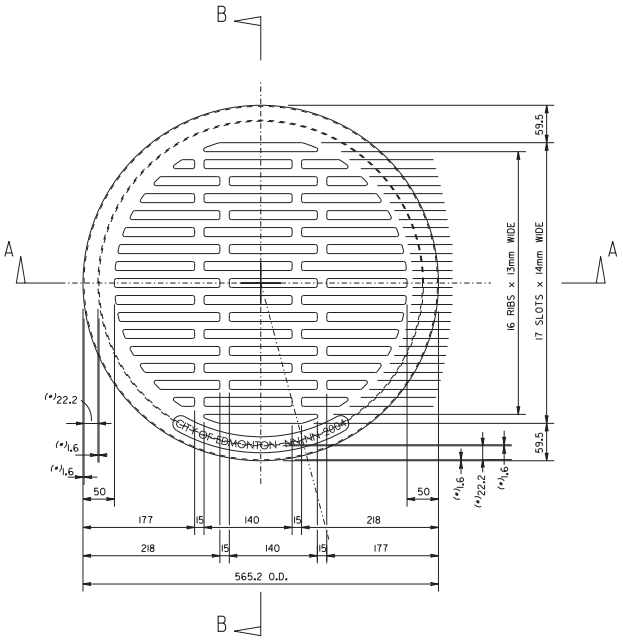
TYPE 41 MANHOLE FRAME AND COVER

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-18-10
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7050

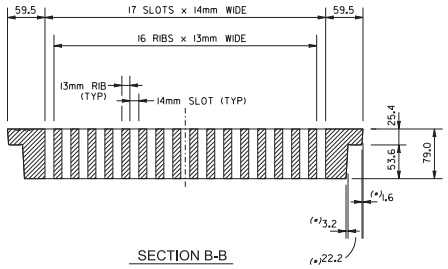


TOP VIEW

NOTE - THIS IS A TYPICAL TYPE 6A FRAME

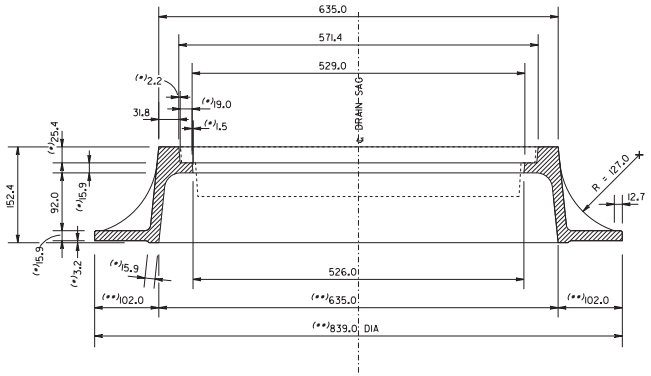


TOP VIEW



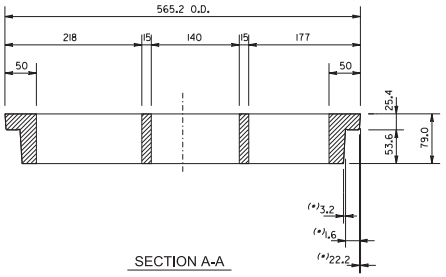
SECTION B-B

WEIGHT = 63 kg.



SECTION A-A

NOTE - THIS IS A TYPICAL TYPE 6A FRAME



SECTION A-A

ALL DIMENSIONS SHALL CONFORM TO ±3mm TOLERANCE - *EXCEPT*:
1) DIMENSIONS MARKED *(*)*SHALL CONFORM TO A TOLERANCE OF 1.5mm.
2) DIMENSIONS MARKED*(**)*SHALL CONFORM TO A TOLERANCE OF 8mm.

NOTE:

THIS DRAWING REPRESENTS DIMENSIONAL INFORMATION FOR PRODUCTS THAT HAVE BEEN PRODUCED FOR THE CITY HISTORICALLY. ALTERNATE DIMENSIONS AND DETAILS MAY BE PROPOSED. PROVIDING ALL ALTERNATIVE PRODUCTS AND COMPONENTS ARE FULLY INTERCHANGABLE WITH THESE PRODUCTS; ALL INLET GRATES PROVIDE THE SAME HYDRAULIC CAPACITY AS THESE PRODUCTS, BY PROVIDING THE SAME GENERAL LAYOUT AND INLET AREA; THE WEIGHTS OF ALTERNATE PRODUCTS ARE WITHIN +/- 5% OF THESE PRODUCTS; AND THE PRODUCTS MEET THE PROOF LOAD TEST REQUIREMENTS FOR HS-20 LOADING AS OUTLINED IN AASHTO M306 (LATEST EDITION).

SPECIFICATIONS

(1) CASTINGS SHALL CONFORM TO ALL REQUIREMENTS OF ASTM DESIGNATION A48 CLASS 35B
(2) COATED CASTINGS WILL NOT BE ACCEPTED.
(3) CASTINGS SHALL BE MARKED WITH THE PROPER IDENTIFICATION MARKINGS WHICH WILL INCLUDE :
(A) SERIES DESIGNATION (CITY OF EDMONTON STANDARD).
(B) FOUNDRY IDENTIFICATION MARKINGS, MONTH AND YEAR OF CASTING AND OTHER REQUIREMENTS AS PER AASHTO M306 STANDARD.
(4) ALL CASTINGS WILL BE FREE OF DEFECTS, BE TRUE TO PATTERN AND BE FREE FROM CRACKS, GAS HOLES, FLAWS AND EXCESSIVE SHRINKAGE. SURFACES OF THE CASTINGS SHALL BE FREE FROM BURNT ON SAND AND SHALL BE REASONABLY SMOOTH.
(5) CASTINGS SHALL BE GUARANTEED NOT TO ROCK WHEN INSTALLED. CASTINGS MAY BE TRIAL FITTED AGAINST STANDARD FRAME PRIOR TO ACCEPTANCE. THE STANDARD FRAME WHICH WILL BE SUPPLIED BY THE CITY, WILL HAVE MACHINE BEARING EDGES.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

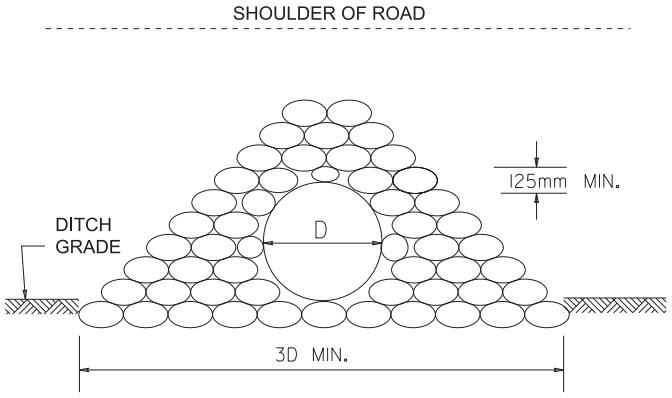
EPCOR

TYPE 6C SLOTTED FLAT COVER TO BE USED ON TYPE 6 FRAME FOR AIR RELEASE

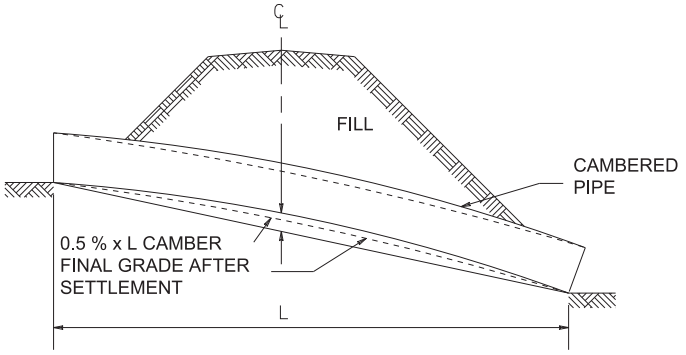
DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	CRB		DR-06-18-11
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7051

PROCEDURE:

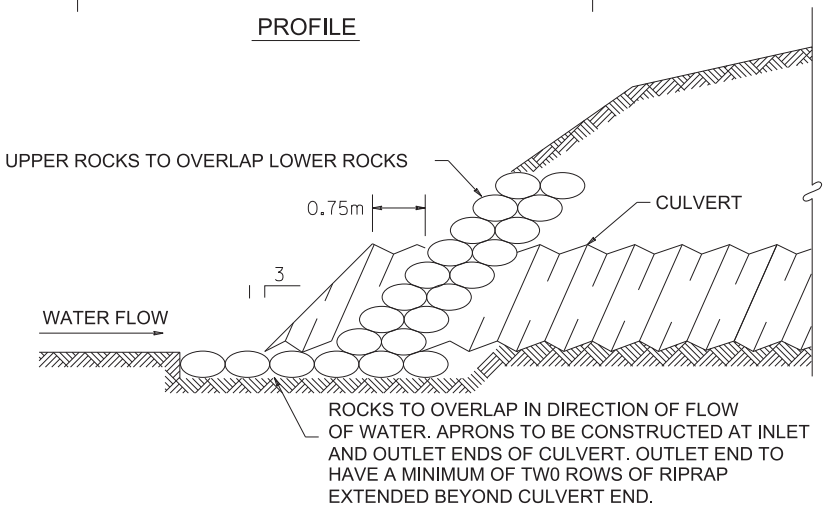
PLACE ROCKS INTO POSITION BY RAMMING, AND PACKING AGAINST EACH OTHER TO FORM A CLOSELY MOULDED AND UNIFORM LAYER AVERAGING NOT LESS THAN 125mm IN THICKNESS. PLACE ROCKS IN STAGGERED PATTERN SUCH THAT ANY ROCK (EXCEPT AT THE BOTTOM) WILL REST ON TWO OR MORE OTHER ROCKS.



INLET AND OUTLET ELEVATION



PROFILE



SIDE ELEVATION

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

EPCOR

CULVERT END RIPRAP

DATE APPROVED	DRAWN BY	APPROVED	DRAWING NUMBER
OCTOBER 2021	JL, DJ		DR-06-19-01
SCALE	CHECKED BY		OLD DRAWING NUMBER
NTS	SK		7062