



ROADS CONSTRUCTION

2021 STANDARD SPECIFICATIONS

Transportation Department
The City of Calgary, ROADS
Construction Division



2021 Revisions

Section	Page Number or Section Revised	Description
-	Specification Definitions	Modified the definition of the “Engineer” and added a new one for “Responsible Member”
-	Authentication and Validation	Added a new section to the spec to indicate who authenticates and validates each section.
-	Reference Sections	Added a new section to the spec to indicate which sections are for reference only.
300.00.00	General	Redefined the scope of this section
300.08.00	Nuclear Moisture Density Gauge Requirements	Typo corrections
301.03.00	Construction Details	Subsection revised
302.01.03	Rock Excavation	Subsection revised
302.04.03	Explosives and Blasting	Subsection revised
304.07.04	Surface Restoration	Subsection revised (Changed 2010 to Current)
307.00.00	Asphalt Concrete	Subsection revised (Material & Research is changed to Pavements, Soils, and Asset Management)
308.00.00	Pavement Design	Subsection revised (Material & Research is changed to Pavements, Soils, and Asset Management)
311.06.00	Concrete Placing	Subsection revised (Material & Research is changed to Pavements, Soils, and Asset Management)
311.13.02	Sidewalk, Curb and Gutter Failures	Subsection revised (Length of sidewalk changed from 6m to 12m for joint displacement or settlements on a road grade for: Less than or equal to 4% Greater than 4%)
314.00.00	Guardrails	Subsection revised
317.00.00	Railway Crossing Planks	Subsection Added
322.00.00	Standard Drawings	Figure 42,43 & 44 are revised – Wheelchair Ramps



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Utility and Pipeline Location

Prior to the commencement of any work, the Contractor shall contact the appropriate agencies to locate existing underground utilities and pipelines in or adjacent to the construction worksite. Contact the utility or pipeline agencies two working days before commencement of work.

Excavation Permits

Excavation Permits shall be obtained prior to any excavation in public right-of-ways from The City of Calgary, Transportation, Roads, Excavation Permit Office, located at 2808 Spiller Rd SE, South Tower, Main Floor.

Emergency Services

If you accidentally damage the coating, scrape, sever, or rupture any underground line, please call the appropriate emergency number immediately.

Watch for above-ground structures such as utility pedestals, power lines and hydrants located in roadways, lanes and private property. If they are damaged, please report the incident immediately.

Specification Definitions

These definitions appear throughout the document and should be used as a general reference where indicated.

Asphalt Concrete – Generally refers to the final HMA product in place.

End Product Specification (EPS) – A specification whereby the methods of construction are not defined. Under EPS, the Engineer will monitor the Contractor's control of the process that produces the construction items and will accept or reject the end product according to a specified acceptance plan. The Contractor is responsible for quality control. End product acceptance, including quality assurance, is the responsibility of the Engineer.

Engineer – As referred to in this specification, is a "Professional Member" as defined in The City of Calgary's Professional Practice Management Plan (PPMP) and is listed in "List of authenticators and responsible members".

Hot Mix Asphalt (HMA) – Generally refers to the mixture of aggregates and asphalt cement, and other additives where applicable.

Job Mix Formula – The job mix formula (JMF) establishes the proportioning of aggregate, asphalt cement and reclaimed asphalt pavement (RAP) and/or liquid anti-strip agents, where applicable, to be used for the production of hot mix asphalt (HMA).

Lot – A Lot is a portion of the work being considered for acceptance and defined as the following:

Category A Projects – One day of plant production, per mix type, when the day's quantity is greater than 5 000 m². At the Engineer's discretion, when a day's production is less than 5 000 m², material may be added to the previous or subsequent day(s) of production. The maximum Category A Lot size shall be 15 000 m².

Category B Projects – For each mix type, 5 000 m², or the entire project quantity when the quantity is less than 5 000 m², or a portion of the entire project less than 5 000 m² as established by the Engineer prior to the project.

At the Engineer's discretion, any portion of the work may be deemed a Lot.

Post-Production Quality Control – Materials and construction quality control conducted by the Contractor or a designate, in accordance with this specification during and after plant mixing.

Pre-Production Quality Control – Materials and process quality control conducted by the Contractor or their Designate, in accordance with this specification before plant mixing.

Project Category – For the purposes of this specification in section 307.00.00 – Asphalt Concrete, projects are to be identified in the Contract Special Provisions as Category A or Category B. Generally, Category A projects have asphalt concrete quantities greater than 3000 tonnes of any one mix type and Category B projects have quantities of any one mix type less than 3000 tonnes. Subdivision developments shall be considered Category B projects, with the exception of Major Roads which may be

deemed Category A projects at the sole discretion of the Engineer. In all cases, the Special Provisions govern with respect to the applicable Project Category.

Quality Assurance – Acceptance testing and monitoring is undertaken on behalf of the Engineer.

Responsible Member - is a “Responsible Member” as defined in The City of Calgary’s Professional Practice Management Plan (PPMP) and is listed in “List of authenticators and responsible members”.

Permit to Practice

Introduction

APEGA Authenticating Professional Work Products practice standard requires authenticating & validating any document that contains technical information. Road Construction Standard Specifications is revised to add authenticators and responsible members for various sections in the specifications. Table A has a list of all sections with their authenticators and responsible members. It is essential to mention that a few sections in the specifications are not authenticated but added only for reference purposes. Table B includes non-authenticated sections that are added only for reference purposes. Authentication and validation will be required on a project-by-project basis for such sections by engineers or designates.



TABLE A: LIST OF AUTHENTICATORS AND RESPONSIBLE MEMBERS

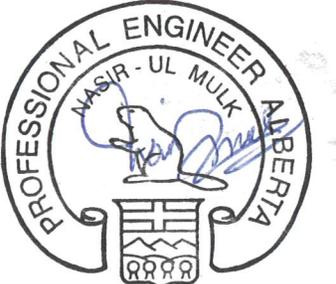
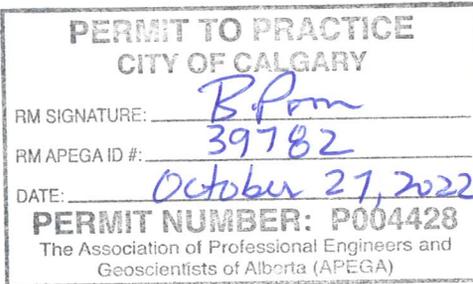
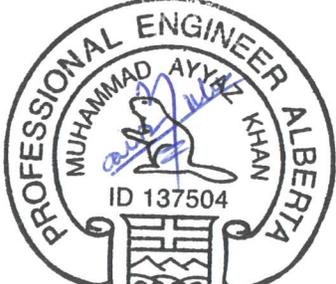
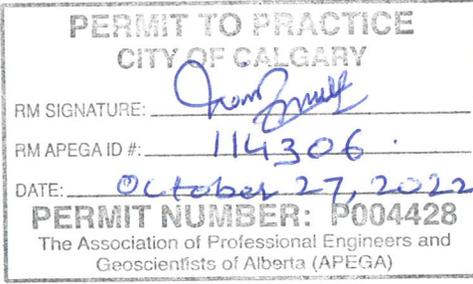
Authenticator	Authenticated Sections	Responsible Member	Authentication Stamp	Validation Stamp
<p>Nasir-ul Mulk (Senior Pavement & Materials Engineer)</p>	<p>304.00.00 – Utility Trench Backfill Regulations 307.00.00 – Asphalt Concrete 308.00.00 – Pavement Design 309.00.00 – Special Surface Construction 310.00.00 – Portland Cement Concrete 311.00.00 – Concrete Sidewalk, Curb and Gutter (Except driveway & maintenance failures) 312.00.00 – Portland Cement Pavement (Except drawings) 315.00.00 – Architectural Pavements</p>	<p>Barry Poon (Manager, Construction)</p>	 <p>October 07, 2022 ID# 114306.</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY RM SIGNATURE: <i>B Poon</i> RM APEGA ID #: <i>39782</i> DATE: <i>October 27, 2022</i> PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>
<p>Muhammad Ayyaz Khan (Pavement Engineer)</p>	<p>300.08.00 – Nuclear Moisture Density Gauge Requirements 301.00.00 – Site Preparation 302.00.00 – Earthwork 302.05.00 – Embankment Construction 303.00.00 – Granular Material 305.00.00 – Gravel Road and Lane Construction (Except drawings) 306.00.00 – Base Stabilization 318.00.00 – Mud-jacking and Soil Stabilization 319.00.00 – Geotextiles and Geomembranes</p>	<p>Nasir-ul Mulk (Senior Pavement & Materials Engineer)</p>	 <p>October 06, 2022</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY RM SIGNATURE: <i>Muhammad Ayyaz Khan</i> RM APEGA ID #: <i>114306</i> DATE: <i>October 27, 2022</i> PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>

TABLE A: LIST OF AUTHENTICATORS AND RESPONSIBLE MEMBERS

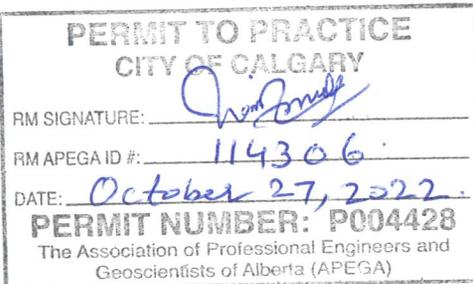
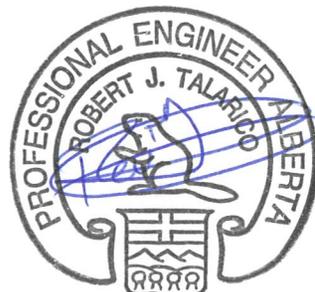
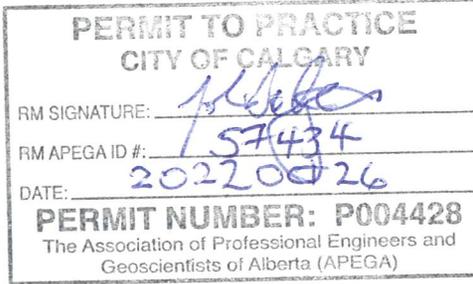
Authenticator	Authenticated Sections	Responsible Member	Authentication Stamp	Validation Stamp
<p>Rashid Hussain (Geotechnical Projects Engineer)</p>	<p>302.05.00 – Embankment construction</p>	<p>Nasir-ul Mulk (Senior Pavement & Materials Engineer)</p>	 <p>Oct 04, 2022 ID # 125391</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>RM SIGNATURE: _____ RM APEGA ID #: 114306 DATE: October 27, 2022 PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>
<p>Rob Talarico (Senior Development & Design Engineer)</p>	<p>309.05.00 – Subdivision Roadway Entrance Features 311.00.00 – Concrete Sidewalk, Curb and Gutter (Driveway & Maintenance Failures) 311.13.00 – Maintenance Standards 311.14.00 – Quantity Measurements</p>	<p>John Bolger (Manager, Development)</p>	 <p>14 Oct 2022 ID 52994</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>RM SIGNATURE: _____ RM APEGA ID #: 57434 DATE: 20220826 PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>



TABLE A: LIST OF AUTHENTICATORS AND RESPONSIBLE MEMBERS

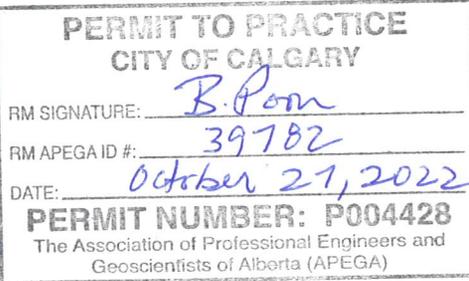
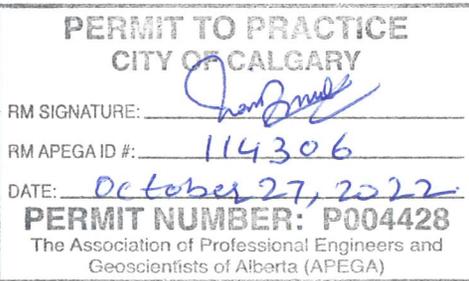
Authenticator	Authenticated Sections	Responsible Member	Authentication Stamp	Validation Stamp
John Bolger (Manager, Development)	309.03.00 – Driveway Aprons	Barry Poon (Manager, Construction)	 <p>57434 2022 OCT 26</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>RM SIGNATURE: <u>B. Poon</u></p> <p>RM APEGA ID #: <u>39782</u></p> <p>DATE: <u>October 27, 2022</u></p> <p>PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>
Ben Wineberger (Senior Engineer, Plan & Infrastructure)	311.13.00 – Maintenance Standards	Nasir-ul Mulk (Senior Pavement & Materials Engineer)	 <p>October 13, 2022 ID# 71967</p>	 <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>RM SIGNATURE: <u>Ben Wineberger</u></p> <p>RM APEGA ID #: <u>114306</u></p> <p>DATE: <u>October 27, 2022</u></p> <p>PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>



TABLE B: LIST OF REFERENCE SECTIONS

Name	Reference Sections
Reference Only	300.00.00 – General 313.00.00 – Fencing 314.00.00 – Guardrails 316.00.00 – Noise Barriers 317.00.00 – Railway Crossing Planks (Except drawings) 320.00.00 – Agricultural Crossings 321.00.00 – Landscaping

300.00.00 – General

The following section lists required specifications and/or qualifications relevant to work carried out under these Specifications. Transportation Infrastructure or Water relevant documents and specifications cover specifications for Bridge, Culvert, and Pipe Structures.

300.00.01 – Application of Specifications

Notwithstanding any other specification, any deviation from these Specifications shall constitute non-compliance and may result in the rejection of the work.

300.00.02 – Basis for Payments

Payment for work carried out under these Specifications shall be under either:

- Lump-sum – no specific unit of payment for work in this category.
- Unit Rate – work paid for by unit, such as tonne, cubic metre (m³), square metre (m²), etc.
- Payment made under either mode of payment shall be considered total compensation for all labour, materials, and equipment necessary to complete the work.
- Force Account – When directed by the Engineer, additional work not covered by either Lump Sum or Unit Rate shall be paid for under the Schedule of Force Account Rates.

300.01.00 – Excavation Permits

Permits are required for all types of street construction. The Contractor acquires one (1) excavation permit from the Excavation Clerk, Roads for each job undertaken under this Contract. All three pages of the permit shall be returned to the Roads Excavation Permit Clerk upon completion of work covered by the permit.

This permit shall be taken out at least forty-eight (48) hours in advance of construction commencement. In the downtown area, an excavation permit shall be required for each block. The downtown area is defined as the area bounded by and including 14 Street SW on the West, 17 Avenue SW on the South, 6 Street SE on the East and the Bow River on the North.

If the work has not commenced within 14 days after the permit has been issued, please contact the Excavation Permit Office for an extension: 403-268 4936.

The Excavation Permit Office is located at 2808 Spiller Rd SE, South Tower, Main Floor.

300.02.00 – Qualifications of Pre-Cast Concrete Manufacturers

All pre-cast concrete elements referred to in these specifications shall be fabricated in a manufacturing plant certified by the Canadian Standards Association in the appropriate categories according to CSA Standard A251-M1982. The pre-cast concrete manufacturer shall be certified prior to submitting the

tender. Only pre-cast concrete elements fabricated in such certified plants shall be acceptable to The City. Plant certification shall be maintained for the duration of the fabrication of the elements for the project.

300.03.00 – Wood Products

Unless otherwise specified, all wood products referred to in these Specifications shall be pressure treated with either Copper Naphthenate or Penta Chlorophenol in accordance with CSA 080.1 and CSA PS-74 and shall be identified using certification marks authorized by the Canadian Wood Preservers Bureau (CWPB) and the National Lumber Grades Authority (NLGA).

<p>Note: Workers should wear personal breathing filters when cutting wood treated with the preservatives mentioned above.</p>
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All panels composed of laminated wood boards shall be in accordance with CSA Standard CAN/CSA-0122-M. All glues shall be water-resistant in accordance with CSA Standard 0112-M. All nails and other fastening devices used with wood products shall be either hot-dip galvanized steel, stainless steel or nonferrous.

300.04.00 – Coatings

All paints, stains, and other coatings referred to in these Specifications shall be subject to certification by the supplier that the coating meets or exceeds the accelerated weathering test in accordance with the requirements of CGSB Standard 1-GP-71 Method 122.1 and ASTM Standard G23-81.

When prepared and tested as outlined, the coating shall, at the 2500-hour exposure evaluation, show no checking, blistering, loss of adhesion or other defects. Chalking shall be seven or higher, and the colour difference shall not exceed five units when measured according to CGSB Standard 1-GP-71 Method 12.1. Unless otherwise specified, stains shall be semi-transparent and shall meet or exceed the accelerated weathering requirements. All coatings shall be free of lead.

300.05.00 – Reinforcing Steel

300.05.01 – General

All reinforcing steel, referred to in these Specifications, when placed in the works, shall be free from hardened mortar, dirt, rust, scale, paint, oil or other foreign material that may destroy the bond.

300.05.02 – Cover

Concrete cover on reinforcing steel shall be a minimum of 50 mm.

300.06.00 – Alternate Construction Materials

Unless otherwise specified, all alternate construction materials including, but not limited to, recycled plastic, recycled concrete, recycled asphalt, etc., proposed as an alternative to materials specified in these specifications, shall be subject to the same or similar specifications as applicable to the already specified material. The use of any alternate material shall be at the sole discretion of the Engineer. The Engineer may request additional tests to ensure that alternate material is suitable for the application intended.

Note: Recycled concrete shall not be used as a surface course or as pipe zone backfill. Recycled asphalt shall not be used as an alternate for gravel under hot mix asphalt.

300.07.00 – Testing

300.07.01 – General

Where reference is made to an ASTM designation or a CSA standard, the current standard applies.

300.08.00 – Nuclear Moisture Density Gauge Requirements

- Approved calibrations will be required on all nuclear moisture-density gauges used on City projects, in areas where The City will become the project's owner, and for all data in reports submitted to The City of Calgary for review.
- All geotechnical reports submitted to The City of Calgary that include moisture and / or density data must include information on all gauge(s) used on each project. Use of gauges not meeting the standard specification requirements may constitute an invalid report and subsequent rejection.
- All geotechnical reports submitted must include the following information for all nuclear moisture density gauges used on the project:
 - Gauge manufacturer
 - Model number
 - Serial number
 - Date of most recent calibration
 - Name of service center providing calibration
- All gauges to be used on City of Calgary projects will require a complete approved calibration, as recommended by the gauge manufacturer and shall not exceed 24 months between calibrations. The date indicated on the most recent calibration report will govern each gauge's re-calibration requirements.
- Calibrations are performed by a recognized nuclear moisture-density gauge service center, using an approved manufacturer method or equivalent deemed acceptable by The City of Calgary (i.e., 3 or 5 block calibration method). Validator calibrations are not acceptable.

- Calibration Verifications may be requested for gauges used on a project at the discretion of The City or Project Engineer. Calibration verification is the first page of the calibration report data sheet indicating the gauge model, serial number, calibration date, source types and serial numbers, reference standard counts, density and moisture calibration count data, and performance parameters.
- All geotechnical material testing or consulting firms using nuclear gauges shall possess a current Canadian Nuclear Safety Commission – “Nuclear Substances and Radiation Devices License” and ensure full compliance with the CNSC Acts and Regulations.

301.00.00 – Site Preparation

301.01.00 – Clearing

All work under this item shall be done in accordance with these Specifications and conformity with the plans.

In developed and semi-developed areas where driveable streets exist and where the project calls for grading and/or paving, the clearing limits include the area covered by the improvement, including private property if accordingly staked by the Engineer. Buildings, fences, lumber piles, trash and obstructions except for utility poles within the area to be cleared shall be removed and properly disposed of by the Contractor.

Trees, shrubbery and flower beds designated by the Engineer are left in place, and the Contractor shall take care not to damage or injure such trees, shrubbery or flower beds by any of their operations. The Contractor shall construct temporary fencing to keep equipment away from tree roots when required by the Engineer.

The Contractor shall construct all temporary fences, gates, telephone lines or other structures necessary to provide temporary service during the progress of the work. All buildings, fences, trees, curbs or other properties, which are not to be removed from the right-of-way, shall be protected during the progress of the work. The Contractor shall not cut or remove shrubs or trees without the prior approval of the Engineer.

The Contractor shall water and fertilize existing trees and shrubs affected by the Contractor's work.

The Contractor shall be responsible for all damages to existing improvements resulting from the Contractor's operations.

301.02.00 – Grubbing

301.02.01 – Protection of Existing Improvements

Where it is necessary to remove stumps, and where there are surface or subsurface improvements, the Contractor shall be responsible for determining which agencies, public or private, have underground or service utilities in the vicinity of the stump to be removed.

Further, the Contractor shall notify each agency and request its assistance in locating its services.

Where sewer, water, electric, telephone, steam, gas and similar underground services into residences are imperilled by stump removal, the utility agency affected cuts the service and replaces same at no cost to the Contractor. Where telephone cable and/or ducts, water mains, gas mains, steam mains, and sewer trunks exist and are likely to be damaged, particular care shall be taken. And stump roots are cut off so that the existing utility installations are not damaged in any way.

301.02.02 – Contractor’s Responsibility

Regardless of the cooperation of affected agencies and utilities, the Contractor shall be responsible for any damage to service and utilities attributable to the Contractor’s operations and shall be responsible for the necessary repairs.

Any damage resulting from the Contractor’s operations to existing improvements within the area to grub, but which are not required to be removed by the grubbing shall be repaired by the Contractor at their expense. The Contractor shall not be held responsible for damage to such improvements if the damage occurred before beginning the Contract.

If the Contractor removes stumps for private property owners along the project, the Contractor shall be responsible for all damage resulting therefrom.

301.03.00 – Construction Details

All stumps, roots, foundations and planking embedded in the ground within limits described herein or otherwise described in the special provisions are removed and disposed of. The engineer shall approve specifications removal of Piling and butts of utility poles. Disposal requirements for grubbing are the same as those described in section 301.01.00 – Clearing.

Removal of sod and lawns that are not to be replaced shall be considered incidental to other work of the project, and no payment shall be made. Grubbing shall otherwise meet requirements previously outlined in section 301.01.00 – Clearing.

301.04.00 – Ornamental and Danger Trees

301.04.01 – Ornamental Trees

It shall be the Contractor’s responsibility to preserve any trees in accordance with provisions in G.C.4.35.6 in the Standard General Conditions; and as per the Tree Protection Bylaw.

301.05.00 – Stripping

The Contractor shall be required to strip, stockpile and re-spread the material as directed by the Engineer. The Contractor shall ensure that sub-soils do not get mixed in with the topsoil. The Contractor shall notify Parks before commencing the stockpiling operation.

302.00.00 – Earthwork

302.01.00 – Definitions

All materials excavated in accordance with these Specifications are classified in the following section.

302.01.01 – Common Excavation

This means the excavating, hauling, placing and compacting in embankments of materials that are not classified as “topsoil” and/or “rock excavation” within the limits of the Contract.

302.01.02 – Waste Excavation

This means the excavating, hauling, disposing and levelling, within the limits of the Contract and at designated disposal areas, of surplus or unsuitable materials, but not of materials classified as “topsoil” and/or “rock excavation”.

302.01.03 – Rock Excavation

All Rock Excavation work requirements shall be developed on a project-specific basis and be approved by the Engineer or Designate.

302.01.04 – Stripping

Stripping is the excavation, hauling and stockpiling (or immediate re-spreading) within the Contract limits of all organic material considered topsoil or loam.

302.01.05 – Re-spreading

Re-spreading is defined as the hauling and spreading of topsoil which has previously been stripped and stockpiled.

302.01.06 – Benching

Where embankments are required on hillsides or where a new fill must be applied on an existing embankment, the slopes of the original ground or embankment (except rock embankment) shall be terraced or stepped by approved means before filling shall commence.

302.02.00 – Grading General

The Contractor excavates any encountered substance to the depth and grades established by the Engineer. After excavation has been completed, the sub-grade shall conform to the design section and grade.

302.02.01 – Ownership of Material

Under no circumstances shall any excavated material be sold or otherwise disposed of by the Contractor, Sub-Contractor or any of their employees. The excavated materials remain the property of The City.

Suitable excavated material shall be used for making all required project embankments. The suitable portion of the excavated material shall be stored on or off the project, as the Contractor may elect, and used for backfilling curbs and dressing up the planting areas, the cost of which shall be considered incidental to the excavation.

The Contractor does not dispose of any excavated material until they are confident there is sufficient material to complete all necessary project embankments and plantings. If an undue amount is wasted, the Contractor secures and furnishes the required material at their own expense.

302.02.02 – Grading Tolerance

The excavation and fill shall be completed and trimmed to proper lines and grades with tolerance as follows:

- Rock: 100 mm vertically and 300 mm horizontally to line or beyond.
- Other Materials: 30 mm vertically and 150 mm horizontally to line or beyond.

Should the Contractor, through negligence or other fault, exceed these tolerances, the Contractor shall bring the grades and lines of all finished surfaces within the specified tolerances at the Contractor's expense.

When excavation changes from one classification to another, the Contractor shall provide ample opportunity for the Engineer to take necessary cross-sections and measurements before proceeding.

For landscaped areas, the maximum allowable slope shall be 3H:1V. The minimum allowable slopes shall be one percent, except for swales, where the minimum allowable shall be two percent. Upon completion of rough grading and before the inspection of the rough grading, grade stakes shall be provided on a 15 m grid according to the approved grading plan.

These grade stakes shall not be required for tot lots, roadways of a major classification or greater.

302.02.03 – Haul Routes

Common and waste excavation haul routes are within the construction limits unless otherwise authorized by the Engineer.

Haul routes shall be maintained to permit free passage of construction traffic.

On completion of the Contract, haul routes are restored to their original condition at the Contractor's expense.

302.03.00 – Dust Control

302.03.01 – General

The Contractor shall control dust around the worksite and along haul routes at all times. Unless otherwise specified, payment for dust control shall be considered incidental to the Contract.

302.04.00 – Excavation

302.04.01 – General

Approaches to the project shall be excavated to the limits indicated on the plans. This excavation shall be made in conjunction with the street excavation and such a manner as to always provide easy and safe access for local and emergency traffic. Where existing streets are to be excavated and are presently surfaced with asphalt concrete or bituminous mats on earth or granular base, these surfaces are considered part of the excavation unless otherwise specified in the special provisions. Where existing street pavements extend behind the new curb line, the Contractor shall also be required to efficiently remove the pavement as part of the excavation.

302.04.02 – Excavation Below Grade

Where the Engineer deems sub-grade material unsatisfactory, excavation below grade shall be required to such depths as he may direct. Excavation below grade shall be of the same classification as that above, provided it is removed in the same operation as the normal excavation. The sides of extra depth excavation are sloped at a maximum slope of three units horizontal to one unit vertical.

The Engineer reserves the right to steepen the side-slopes of the sub-excavation to conserve material. Material deposited and compacted in the sub-cut shall be considered as material deposited and compacted in an embankment.

Where the Contractor has completed the roadway excavation and is required to return to remove unsuitable material, or where the additional depth requires special equipment because of the presence of shallow utilities or other unforeseen conditions, the work shall be performed as directed and payment for excavation below grade shall be made under the Schedule of Force Account Rates.

If the excavation below grade is required because of negligence on the Contractor's part, the necessary excavation below grade and the backfilling required to restore the surface satisfactorily shall be at the Contractor's expense.

302.04.03 – Explosives and Blasting

When explosives are used, the Contractor shall be responsible for their handling, storage and transportation in accordance with City By-laws including and not limited to Fire 55M2014, and with the provisions of the Explosives Act (Canada) and the regulations made thereunder, and with the provisions of Alberta Regulation 272/76, the Explosives Safety Regulations and any amendments to it or substitution therefore and with the applicable provisions respecting explosives and the transportation thereof found in the 1968 Calgary Fire Prevention Bylaw and any amendments to it or substitutions, therefore. In the event of any conflict or duplication of the provisions of Alberta Regulation 272/76 and the bylaw described above, the Contractor shall comply with the more stringent conditions. When required, on a per-project basis, The City may approve blasting required developed by the project Consultant engineer.

302.04.04 – Slides

Side slopes in cuts and on embankments are constructed as staked or established by the Engineer. If a slope that has been finished to the lines as staked or established by the Engineer slide back of the established slope onto the roadway prism, or out of an embankment, before final acceptance of the work, such slide material shall be removed by the Contractor from the roadway, or replaced in the embankment, at the Unit Rate for the class of excavation involved. The slopes are to be refinished as directed by the Engineer. Materials to replace embankment slides shall be obtained from sources designated by the Engineer. Slopes undercut at the base or destroyed in any manner by an act of the Contractor are to be re-sloped parallel to the damaged slope or as established by the Engineer at the Contractor's expense.

302.04.05 – Ditches

All ditches shall be constructed as shown on the plans and are graded as to the natural flow of the water to inlets, catch basins, culverts or channels. Ditches from cuts are located in such a manner as to bypass any part of the adjacent fill to prevent damage by running water.

302.04.06 – Borrow

Borrow consists of the excavation and disposal of suitable and satisfactory material obtained from borrow pits designated and measured by the Engineer to construct embankments, sub-grade, parking strips and sidewalk areas, or shoulders and other facilities. The widening of street cuts and ditches shall be considered as street excavation and not as borrow.

302.04.07 – Disposal

All waste materials shall be appropriately disposed of at approved recycling sites, City of Calgary landfill sites, or other approved Waste Management sites. At the direction of the Engineer, suitable excess fill material may be stockpiled in designated areas for future use by The City.

302.04.08 – Excavation of Planting Beds

Stake out the locations of all items requiring excavation and obtain the approval of Parks before commencing work. Obtain the approval of Parks for all excavations.

Dispose of excavated material off-site unless approved for use as fill material. Excavate to the elevations and dimensions indicated or required for construction work.

Where the bearing capacity of the subsoil appears to be insufficient, obtain the written approval of Parks to have soil investigations carried out.

Excavation exceeding that shown on the drawings, if authorized in writing by the Engineer, shall be paid Force Account Rates in accordance with the Standard General Conditions.

Do not disturb soil within the branch spread of trees that are to remain. If excavating through roots is required, inform Parks. The cutting of roots shall only be done by Parks or by an approved arborist.

302.04.09 – Excavation of Irrigation System Trenches

Excavate trenches to lines and grades show to a minimum of 75 mm below pipe invert where bedding is required. Provide recesses for bell and spigot pipe to ensure bearing will occur along the barrel of pipe. Cut trenches three times wider than the maximum pipe diameter. Trim and shape trench bottoms and leave free of irregularities, lumps or projections.

302.05.00 – Embankment Construction

302.05.01 – General

Embankment construction shall be divided into two classes – rock embankments and earth embankments. Rock embankments are all, or any part of an embankment in which the material consists of 10 percent or more, by volume, of gravel or stone 100 mm or greater in diameter. Embankments of all other materials are considered as earth embankments.

The maximum density and optimum moisture content for each soil type shall be determined by ASTM D698.

302.05.02 – Embankments on Soft, Wet, or Swampy Ground

When embankments are constructed across wet or swampy ground that does not support the weight of heavy hauling and spreading equipment, the Contractor shall be required to choose such embankment construction methods and hauling and spreading equipment as will least disturb the soft foundation. When soft foundations are encountered, the lower part of the fill may be constructed by dumping and spreading successive vehicle loads in a uniformly distributed layer of thickness not greater than that necessary to support the vehicle while placing subsequent layers. The remainder of the embankment shall be constructed in layers and compacted as specified.

The Contractor will not be allowed to increase the planned depth of embankment material over soft, wet, or swampy ground for the sole purpose of providing support for heavy hauling and spreading equipment.

302.05.03 – Materials

All materials used in embankments or for any other purpose are subject to the Engineer's approval. The use of frozen materials shall not be permitted for embankment construction. The materials composing the embankments shall be entirely imperishable. If the Engineer judges the natural surface upon the embankment to impair the stability or usefulness of the street, the natural surface shall be stabilized or removed and disposed of as directed by the Engineer.

302.05.04 – Compaction

Embankments are constructed in compacted layers of uniform thickness. The layers are carried up full width from the bottom of the embankment to avoid widening the edges after the centre is brought to grade.

Embankments are compacted with modern, efficient, compacting units capable of compacting each material lift to the specified density. The right shall be reserved for the Engineer to order the use of any particular compacting unit discontinued if it is not capable of compacting the material to the required density in a reasonable time.

Hauling equipment shall not be accepted in lieu of compaction equipment. Water added to the fill material for compaction purposes shall be free from deleterious materials.

302.05.05 – Maximum Lift Thickness and Minimum Compaction

TABLE 1: MAXIMUM LIFT THICKNESS AND MINIMUM COMPACTION

For materials classified as:			
	Maximum Lift Thickness	Moisture Content	Minimum Density
Soil	200 mm	Optimum to optimum +3 %*	97.0 % of maximum
Granular	300 mm	±3 % of optimum	As specified in section 305.00.00 – Gravel Road and Lane Construction.

Note: Subject to approval by the Engineer, the moisture content may be lowered if warranted by soil conditions to achieve stability requirements for proof rolling.

At all locations that are inaccessible to a roller, the embankment shall be brought up in horizontal layers and compacted thoroughly with mechanical tampers. The horizontal layers shall not exceed 200 mm in loose thickness, except that the layers of the top 600 mm shall not exceed 100 mm in loose thickness.

302.05.06 – Embankment at Structures, Trestles and Bridge Ends

The work of filling around structures, the ends of trestles and bridges, and constructing embankments shall be undertaken and completed as soon as each structure is completed or when ordered by the Engineer. In filling around the structure, trestle and bridge ends, the Contractor shall bring the fill-up equally on all sides of the bracing and the columns of the ledge to prevent distortion of the bents and columns. This method shall also bring up the fill on both sides of the bulkheads as shown on the plans or as directed by the Engineer. The embankments must be constructed under the bridge to the height and dimensions shown on the plans or as directed by the Engineer.

The embankment and backfill at both ends of all rigid frame concrete structures do not have provisions for expansion. They are to be brought up and compacted simultaneously to prevent lateral displacement of the structure due to unbalanced earth loading.

All embankment and backfill within 30m of an existing or proposed structure, trestle or bridge end shall be compacted to a minimum of 100 percent of the maximum density as determined by ASTM Designation D 698 (Moisture Density Relationships of Soils).

302.06.00 – Sub-grade Preparation

302.06.01 – General

The elevation of any given point shall not vary by more than 15 mm from the design grades. The difference between the actual elevations and the design elevations shall not vary by more than 15 mm in 20 metres. In any area where fill is required, the fill shall be compacted to a minimum of 97.0 percent of its maximum density as determined by ASTM Designation D 698 (Moisture Density Relationships of Soils) and then fine graded.

In cut areas, before placing any gravel, the sub-grade shall be scarified to the depth of 150 mm and compacted to a minimum of 97.0 percent of its maximum density as determined by ASTM Designation D 698 (Moisture Density Relationships of Soils).

302.06.02 – Proof Rolling

The Contractor shall supply and operate a loaded test vehicle of 8200 kg axle load to test the sub-grade for rutting, weaving, and soft spots when required by the Engineer. Where proof rolling indicates defective areas, the Contractor shall remove and replace the material with suitable compacted material. Proof rolling shall be considered incidental to the grading work.

302.07.00 – Quantity Measurement

302.07.01 – Excavation

Quantity of common excavation, waste excavation and rock excavation shall be based on the calculated excavated volume as measured in place in the cut.

Where a disposal area for waste excavation is designated as being outside the common excavation fill area, The City reserves the right to dispose of surplus materials in the common excavation fill area without compaction and to make payment for this work at the Unit Rate for Common or Waste Excavation, whichever is less.

The volume of boulders shall be calculated by multiplying the greatest dimension of the boulder in each of three (3) directions at right angles. The mass or bedrock excavation measurement shall be taken from the top of the rock strata to the depth below the pipe specified for “Bedding in Rock Excavation”. The maximum width payable for rock excavation shall be the maximum allowable trench width.

302.07.02 – Benching

Benching for embankments shall be measured and included as common excavation.

302.07.03 – Embankments at Structures, Trestles and Bridge Ends

Embankments in connection with this work are considered incidental to the construction of the improvement. They are deemed to be incidental to the Unit Rate of the various units of work involved.

302.07.04 – Overhaul

Where The City changes the disposal location, an overhaul adjustment shall be made for additional haul beyond the distance that would have been travelled to the specified disposal location using the overhaul Unit Rate.

302.07.05 – Concrete or Asphalt Breakout

All edges of existing concrete and/or asphalt immediately adjacent to the breakout area shall be saw cut to a minimum depth of one-third of the concrete and/or asphalt thickness to provide a smooth and even edge. All saw cutting shall be approved by the Engineer before proceeding.

303.00.00 – Granular Material

303.01.00 – Pit Run Fill Gravel

303.01.01 – Gradation

TABLE 2: PIT RUN FILL GRAVEL

(Square Openings) Metric Sieve Sizes	Percent Passing by Weight	
200 mm	100	Total Sample
150 mm	96 – 100	
80 mm	60 – 80	
25 mm	70 – 100	Material Passing 80 mm Sieve
5.0 mm	25 – 63	
1.25 mm	14 – 41	
0.630 mm	7 – 30	
0.160 mm	3 – 18	
0.080 mm	2 – 9	

303.01.02 – Properties

- No oversized material shall be tolerated.
- All grading curves submitted shall show the following:
 - Grading for the total sample.
 - Grading for material passing the 0.08 mm sieve.
- % Passing 0.08 mm sieve - shall not exceed 2/3 of the material passing the 0.630 mm sieve.
- The material shall be free of harmful coating, and any gravel containing loam or other unsuitable materials shall be promptly rejected.

303.01.03 – Method of Measurement and Payment

1) Measurements

Pit run gravel fill shall be measured in tonnes of material or square metres at the specified thickness, as identified in the Tender Form.

Materials shall be scaled and recorded by the Contractor on duplicate weigh slips. Both parties must sign Weigh slips at the time of delivery and a copy supplied to the Engineer.

2) Payment

The granular material shall be paid for at the contract unit prices bid, as listed on the Tender Form. The payment shall include furnishing all material, production, handling, hauling and placing, spreading, mixing and compacting the materials on the site.

303.02.00 – Granular Base Course and Sub-Base Course Gravel

303.02.01 – General

1) Description

This section specifies requirements for supplying, producing, hauling, placing and compacting processed gravel or quarried stone as a granular base or sub-base to lines, grades and typical cross-sections or as otherwise directed.

The granular sub-base is the initial layer of granular material placed upon the prepared sub-grade to form an integral part of the entire pavement structure.

The granular base is defined as the layer of granular material placed upon the compacted granular sub-base or prepared sub-grade to form an integral part of the entire pavement structure.

2) Related Work

Asphalt Concrete – refer to section 307.00.00 – Asphalt Concrete.

3) Samples

At least two (2) weeks prior to commencing work, the Engineer shall be advised of the proposed source of aggregates and access for sampling shall be provided.

4) Materials Certification

Aggregates – At least two (2) weeks prior to commencing work provide:

- Test data reports representing granular base and/or granular sub-base processed into stockpile. Submit one complete aggregate gradation analysis report for every 1500 tonnes of each material produced or one complete analysis for each production day when the production rate is less than 1500 tonnes. Include the percentage of crushed coarse aggregate particles for each granular base test and every three granular sub-base tests.
- Certification that the physical properties of the aggregates meet the requirements of this section.
- At least two (2) weeks prior to contemplate change in source of aggregates, provide written notification to the Engineer and provide new materials certification in accordance with the requirements of this section.

5) Delivery and Storage

- Aggregates shall be delivered and stockpiled in accordance with the requirements of this section.
- Handle and transport products to avoid segregation, contamination and degradation.
- Stockpile products in sufficient quantities to meet project schedules. When adding new products to the stockpile after removal to the project site has commenced, do not deposit material against the working face of a stockpile.
- Separate product stockpiles with substantial dividers or stockpile far enough apart to prevent intermixing.
- Reject intermixed or contaminated materials. Remove and dispose of rejected materials as directed by the Engineer within 48 hours of rejection.
- Construct stockpiles in uniform lifts using trucks or other equipment approved by the Engineer, being careful to avoid spillage of materials over the ends of previously placed lifts.
- To prevent contamination, provide a previously stabilized stockpile base or a compacted sand base not less than 300 mm in depth. Alternatively, stockpile aggregates on the ground but do not incorporate the bottom 300 mm of pile into the work.

303.02.02 – Products

1) Granular Base

Crushed stone or gravel shall consist of hard, durable, angular particles and be free of clay lumps, cementation, organic material, frozen material and other deleterious materials.

Aggregates shall exhibit the following physical properties:

- % Fracture, by weight (2 faces) - 60 min.
- Los Angeles Abrasion, loss, % - 45 max.
- Liquid Limit, % - 25 max.
- Plasticity Index, % - 6 max.
- California Bearing Ratio, when compacted to 100 % of ASTM D698 - 80 min.

Gradation shall be within the following limits when tested to ASTM C-117 with sieve sizes to CAN/CGSBD 8-GP-2M rather than ASTM E11, and too shall have a smooth curve without sharp breaks when plotted on a semi-log grading chart.

TABLE 3: GRANULAR BASE COURSE GRADATION LIMITS

Sieve Size (mm)	Percent Passing Sieve Size
25	100
20	95-100
10	55-80
5	35-65
2.5	28-52
0.630	13-35
0.315	9-26
0.160	6-18
0.080	4-10

2) Granular Sub-Base

Crushed stone or gravel shall consist of hard, durable, angular particles and be free of clay lumps, cementation, organic material, frozen material, and other deleterious materials.

Aggregates shall exhibit the following physical properties:

- % Fracture, by weight (2 faces) - 20 min.
- Los Angeles Abrasion, loss, % - 45 max.
- Liquid Limit, % - 25 max.
- Plasticity Index, % - 6 max.
- California Bearing Ratio, when compacted to 100 % of ASTM D698 - 40 min.

Gradation shall be within the following limits when tested to ASTM C-117 with sieve sizes to CAN/CGSBD 8-GP-2M rather than ASTM E11, and too shall have a smooth curve without sharp breaks when plotted on a semi-log grading chart.

TABLE 4: GRANULAR SUB-BASE COURSE GRADATION LIMITS

Sieve Size (mm)	Percent Passing Sieve Size
80	100
40	60-90
20	40-70
10	25-60
5	15-45
2.5	10-35
0.630	5-23
0.160	3-12
0.080	2-10

303.02.03 – Execution**1) Preparation**

The sub-grade shall be prepared according to section 302.00.00 – requirements and the cross-sections shown on drawings. The Contractor shall maintain the sub-grade to the specified section, free from ruts and undulations until granular sub-base material is placed. The sub-grade shall be in a dry condition and must be approved by the Engineer before gravel is placed. The depositing of granular base or sub-base on a soft, muddy or rutted sub-grade shall not be permitted.

2) Placement

Material shall only be placed on a clean, unfrozen surface, adequately shaped and compacted, and free from snow and ice.

Placing methods shall not promote segregation or degradation of the aggregate. Approved methods shall be used to create uniform windrows of material along a crown line or high side of a one-way slope.

Materials shall be placed to full width in layers not exceeding 200 mm in compacted thickness.

Each layer shall be placed to a smooth contour and compacted to the specified density before the next layer is placed.

Areas where the material becomes segregated, shall be removed and replaced.

3) Compacting

Granular sub-base and base coarse materials shall be conditioned to be within -3 and +1 percent of the optimum moisture content of the material.

Compaction shall achieve densities of not less than 98% of maximum dry density in accordance with ASTM D698 (Method C or D).

Granular base and sub-base shall be shaped and compacted alternately to obtain a smooth, even, and uniformly compacted base.

In areas not accessible to rolling equipment, the specified density shall be achieved using approved mechanical tampers.

4) Finish Tolerances

Finished sub-base and base surfaces shall be within plus or minus 10 mm of established grade, but not uniformly high or low.

Surface irregularities shall be corrected by loosening and adding or removing materials until the surface is within the specified tolerances.

5) Maintenance

The finished base shall be maintained in a condition conforming to the requirements of this section until the succeeding material is applied or until acceptance.

6) Testing

The Engineer shall perform all tests for acceptance in accordance with the requirements of this section. Test data provided by this testing shall be final and binding on both The City and the Contractor.

303.02.04 – Method of Measurement and Payment

1) Measurements

Granular base and granular sub-base shall be measured in tonnes of material or square metres at the specified thickness, as identified in the Tender Form.

Material shall be scaled and recorded by the Contractor on duplicate weigh slips. Both parties must sign Weigh slips at the time of delivery and a copy supplied to the Engineer.

2) Payment

The granular material shall be paid for at the contract unit prices bid, as listed on the Tender Form. The payment shall include furnishing all material, production, handling, hauling and placing, spreading, mixing, and compacting the materials on the site.

303.03.00 – Drainage Gravel

303.03.01 – Drainage gravel for roadway applications

Drainage gravel for roadway applications shall be as per the Waterworks specifications.



303.03.02 – Method of Measurement and Payment

1) Measurements

Drainage gravel shall be measured in tonnes of material or square metres at the specified thickness, as identified in the Tender Form.

Material shall be scaled and recorded by the Contractor on duplicate weigh slips. Both parties must sign Weigh slips at the time of delivery and a copy supplied to the Engineer.

2) Payment

The granular material shall be paid for at the contract unit prices bid, as listed on the Tender Form. The payment shall include furnishing all material, production, handling, hauling and placing, spreading, mixing and compacting the materials on the site.

303.04.00 – Gravelled Lane Gravel

303.04.01 – Constructing Gravelled Lanes

Gravelled lanes shall be constructed using 50 mm crushed gravel as per File Number 454.1011.003 and shall have the following gradation limits:

TABLE 5: 50 MM CRUSHED GRAVELLED LANE GRAVEL GRADATION LIMITS

Sieve Size (mm)	Percent Passing Sieve Size
50	100
40	95-100
20	50-75
10	25-52
5	15-40
2.5	10-33
0.630	5-23
0.160	2-14
0.080	1-10

Aggregates shall exhibit the following physical properties:

- % Fracture, by weight (2 faces) - 30 min.
- Los Angeles Abrasion, loss, % - 45 max.
- Liquid Limit, % - 25 max.
- Plasticity Index, % - 6 max.
- California Bearing Ratio, when compacted to 100 % of ASTM D698 - 40 min.

303.04.02 – Method of Measurement and Payment

1) Measurements

As identified in the Tender Form, gravelled lane gravel shall be measured in tonnes of material or square metres at the specified thickness.

Material shall be scaled and recorded by the Contractor on duplicate weigh slips. Both parties must sign Weigh slips at the time of delivery and a copy supplied to the Engineer.

2) Payment

The granular material shall be paid for at the contract unit prices bid, as listed on the Tender Form. The payment shall include furnishing all material, production, handling, hauling and placing, spreading, mixing and compacting the materials on the site.

304.00.00 – Utility Trench Backfill Regulations

304.01.00 – General

The specifications in this section apply to compaction of the following:

- All waterworks and sewer service cuts, repairs, replacements, main breaks, extensions etc.
- All shallow cuts by utility companies.
- All cuts for the installation of streetlight ducts and bases.
- On all existing or proposed streets, lanes or easements for the entire width of the right-of-way where The City is responsible for maintenance.

A trench or cut shall be defined as that portion of any excavation extending from within 300 mm below the pipe to the finished subgrade surface.

A trench or cut is further divided into the pipe zone and the street zone defined as follows:

1) Pipe Zone

The pipe zone is defined as a trench area or cut from 300 mm below the conduit to 300 mm above the conduit.

The method of bedding, backfill and compaction and type of equipment used in water and sewer installations shall comply with:

- Standard Specifications Waterworks Construction
 - 504.03.00
- Standard Specifications Sewer Construction
 - 403.04.00
 - 403.07.01
 - 403.08.02

2) Street zone

The street zone is defined as that area of a trench or cut from:

- The top of the pipe zone to the finished sub-grade surface and/or
- From 150 mm below the streetlight duct and/or base to the finished sub-grade surface.

The street zone shall be backfilled in uniform lifts with native material, and each lift shall be mechanically compacted. Testing procedures determine the thicknesses of lifts during the construction process.

When soils removed from any trench, appear unsuitable for replacement due to moisture content or other reasons, and suitable material is not available in the construction area, the street zone shall be backfilled with compacted crushed gravel. At the Engineer's discretion, base gravel or bank gravel (pit run) may be

used for backfill if trench width permits. Under no circumstances shall frozen material be used for backfill. Positive drainage to the storm sewer system shall be provided from all granular backfill material. Granulite, drainage gravel and/or other gap graded material as backfill material in the street zone is prohibited unless the material is enveloped in a drainage membrane and positive drainage to the storm sewer system is provided. Please refer to section 320.00.00 – Agricultural Crossings.

304.02.00 – Moisture Requirements

The soil used for trench backfill shall be within optimum to +2% of its optimum moisture content. Subject to approval by the Engineer, the moisture content for the last metre of backfill may be lowered if warranted by soil conditions.

Granular material shall be within -3 percent to optimum moisture content.

304.03.00 – Density Requirements

304.03.01 – Summer Compaction

TABLE 6: COMPACTION REQUIREMENTS FOR UTILITY TRENCH BACKFILLING COMPACTION

	Percent of Soils Maximum Density
Pipe Zone (Unless otherwise specified)	Minimum 95.0
Street zone	Minimum 97.0

Requirements apply to the entire width of the right-of-way except for the boundary area from the property line up to one (1) metre from the constructed or designed surface installation. In the boundary area, the soil shall be compacted to a minimum of 90 percent of the soil’s maximum density.

304.03.02 – Winter Compaction

All settlements related to winter backfill operations shall be reworked and re-compacted by the utility to a minimum standard density of 97% of the maximum obtainable density by no later than the following May 31.

304.04.00 – Non-Shrink Fill

Specifications

- Compressive strength of two (2) to five (5) MPa.
- Aggregate Grading:


TABLE 7: AGGREGATE GRADING SPECIFICATIONS FOR NON-SHRINK FILL MATERIAL

Sieve Size	Percent Passing by Weight
5.0 mm	55 - 100
2.0 mm	37 - 67
0.08 mm	0 - 30
PI	10 maximum

- Binder
- Portland cement type 10 or Lime/Fly Ash.

304.04.01 – Placing

Non-shrink Fill (N-S Fill) shall be cast on the compacted backfill from one metre below sub-grade to asphalt base. N-S Fill shall be rodded or vibrated to eliminate voids, rough areas, honeycombing and to ensure contact with the sides of the trench.

304.05.00 – Control Density Fill

304.05.01 – General

A flowable fill with self-levelling properties for trench backfill consisting of fine aggregate, sand, and cementitious content. The control density fill shall be resistant to settlement after hydration.

304.05.02 – Materials

Portland cement shall conform to the requirements of CSA Standard CAN3-A5-M, Type 10 or Type 30. Supplementary cementing materials, when permitted, shall conform to the requirements of CSA Standard CAN3-A23.5-M.

Both fine and coarse aggregate shall conform to the requirements of CSA Standard CAN3-A23.1-M. The gradation shall conform to Table 1 of the CSA Standard.

Mixing water used shall meet the requirement of CAN3-A23.1-M.

Air-entraining admixtures shall conform to the requirements of CSA Standard CAN 3-A266.1-M.

304.05.03 – Mix Design

After awarding of Tender and prior to any delivery of control density fill, the supplier shall immediately submit to the Engineer for approval the proposed mix design, including the source of proposed aggregates.

- Slump of the control density fill shall be between 150 to 250 mm.
- Minimum performance values at one (1) day shall be a CBR of 15 and compressive strength of 0.10 MPa.

- Maximum performance values at (28) twenty-eight days shall be a CBR of 60 and compressive strength of 0.60 MPa.

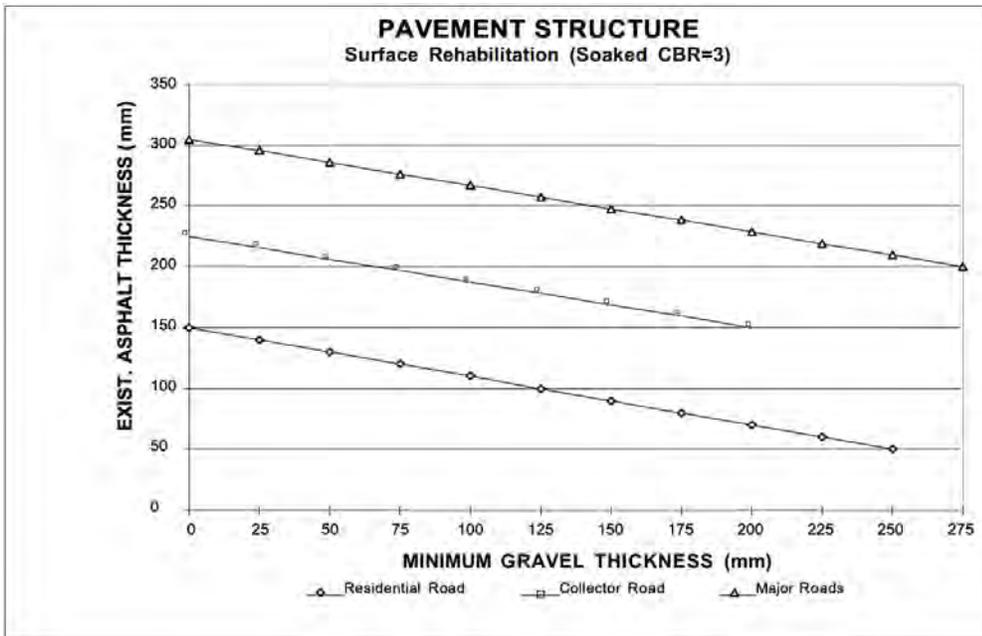
304.05.04 – Trench Restoration

The utility shall be bedded and protected before placing the control density fill. It shall be struck off at a level 100 mm below the pavement surface or to the bottom of the existing asphalt, whichever is the greater.

304.06.00 – Surface Rehabilitation of Trenches or Cuts

304.06.01 – Paved Streets and Lanes

In the case of existing paved streets and lanes, compaction shall be carried out on all lifts up to the level of the existing sub-grade. The construction of the pavement structure shall match the existing asphalt thickness plus gravel. Gravel thickness, based on crushed gravels, shall be as per the following graph. If base gravel is used, add 50 mm to the minimum gravel thickness.



To ensure a neat edge, the pavement shall be saw-cut or routed to a depth of 100 mm or one-half the pavement thickness, whichever is greater, for the entire perimeter.

Patches greater than or equal to 100 m² in area shall be placed with an asphalt spreader. Please refer to section 308.00.00 – Pavement Design.

Asphalt concrete lifts shall not exceed 110 mm. Each lift shall be thoroughly compacted before placing an additional lift.

The final lift of the asphalt patch shall be the equivalent mix design of the wearing surface of the adjacent asphalt.

304.06.02 – Gravelled Streets

In the case of existing gravelled streets, oiled or otherwise, compaction shall be carried out on all lifts up to the level of the existing sub-grade.

Surfacing shall be in accordance with Standard Drawing 454.1005.004 except that the 25 mm crushed gravel shall be oiled in case of oiled streets.

304.07.00 – Excavation in Newly Resurfaced or Top Lifted Streets

304.07.01 – General

Utility excavations shall not be permitted on streets resurfaced or top lifted within the past two (2) years. Exceptions shall be granted only where it can be shown that the utility excavation was beyond the control of the utility involved. This shall include, but not be limited to, emergency work or redevelopment/development requiring service connections. All utility excavation permits applied for prior to the two (2) year period shall be reviewed by the Roads General Manager and shall be subject to the following rehabilitation standard of the street surface:

304.07.02 – Edges

All excavations shall be sawed cleanly through the pavement before excavation.

304.07.03 – Backfill

All trenches shall be backfilled in accordance with the Specifications. Where the trench width does not permit conventional compaction equipment to meet the Specifications, other means acceptable to Roads shall be employed. This may include using non-shrink material for the top one (1) metre of the trench.

304.07.04 – Surface Restoration

Surface restoration is required for any excavation made in a street with a Visual Condition Index (VCI) equal to or greater than 7.0. This includes streets listed in the Pavement Surface Restoration Listing for the current Construction Season document and streets located in areas that recently received a Final Acceptance Certificate (FAC). Some recent FAC streets may not be listed in this document. However, surface restoration requirements apply.

Surface restorations must include planing a minimum of 50 mm and placing new asphalt with a paver.

Surface restoration must be completed by the end of the following construction season.

The final lift of the asphalt patch shall be the equivalent mix design of the wearing surface of the adjacent asphalt.

All patches greater than or equal to 100m² in area shall be machine laid.

Where the excavation runs longitudinally for some distance, such as in the case of a utility installation, the width of the patch shall be the narrowest width that can be placed by a paving machine.

304.07.05 – Pavement Degradation Fee

Costs associated with the restoration or degradation of the pavement and any other impacted City infrastructure are recoverable as per Section Number 37 of Bylaw Number 20M88. This fee is not applicable to newly constructed roads in the sub-division developments, before issuance of Final Acceptance Certificate (FAC).

304.07.06 – Maintenance

In all cases, the utility shall be responsible for the maintenance of the trench backfill for the two (2) year period as specified in the Excavation Permit.

All costs shall be recovered against the excavation permit and charged to the utility involved. All other requirements as stated in the Specifications shall be met.

304.08.00 – Testing

304.08.01 – Testing Services and Reports

The following shall be the minimum acceptable standard for Testing Services and Reports.

Tests are taken within 24 hours of the backfill being placed in the trench or cut. Reports indicate the date when the backfill was placed and testing completed.

Soil density and moisture content tests are taken on each 500 mm of trench depth for a maximum of 75 metres.

Tests shall be so distributed that they are representative of the entire area of the backfill operations.

Service connector trenches shall be tested from pipe zone to finished sub-grade.

Such tests are taken adjacent to all manholes and valves from pipe zone to finished sub-grade.

304.08.02 – Utility Mains - Testing Requirements

All sewer and water main installations within The City right-of-way are subject to continuous testing and inspection to verify compliance with current backfill and compaction specifications. Testing Agencies shall send copies of all test results to Roads.

All utility installations within City rights-of-way have sufficient tests taken to verify compliance with City backfill regulations.

304.08.03 – Compaction Control

The maximum density and optimum moisture content for each soil type shall be determined by ASTM Designation D 698.



The field density of soils shall be determined by ASTM Designation D 2922. For spot checks, the following methods are also acceptable:

- ASTM Designation D 1556
- ASTM Designation D 2167
- ASTM Designation D 2216.

Rapid drying of the soils to determine their field moisture content shall be permitted with a corresponding sample laboratory dried.

304.08.04 – Backfill Compliance Certification

It shall be the responsibility of the consulting engineer engaged by the Contractor to certify that all City Backfill Regulations are met or exceeded. Copies of the soil moisture/density tests shall accompany the Letter of Certification.

If the entire street serviced area is deficient or irregular in testing coverage or failed to maintain the design cross-section and/or grade at any period prior to issuing a FAC; that portion of the right-of-way may be retested under observation by the Engineer or their representative before the issuing of a CCC for the paving and surface concrete work.

If such action is not undertaken, or the retests do not indicate compliance, the value of the surface improvements to be constructed in the affected area may be computed and a deposit in this amount may be required to serve as a guarantee against the failure of the surface improvement due to failures in the sub-base. The term of such a deposit shall be five (5) years, and the deposit shall be required before the construction of surface improvements.

305.00.00 – Gravel Road and Lane Construction

305.00.01 – General

The dimensions of all work shall be in accordance with the typical cross-sections shown on the Standard Drawings. The Engineer may alter the dimensions as conditions and circumstances require.

Where the finished grade is less than 1400 mm above the existing natural ground, all topsoil shall be removed before any fill material is placed.

The top 150 mm of the sub-grade through a cut section shall be scarified and re-compacted to a minimum of 97.0 percent of Maximum Design Density in roadway sections and 95.0 percent of Maximum Design Density in lanes.

Culverts shall be installed at intersecting service streets, the size and type of culvert shall be determined by Wastewater.

The sub-grade shall be trimmed during each phase of construction to conform to the proper grades and line.

No gravel shall be placed on any street or lane before the Engineer accepts the grading work.

Swales shall not discharge into a gravelled lane without the prior written approval of the Engineer.

305.00.02 – Gravelled Lane Construction

Generally, lanes are constructed as shown on Standard Drawing 454.1011.003.

The lane at a catch basin location shall be constructed as shown on Standard Drawing 454.1011.002.

The portion of the lane from the Back of Walk to a point 15 m into the lane shall be constructed as shown on Standard Drawing 454.1011.004.

Gravel lanes shall be deep based at intersections for five (5) metres beyond the intersection.

305.00.03 – Materials

Base course gravel shall conform to the requirements outlined in section 303.00.00 – GRANULAR MATERIAL.

25 mm and 50 mm crushed gravel shall conform to the requirements outlined in section 303.00.00 – GRANULAR MATERIAL. The gravel shall be uniformly and thoroughly compacted throughout. Recycled asphalt shall not be used in lieu of 25 mm or 50 mm crushed gravel.

305.00.04 – Completion Requirements

The following conditions shall be met to qualify for substantial completion:

- The lane or roadway grade conforms to the final approved grade.
- The right-of-way conforms to standard cross-section as shown on the Standard Drawings.
- All slopes are completed and trimmed.

- Catch basins are completely constructed as shown in the Standard Specifications Sewer Construction.
- The minimum depth of compacted crushed gravel shall be in accordance with Standard Drawing 454.1005.004 for gravelled streets and Standard Drawing 454.1011.003 for gravelled lanes.

To qualify for Final Acceptance, the gravelled street or lane shall meet the following conditions in addition to those listed under substantial completion:

- To the Engineer's satisfaction, the entire right-of-way shall be free from all foreign material and maintained adequately by the Developer.

305.01.00 – Base Gravel Base Course

Note: Please use section 303.00.00 – Granular Material as a reference for supplying, producing, hauling, placing and compacting Base Gravel Course.

The surface of the final lift of base gravel shall be compacted to proper grade and cross-section.

The Contractor places and compacts approved crushed gravel in lieu of base course gravel when directed by the Engineer. The crushed gravel shall conform to the gradation shown in the following tables:

- Table 3: Granular Base Course Gradation Limits.
- Table 4: Granular Sub-Base Course Gradation Limits.
- Table 5: 50 mm Crushed Gravelled Lane Gravel Gradation Limits.

305.02.00 – Fine Grading Of Base Course

Note: Please use section Gravelled Lane Gravel, Table 3: Granular Base Course Gradation Limits as reference for placing and compacting Fine Grading of Base Course.

305.02.01 – New Construction

Following the compaction of the base gravel, 25 mm crushed gravel shall be placed. The 25 mm crushed gravel shall be brought to proper grade and cross-section and compacted, using approved vibratory compactors, to 98 percent of the Maximum Design Density. To achieve the required compaction, the crushed gravel shall be brought to a moisture content at or below the optimum moisture content.

Care shall be taken along gutters to leave precisely the specified depth for the subsequent placing of the final asphalt layer(s).

305.02.02 – Base Gravel Base Course Previously Placed

Following the reshaping of the existing base course, the Contractor shall be required to place 25 mm crushed gravel to bring the roadway to the desired cross-section. Grade alterations in excess of 100 mm are brought to proper shape by the placing of 80 mm crushed gravel.

305.03.00 – Quantity Measurements

305.03.01 – Base Course

Payment for base gravel shall be based on the actual tonnage incorporated in the work unless this tonnage is more than the theoretical volume multiplied by 2.22 t/m³.

The Contractor shall not be compensated for material placed over this tonnage unless authorized previously by a written change order.

The excavation area shall be used for base gravel calculation purposes, with each street or section being treated on an individual basis. Base gravel placed in authorized extra-depth areas shall be compensated based on a maximum 2.22 t/m³.

305.03.02 – Fine Grading

1) New Construction

Payment for crushed gravel shall be based on the actual tonnage incorporated in the work unless this tonnage is more than the theoretical volume multiplied by 2.22 t/m³. Amounts above the specified maximum shall be compensated for at the established base gravel Unit Rate. For calculation purposes, each street or section shall be treated on an individual basis.

2) Base Gravel Base Course Previously Placed

The reshaping of the existing base course and the placing and compaction of the additional crushed gravel shall be paid for under the Schedule of Force Account Rates. Payment for the crushed gravel shall be based on the actual tonnage incorporated in the work and includes only the hauling and placing of material at the proper location.

306.00.00 – Base Stabilization

306.01.00 – Soil Cement Base Course

306.01.01 – Description

Soil cement base course consists of soil and Portland Cement uniformly mixed, moistened, compacted, finished and cured in accordance with these Specifications, and it conforms to lines, grades, thickness and typical cross-section shown or as directed by the Engineer.

306.01.02 – Materials

1) Portland Cement

Portland Cement shall meet the requirements of CAN3-A5-M77.

2) Water

Water shall be free from substances deleterious to the hardening of soil cement and be subject to the Engineer's approval.

3) Curing Seal

The curing seal shall be an emulsified asphalt, type RS-1H or RC-70.

4) Soil

Soil consists of the material existing in the street to be paved, in an approved borrow pit, or a combination of these materials in a definite controlled proportion. The soil shall not contain gravel or stone retained on a 50 mm sieve or more than 45 percent retained on a 5.0 mm sieve.

306.01.03 – Preliminary Testing

An approved testing firm in accordance with recommendations of the Portland Cement Association shall conduct testing and interpretation of results to determine minimum cement contents. The 'short cut' test procedure is not accepted for determining cement contents; however, it may be used for confirmation tests. The 'Rapid Test' procedure is not acceptable to The City.

The design cement content, AASHTO soil classification, and results of the following tests shall be submitted to The City for approval:

- Organic impurities in sands. ASTM Designation C- 40.
- Grain size analysis of soil, including hydrometer analysis. ASTM Designation D-442.
- Liquid limit and plasticity index. ASTM Designation D-423 and Designation D-242.
- Moisture density relations of soil-cement mixtures. ASTM Designation D-558.
- Wetting and drying tests of compacted soil-cement mixtures. ASTM Designation D-559.
Minimum of one (1) cylinder per test at the recommended cement content.

- Freezing and thawing tests of compacted soil-cement mixtures. ASTM Designation D-560. Minimum of three cylinders per test at varied cement contents.
- Compressive strength tests on soil-cement mixtures. A minimum of three cylinders per test at varied cement contents to be broken at seven days.

Frequency of tests shall be as follows where in-place material is to be stabilized:

- Test No. 1 - Minimum of one (1) test per 150 m of street to be paved.
- Test No. 2 and Test No. 4 - Minimum of one (1) test per 300 m of street to be paved.
- Test No. 5 to Test No. 7 - Minimum of one (1) test per 600 m of street to be paved provided that previous tests show uniformity of soil in the area; otherwise, frequency of tests is determined by The City.

The above lengths of street per test apply only to continuous or adjacent streets in any one area. Short, isolated streets to be paved require at least one (1) complete set of tests on each.

Where material to be stabilized is to be taken from a borrow pit, The City shall determine the frequency of tests.

306.01.04 – Equipment

Soil cement shall be constructed by any machine, a combination of machines or equipment that will produce results meeting the requirements for soil pulverization, cement application, mixing, water application, incorporation of materials, compaction, finishing and curing as controlled by these Specifications. All equipment necessary for the proper construction of the base course shall be on the project and in satisfactory condition before construction begins.

306.01.05 – Construction Methods

1) Preparation

Before other construction operations are begun, the areas to be paved are graded and shaped as required to construct the base course in conformance with grades, lines and typical cross-section shown on the plans. Unsuitable or excess material shall be removed, disposed of and levelled at a designated disposal area.

The sub-grade shall be firm and able to support, without displacement, the construction equipment and compaction hereinafter specified. Soft or yielding sub-grade shall be made stable before construction proceeds.

Where a central plant mix operation is used, the material shall be excavated to sub-grade level across the entire width of the street. The top 150 mm of sub-grade shall be scarified, brought to within two (2) percentage points of optimum moisture content and compacted to a minimum density of 100 percent of the soils' Maximum Design Density as determined by a moisture density test, ASTM Designation D-558.

2) Pulverization

The soil shall be so pulverized that after moist mixing, 100 percent by dry weight passes a 25 mm sieve, and a minimum of 80 percent passes a 5.0 mm sieve, exclusive of gravel or stone retained on these sieves.

3) Application of Cement

No cement shall be spread or added to the soil when the sub-grade is frozen or when the air temperature is less than 4° Celsius. At the time of cement application, the percentage of moisture in the soil shall not exceed by more than two (2) percentage points the optimum moisture content for the soil-cement mixture. Cement shall be applied or added only to material that can be mixed, spread and compacted within six (6) hours. The specified quantity of Portland Cement shall be uniformly distributed through the soil during the mixing operation. In any mixture sample, the amount of cement shall not vary by more than five (5) percent from the theoretical design quantity.

4) Mixing and Spreading

Road Mix Operation

Soil shall be scarified and pulverized before applying the cement. Where required by the Engineer, the loosened material shall be bladed into one or more windrows of uniform cross-section and of a size that all the material in one windrow can be passed through the mixing machine in one operation. Immediately after the cement has been spread, it shall be mixed with the soil until they have been sufficiently blended to prevent the formation of cement balls when water is applied. Water shall then be incorporated into the mixture until it has reached the required moisture content for compaction purposes. The water shall be applied by pressure distributing equipment or other approved means to avoid excessive water concentrations. After all mixing water has been applied, mixing continues until a uniform, intimate mixture of soil, cement and water is obtained.

Central Plant-Mix Operation

The soil material, cement and water are mixed at a central mixing plant of the pugmill or rotary drum type using a batch or continuous feed. The materials are proportioned by weight if a batch feed is used and proportioned by volume if a continuous feed is used. If the Contractor employs a continuous type mixer and feed, the soil shall be drawn from storage bins or areas through adjustable calibrated gates or fixed gate feeder with adjustable speed control. The mixer shall be equipped with metering devices of an approved type that introduce the cement and water into the mixer in desired proportions. The metering devices and soil feeder shall be interlocked and synchronized to maintain a constant ratio between soil, cement, and water.

Where the Engineer deems it necessary for the accurate control of cement feed, the Contractor equips the cement storage hoppers with a compressed air system to eliminate the possibility of arching of the cement. The plant shall be equipped with facilities satisfactory to the Engineer for calibrating gate opening or rate of feed by weighing check samples.

The weight of charge in a batch mixer or the rate of feed to a continuous type mixer shall not exceed that which permits complete mixing of all material. Dead areas in the mixer, in which material does not move or is not sufficiently agitated, are corrected either by reduction in volume of material or by other adjustments.

Mixing of the materials shall be continued until the cement and water are evenly distributed through the mass and a uniform mixture of unchanging appearance is obtained.

In no case shall the mixing period be less than thirty (30) seconds from the time all materials are in the mixer. Sufficient mixing capacity shall be provided to produce a minimum of 150 tonnes of soil cement mixture per hour. The City, wherein the Engineer's opinion, reserves the right to discontinue the use of any proportioning or mixing equipment that fails to produce a satisfactory mixture.

Immediately prior to spreading soil-cement base course material, the surface of the prepared sub-grade shall be moistened and kept moist until covered by the mixture. Materials are transported from the central mixing plant to the street utilizing suitable vehicles, equipped with protective covers, and deposited using approved spreading equipment. Dumping in piles on the sub-grade shall not be permitted.

The mixture shall be spread in one layer of uniform density and of such thickness that the finished soil cement base conforms to the required grade and cross-section after compacting. The spreading progresses continuously—without breaks—and shall be organized so that not more than thirty (30) minutes elapse from placing the material in adjacent lanes at any location.

After a part width section is completed, the longitudinal joint against which additional material will be placed shall be trimmed in a neat line parallel to the curb and with a vertical edge.

Material cut away from the edge shall be spread uniformly over the adjacent sub-grade and compacted or disposed of by the Engineer's direction. Transverse construction joints are treated similarly.

5) Compaction

The mixture shall be compacted within two (2) hours after the addition of water. Any soil and cement mixture which is not compacted and finished shall not remain undisturbed for more than thirty (30) minutes. At the start of compaction, moisture in the mix shall be within two (2) percentage points of the specified optimum moisture content. This shall be determined by a moisture density test, ASTM Designation D-558, on representative samples of the soil cement mixture.

Prior to compaction, the mixture shall be in a loose condition for its full depth. Compaction shall be carried out on the loose material until it has attained a uniform density of one hundred (100) percent of the Maximum Design Density as determined by a moisture density test, ASTM Designation D-558.

Compaction may be obtained by steel wheel, grid or pneumatic rollers, vibratory or sheepsfoot packers or any other means approved by the Engineer. Following initial compaction, the mixture shall be shaped to the required grade and cross-section. Where necessary, the surface shall then be scratched to remove compaction planes that may have developed during compaction. Final compaction to the specified density shall be done with a steel wheel or pneumatic rollers, or vibratory packers. If the specified density is not attained, the Contractor, at their own expense, shall complete one of the following operations as instructed by the Engineer.

- Reprocess the same soil-cement material within twenty-four (24) hours of the original application of cement and water, with the addition of seventy-five (75) percent of the original cement content.
- Reprocess the same soil-cement material after the elapse of twenty-four (24) hours with the addition of one hundred (100) percent of the original cement content.
- Remove the soil-cement base and replace it with new approved material processed in accordance with these Specifications.
- Complete the surfacing operation in two (2) lifts, applying a total average depth of 75 mm of asphalt concrete.

6) Finishing

After final compaction, the surface shall be smooth and free from cracks, ridges and loose material. Any ridges or undulations are removed by planing with a motor grader and the resulting loose material removed from the area. The finishing and construction operations shall be completed before six (6) hours has elapsed from the time of addition of water to the mix.

The surface of the compacted base course shall be kept moist until a curing seal has been applied. Water shall be applied in a fine spray that does not segregate the cement from the soil particles.

7) Curing

A curing seal of emulsified asphalt, type SS-1H, shall be applied to the dampened surface at a temperature of 20°C - 50°C, and at a uniform rate of 2.5 litres per square metre. The seal covers the entire width of the roadway and shall be allowed to cure thoroughly before the Engineer grants permission to pave.

306.01.06 – Alternative Method of Construction

The Contractor may use any equipment capable of carrying out two or more of the following operations simultaneously:

- Scarification, pulverization, application of cement, mixing, addition of water, spreading and compaction.

- Any such combination of operations shall comply in every respect with conditions as set out under the various sections of Construction Methods in these Specifications.

306.01.07 – Maintenance

The Contractor shall, within the Limits of Contract, maintain the soil-cement base course in good condition. Faulty areas are replaced for the full depth of the base course with fresh soil cement mixture or concrete. Surface depressions are brought up to proper grade by patching with asphaltic concrete before applying the asphaltic surface course.

Areas, where the curing seal is removed by traffic or otherwise, shall be resealed immediately, at the Contractor's expense.

306.02.00 – Lime Stabilization

306.02.01 – Description

Lime stabilized base course shall consist of soil and lime uniformly mixed, moistened, compacted, finished, and cured according to these Specifications. It shall conform to lines, grades, thickness and typical cross-sections shown or as directed by the Engineer.

306.02.02 – Temperature

Lime stabilization should not be carried out when the temperature falls below 5° Celsius.

306.02.03 – Materials

1) Lime

Lime shall be of an approved brand and shall conform to the requirements of ASTM Designation C110. Project Specification shall govern lime grade and classification.

2) Water

Water shall be free from substances deleterious to the lime and soil mixture's hardening and be subject to the Engineer's approval.

3) Soil

Soil shall consist of the material existing in the street to be paved or approved borrow material.

306.02.04 – Equipment

Lime stabilized or modified base may be constructed by any machine, a combination of machines or equipment that produces results meeting the requirements for soil pulverization, lime application, mixing, water application, compaction, finishing and curing as controlled by these Specifications. All equipment necessary for the proper construction of the base course shall be on the project and in satisfactory condition before construction begins.

306.02.05 – Construction Methods

1) Preparation

Before other construction operations begin, the area shall be graded and shaped as required to construct the base course in conformance with the grade, line and typical cross-section shown on the plans.

Unsuitable or excess materials are removed, disposed and levelled at a designated disposal area. All work shall meet the requirements outlined in 302.00.00 – EARTHWORK.

2) Scarification and Pulverization

The soil shall be scarified to a minimum of 150 mm over the entire road width and then partially pulverized. All deleterious materials and aggregates larger than 75 mm are removed.

3) Lime Spreading

Lime shall be uniformly spread, using either dry or slurry methods.

Dry lime should be sprinkled lightly to reduce dusting. After application, the lime shall be mixed into the soil within six (6) hours to prevent wind loss and minimize lime carbonation. The Engineer shall specify the percentage of lime applied after laboratory testing.

4) Preliminary Mixing and Watering

The lime shall be uniformly distributed throughout the soil to the minimum depth of 150 mm and the entire road width. Mixing shall continue until all soil is pulverized to minus 50 mm. The moisture of the soil-lime mixture shall be at least five (5) percent above optimum moisture content throughout the mixing operation. After initial mixing, the lime-treated layer shall be shaped to section and lightly compacted.

5) Final Mixing and Pulverization

Mixing and pulverization shall continue until all soil clods are broken down to pass a 25 mm sieve, and at least 60 percent pass a 5.0 mm sieve. The lime-treated layer shall be at optimum moisture prior to compaction.

6) Compaction

The lime-soil mixture shall be compacted to a minimum 97.0 percent of the maximum density of lime-soil mixture determined by ASTM Designation D698. Compaction begins immediately after the final mixing. The 97.0 percent compaction requirement may be waived by the Engineer, with proof rolling required instead.

7) Finishing

After final compaction, the surface shall be smooth and free from cracks, ridges and loose material.

8) Curing

After compaction and finishing, the stabilized soil shall be carried for three to seven days before placing the subsequent layer of base course. Curing shall be by either:

- Moist curing – maintain the surface in a moist condition by light sprinkling and rolling as required.
- Membrane curing - seal the compacted layer with a bituminous prime coat.

306.03.00 – Asphalt Stabilization

306.03.01 – Description

Asphalt stabilized base course consists of soil, crushed aggregate, and emulsified asphalt uniformly mixed, moistened, compacted, and finished according to these Specifications. It conforms to line, grade, thickness and typical cross-section shown or as directed by the Engineer.

306.03.02 – Materials

1) Emulsified Asphalt

SS-1 emulsified asphalt shall conform to the Canadian Specifications Board Specification for Emulsified Asphalt (16-GP-2).

2) Water

Water shall be free from substances deleterious to the hardening of the asphalt, soil mixture and shall be subject to the Engineer's approval.

3) Soil

Soil shall consist of the material existing in the street to be paved or approved borrow material.

4) Aggregates

Aggregates shall conform to the gradation specified in section 303.00.00 – GRANULAR MATERIAL.

306.03.03 – Mix Design

The amount of emulsified asphalt and soil/aggregate blends shall be established by the following tests:

- ASTM Designation D915 Method of Testing Soil Bituminous Mixtures.
- ASTM Designation D1560 Resistance to Deformation and Cohesion of Bituminous Mixtures by means of Hveem Apparatus.
- ASTM Designation D1561 Preparation of Test Specimens of Bituminous Mixtures by means of California Kneading Compactor.

306.03.04 – Equipment

Mixing and spreading shall be accomplished through the use of a rotary type mixer with transverse shafts that mix emulsified asphalt and soil/aggregate by revolving tines under a hood, preferably with an internal spray system which applies the emulsified asphalt while mixing. All equipment necessary for the proper construction of the base course shall be on the project and in satisfactory condition before construction begins.

306.03.05 – Construction Methods

1) Preparation

Before other construction operations are begun, the area shall be graded and shaped as required to construct the base course in conformance with grade, line and typical cross-section shown on the plans. Unsuitable or excess material shall be removed, disposed of and levelled at a designated disposal area. All work shall meet the requirements outlined in section 302.00.00 – EARTHWORK. Construction only occurs during daylight hours and when the temperature is more than 4° Celsius.

2) Scarification and Pulverization

The soil shall be scarified to a minimum of 150 mm over the entire road width and then partially pulverized. All deleterious materials and aggregates larger than 75 mm are removed.

3) Mixing

Rotary mixing of the emulsion and soil/aggregate shall be used unless the Engineer approves other mixing methods.

Emulsified asphalt shall be applied in increments of three litres per square metre until the total required amount is achieved and is uniformly distributed throughout the soil to the minimum depth of 150 mm and the entire road width. Mixing shall continue until all soil is pulverized to minus 50 mm. The moisture of the soil-emulsified asphalt moisture shall be above optimum moisture content throughout the mixing operation. Mixing and pulverization shall continue until all soil clods are broken down to pass a 25 mm sieve, and at least 60 percent pass a 5.0 mm sieve.

4) Compaction

The emulsified asphalt soil mixture shall be compacted to a minimum 97.0 percent of maximum density. Compaction begins as soon after mixing as the mat bears the weight of the compaction equipment. The 97.0 percent compaction requirement may be waived by the Engineer, with proof rolling required instead.

5) Finishing

After final compaction, the surface shall be smooth and free from cracks, ridges and loose material and conform to design cross-section.

306.04.00 – Chemical Stabilization

Chemical stabilization takes place only with the approval of the Engineer. Application and construction methods shall be in accordance with the manufacturer's specifications. Prior to application, the manufacturer shall prove to The City that applying the chemical(s) is effective for the in-situ soils. All pre-application testing shall be done within The City of Calgary at a City-approved testing firm at no cost to The City.

307.00.00 – Asphalt Concrete

307.00.01 – Description

Asphalt concrete consists of a hot mixed coarse aggregate and fine aggregate, with or without mineral filler, uniformly coated and mixed with asphalt cement in an approved mixing plant.

307.00.02 – Preparation for Paving

1) General

The hot asphalt mixture shall be laid upon a dry firm base, true to grade and cross-section and free from all screenings or other loose or foreign material. No hot mix shall be spread when the granular base or sub-base is wet or other conditions prevent proper spreading, finishing, or compaction.

Existing asphalt surfaces and gutter areas shall be thoroughly cleaned of all loose or deleterious materials or objects before commencing the levelling course or top lift paving operations.

Cleaning prior to paving shall be considered incidental to the Unit Rate for asphalt concrete.

Granular materials and/or asphalt shall not be used as fill under full-depth asphaltic concrete paving unless positive drainage is provided. If extra material is required to bring the subgrade to the proper grade, the material shall be obtained from a suitable earth borrow area.

2) Procedure for Prime Coat

Upon a uniformly damp base course, a prime coat of diluted SS-1 emulsified asphalt shall be uniformly applied, as follows:

- Dilution rate: 2 parts SS-1 emulsion to 1 part water
- Distribution rate: 2.0 litres per square metre
- Emulsion temperature: 20°C to 50°C
- Ambient air temperature: shall be greater than 4°C
- Curing time: a minimum of two hours. If weather or other conditions have been such that the prime has not fully cured at the end of two hours, the Engineer may extend the curing period as he/she deems necessary.

3) Procedure for Tack Coat

The tack coat shall be applied between successive lifts of asphaltic concrete, only after the surface has been cleaned of all loose or deleterious materials or objects, and as follows:

- Type: SS-1H emulsion
- Distribution rate: not greater than 0.5 litres per square metre
- Emulsion temperature: 20°C to 50°C
- Ambient air temperature: greater than 4°C

307.00.03 – Manholes, Valves and Appurtenances

The Contractor shall bring all manholes, water valve boxes and other appurtenances to the finished grade of the road or median strip at no cost to The City. This work shall be done in each block no later than one week after final paving operations have been completed in that block. The cost of repairing or replacing water valves, manholes and other appurtenances damaged due to the Contractor's operations shall be borne by them.

The final surface shall not vary more than 10 mm when checked with a 3 m straight edge. However, The City does not allow any tolerance for a vertical drop of the finished surface in the vicinity of any utility appurtenance. The Contractor shall be responsible for correcting any irregularities in the final surface around any utility appurtenance, at their expense and within the Engineer's specified time.

Raising or lowering manhole rims shall be done using pre-cast concrete collars conforming to ASTM Designation C-139 and an approved cement mortar. The completed work shall be in accordance with the Standard Specifications Sewer Construction. All work shall be subject to inspection and approval by the Engineer before it shall be considered complete.

Adjustment of sewer manholes shall be made in accordance with the following:

- All manhole adjustments shall be in accordance with the Standard Specifications Wastewater Construction
- Top lift paving shall not commence until all necessary manhole rebuilding has been done
- The Contractor shall be responsible for lowering or raising manholes to a maximum of 300 mm when the grade change can be made by use of collars or brickwork

Manhole adjustments within 300 mm of the final grade, which involve alterations to other than brickwork or collars, shall be undertaken by the Contractor under the Schedule of Force Account Rates. Manholes to be raised or lowered more than 300 mm or manholes that require replacement shall be done by the Contractor at Force Account Rates.

Where existing manholes have excessive rows of bricks or collars and the adjustment does not place the manhole within the accepted standard, the manhole shall be brought to standard by the Contractor at Force Account Rates when directed to do so by the Engineer.

Note: When wastewater rebuilds or alters a manhole, final grade adjustment shall be completed by the Contractor.

The following procedure shall be used in the adjustment of Water Valves.

- The Contractor shall not use force to adjust a valve without loosening the set screw on the top box.
- To raise a service valve, either loosen the set screw on the top box or a collar and threaded nipple can be used.

- To raise a main valve, the set screw should be loosened first be loosened. If the top box fails to move, risers can be used to bring it to grade (maximum of three (3) risers).
- The Contractor shall replace any damaged top boxes.

This work shall be done at no cost to The City. Replacement of existing damaged top boxes shall be done under the Schedule of Force Account Rates. The Contractor shall repair, at their expense, any damage to valves resulting from construction.

Before being considered acceptable, any projecting manhole, valve or other appurtenance shall be ramped at 1:40 at the Contractor's expense.

307.00.04 – Elevation of Manholes

Where top/final lift of asphalt is not placed in the same year as the base lifts, manhole frames/covers, and other surface appurtenance shall be set to interim asphalt grade.

Manholes, etc., are not required to be ramped if the adjacent asphalt has been planed or the top lift omitted, provided frames, etc., do not project by more than 40 mm for more than fourteen (14) days. Projecting covers, etc., shall be signed.

Ramping, where required, shall be at 40:1. Ramping shall be at the Contractor's expense.

Where top lift, overlays, etc., are to take place it shall be permissible to record the position of appurtenances for raising immediately after the asphalt placement is complete.

307.00.05 – Road Planing

1) General

The work shall consist of milling pavements to remove imperfections, bringing the planed surface to the specified grade and cross-section. The surface of the planed pavement shall be free of continuous longitudinal striations and acceptable for use as a riding surface for extended periods.

2) Equipment

The equipment furnished shall be specifically designed and built for this type of work. It shall be self-propelled with sufficient power, traction and stability to maintain an accurate depth of cut and slope. Automatic grade and slope shall be provided. Acceptable tolerances on the milled surface shall be ± 6 mm of reference grade and cross-section and of ± 3 mm for matching adjacent milled surface.

The cutting head shall be capable of full drum width milling of a 75 mm thickness of asphaltic concrete in a single pass.

The equipment shall have a means of controlling dust.

Equipment using heaters shall have adequate shielding to prevent damage to property in the vicinity of the planing.

Means shall be provided to immediately remove materials being trimmed from the surface of the travelled roadway. Personnel shall be provided to ensure that all cuttings are removed from the street surface within 30 m of milling operation and swept within 150 m. Stockpiling planed material shall not be permitted on the project site.

The machine shall produce a minimum coverage of 2 000 m² per hour while planing a minimum of 15 mm of the existing pavement per pass and cut flush to all gutters, curb walls, manholes, valves, catch basins or other obstructions within the paved area.

3) Construction

Sufficient passes, or cuts, shall be made so that all irregularities or high spots are eliminated and that 100 percent of the surface area is planed to the design grade or the Engineer's satisfaction. The Contractor shall provide all necessary labour, materials and equipment to load the asphalt cuttings into dump trucks supplied by him and hauled to a disposal area designated by the Engineer.

All material recovered in the planing process remains the property of The City.

No work shall be permitted between 7 - 9 a.m. and 4 - 6 p.m. on major and arterial streets during weekdays.

Certain streets may require night planing or weekend planing as designated by the Engineer. Upon completion of planing, the surface shall be left in such condition that it can be reopened to traffic as soon as the loose materials have been removed.

4) Method of Measurement

Pavement planing performed and provided above shall be measured by the square metre of variable depth up to a maximum of 25 mm below the surface, i.e. any planing up to a depth of 25 mm shall be paid at the rate quoted for that depth. An additional pay item shall be provided for areas requiring extra depth in increments of 25 mm. The Contractor shall provide a planing rate for 50 mm and 75 mm cuts.

307.00.06 – Notification

- The Contractor shall notify the Pavements, Soil, and Asset Management (PSAM) dispatcher of ROADS of their intention to place asphaltic concrete by 15:00 hours (3:00 p.m.) of the previous working day to permit arrangements to be made for the inspection and testing of the work. Contractor notification directly to a testing agency shall not relieve their obligation in this regard. Advice as to work for later than the following working day, except in the case of weekends, shall be taken as advice only and shall not constitute notification as required under this section.

Note: Pavements, Soil, and Asset Management (PSAM) maintain a 24-hour answering service at 403-268-1602.

- The Contractor shall provide the Engineer with a minimum of six hours notice of the intention to commence paving over any previously approved primed or tacked surface.
- The hot asphalt mixture shall be laid upon a dry, firm surface, true to grade and cross-section, free from loose or foreign material. No hot mix shall be placed on asphalt that has not sufficiently cooled or when the surface is wet, or when other conditions prevent proper spreading, finishing or compaction.
- If undercutting and subsequent backfill with asphalt concrete are done, the backfill operation shall be performed sufficiently before the paving operation to allow the asphalt concrete time to cool down enough to support equipment.

307.01.00 – Asphalt Binder

307.01.01 – General

1) Description

This section specifies the requirements for asphalt binder utilized in hot mix asphalt (HMA) production. Generally, the requirements are for Performance Grade (PG) asphalt binders, with the exception of permitted alternatives.

This Specification describes the property criteria and handling and storage requirements for asphalt.

2) Related Work

- 307.02.00 – Asphalt Concrete - Superpave
- 307.03.00 – Asphalt Concrete - Marshall
- 307.04.00 – Stone Matrix Asphalt

3) Samples

- At least four (4) weeks before commencing work, the Engineer shall be informed of the proposed supplier for the asphalt binder.
- When requested, at least four (4) weeks before commencing work, the Engineer shall be provided with 5 litres of the asphalt binder product.
- Access for the Engineer to sample material incorporated into the work as required shall be provided.

4) Materials Certification

- At least four (4) weeks before commencing work, the supplier's test data and certification that the physical properties of the asphalt binder meet the requirements of this section shall be provided to the Engineer.

- At least two (2) weeks' notice of contemplated changes in the source of asphalt binder shall be given, and updated materials certification in accordance with the requirements of this section shall be provided.

5) Delivery and Storage

- Storage, heating and pumping facilities for the asphalt binder shall be subject to the Engineer's approval. Storage and mixing temperatures shall be in accordance with supplier recommendations.
- Dedicated storage tank(s) shall be provided for asphalt binder product for the duration of paving on the project. No other material shall be introduced into the dedicated storage tanks during this time.
- Freight and way-bills for asphalt binder shipments received shall be made available to the Engineer upon request.

307.01.02 – Materials

1) Products

- Performance Grade Binder, or approved alternative, shall be supplied in accordance with the binder grade specified in the Tender Form.
- Products shall meet the requirements of AASHTO M 320, "Standard Specification for Performance Graded Asphalt Binder".
- The minimum required Performance Grade Asphalt Binder shall be as per applications specified in Table 8 below.



TABLE 8: PERFORMANCE GRADE ASPHALT BINDER REQUIREMENTS FOR DIFFERENT ROAD CLASSIFICATIONS

Application	Traffic (20-Year Design ESALs)	New Construction or Rehabilitation
Base Course Lifts (All Roadway Applications)	N/A	PG 58-31
Surface or Binder Course (Residential & Non-Transit Collector)	N/A	PG 58-31
Surface or Binder Course (Transit Collector)	N/A	PG 64-34
Surface or Binder Course (Major with No Intersections)	< 5 Million	PG 58-31
Surface or Binder Course (Major with Intersections)	< 5 Million	PG 64-34
Surface or Binder Course (Major with No Intersections)	5 to 10 Million	PG 64-34
Surface or Binder Course (Major with Intersections)	5 to 10 Million	PG 70-31
Surface or Binder Course (Major with No Intersections)	> 10 Million	PG 70-31
Bridge Mastic Asphalt	N/A	PG 70-40

Note: A 1°C tolerance for low-temperature grading will be permitted for PG 58-31. A Binder course is a lift located directly below the surface course and above the base course.

307.01.03 – Measurement and Payment

1) Measurement

No measurement of asphalt binder will be made given it is considered incidental to the supply of asphalt concrete under this Specification.

2) Payment

Unless specified otherwise in the Contract Specifications, asphalt binders shall not be paid for separately and shall be considered incidental to the supply of asphalt concrete.

307.02.00 – Asphalt Concrete - Superpave

307.02.01 – General

1) Description

This section specifies the requirements for the supply of Superpave asphalt concrete paving.

This Specification describes the mix property criteria and construction requirements for Superpave asphalt concrete in terms of aggregate nominal maximum size (NMS), fine or coarse gradation, as identified in the Contract and Tender Form.

The work includes the supply of aggregates and asphalt cement, reclaimed asphalt pavement and liquid anti-strip where applicable; asphalt plant mixing, transporting, placement finishing, and compaction to all requirements of this Specification.

The work includes all materials certification, quality control, verification and mix design testing, analysis and reporting to be completed as required in this Specification.

2) Warm Mix Asphalt Technology

The City of Calgary will consider Warm Mix Asphalt (WMA) proposals on a case-by-case basis. The properties of the WMA mix design must satisfy all the requirements for the specified mixture type.

The Contractor must provide a detailed proposal, identifying as a minimum the following:

- The type of process or additive and specifics regarding previous experience.
- Quality Control / Quality Assurance considerations specific to the WMA process.
- Proposed WMA design program, performance testing program and binder rheology assessment program.
- Economic considerations.

Subject to review and approval of the WMA Proposal, the Contractor will undertake the necessary work in accordance with the proposal and these Specifications. Final approval will be subject to satisfying the proposal requirements and the Specifications and is solely at the discretion of the Pavements, Soil, and Asset Management (PSAM) Engineer.

3) Related Work

Asphalt Binder – see section 307.01.00 – Asphalt Binder.

4) Definitions

Refer to section Specification Definitions.



307.02.02 – Products

1) Materials

Asphalt Binder – refer to section 307.01.00 – Asphalt Binder.

Coarse aggregate is aggregate retained on the 5.0 mm sieve; fine aggregate is aggregate passing the 5.0 mm sieve.

Aggregate materials shall be crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps cementation, organic material, frozen material, and other deleterious materials.

Gradations to be within limits specified when tested to ASTM C-136 and ASTM C-117 with sieve sizes to CAN/CGSB 8-GP-2M rather than ASTM E11.

Aggregate shall be processed to meet the following requirements:

- Natural fines shall be pre-screened and stockpiled with not more than 10 % of material retained on the 5.0 mm sieve and 100 % passing the 10.0 mm sieve.
- The aggregate delivered to the crushing plant shall be pre-screened and contain no more than 5 % passing the 5.0 mm sieve.
- Crushed aggregates shall be separated and stockpiled in accordance with the following:
 - Coarse fraction to contain no more than 40 % of material passing the 5.0 mm sieve.
 - Fine fraction or manufactured sand contains no more than 20 % of material retained on the 5.0 mm sieve.
 - Physical properties of aggregates to meet the requirements in Table 9 below.

TABLE 9: AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

Property	Test Standard	Requirement
Los Angeles Abrasion, Grading B (% Loss)	C131	30 max.
Magnesium Sulphate Soundness (% Loss)	C88	
Coarse Aggregate:		12.0 max.
Fine Aggregate:		12.0 max.
Lightweight Particles (%)	C123	1.5 max.

- Blend Sand:
 - Shall consist of natural or manufactured sand passing the 5.0 mm sieve.
 - Stockpile volumes shall be maintained to ensure a minimum of 5 000 tonnes of plant mix production at all times.
- Blended Aggregate Requirements:
 - Aggregate Gradation Requirements, including RAP, for fine and coarse graded mixtures, to meet the requirements of Table 10 below.

TABLE 10: BLENDED AGGREGATE GRADATION REQUIREMENTS

Sieve Size (mm)	Nominal Maximum Aggregate Size Percent Passing					
	20 mm		12.5 mm		10 mm	
	Coarse Graded	Fine Graded	Coarse Graded	Fine Graded	Coarse Graded	Fine Graded
25	100	100	-	-	-	-
20	90-100	90-100	100	100	-	-
12.5	90 max	90 max	90-100	90-100	100	100
10.0	-	-	90 max	90 max	90-100	90-100
5.0	-	-	-	-	90 max	90 max
2.5	23-35	35-49	28-39	39-58	32-49	49-67
0.080	2-8	2-8	2-10	2-10	2-10	2-10

Coarse Aggregate Fracture: The percentage of fractured particles shall be by mass of coarse fraction (retained on 5.0 mm sieve size).

TABLE 11: MINIMUM REQUIREMENTS FOR COARSE AGGREGATE FRACTURE COUNTS

Traffic Level (20-Year ESALS)	Minimum Coarse Aggregate Fracture					
	20 mm NMS		12.5 mm NMS		10 mm NMS	
	1 Face	2 Face	1 Face	2 Face	1 Face	2 Face
< 1 Million	65	60	75	70	75	70
> 1 Million	75	70	95	90	95	90

- Flat and Elongated Particles: Of coarse fraction (retained on 5.0 mm sieve size), the percentage of flat and elongated particles greater than a 5:1 ratio shall be by mass less than 10.0 %.
- Manufactured Sand (TLT 314): Of total fine fraction (passing 5.0 mm sieve size), manufactured sand shall be by mass:
 - 20 mm NMS – 60 % minimum
 - 12.5 mm and 10 mm NMS – 70 % minimum
 - For mixes incorporating RAP, 50 % of the RAP sand portion shall be considered manufactured sand.



- The sand equivalent value (ASTM D2419, Mechanical Method) determined for the fine aggregate portion shall be:
 - 20 mm NMS – 40 % minimum
 - 12.5 mm and 10 mm NMS – 45 % minimum
- The fine aggregate angularity (ASTM C1252 Un-compacted Void Content) of minus 2.5 mm fraction shall be:
 - 20 mm NMS – 40 % minimum
 - 12.5 mm and 10 mm NMS – 45 % minimum
- Reclaimed Asphalt Pavement (RAP) may be used as follows:
 - A RAP portion of up to 20 % binder contribution, as a percent of the total binder content, will be allowed without the need for a binder rheology assessment.
 - Other material additives will be considered subject to submission of proposed binder rheology and/or aggregate assessment program and subject to the approval of The City of Calgary Pavements, Soil, and Asset Management (PSAM) Engineer.

2) Mix Design

An asphalt mix design must be prepared and submitted to The City/Developer Designate for review and approval at least one week prior to work. The Contractor shall use qualified engineering and testing services licensed to practice in the Province of Alberta.

The trial mix design shall be performed in accordance with the AASHTO Designation M 323, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.

Design of Mix:

- Design Traffic (20 Year) < 5 Million ESALs
 - Initial number of gyrations (N_{initial}) – 7
 - Design number of gyrations (N_{design}) – 75
 - Maximum number of gyrations (N_{max}) – 115
- Design Traffic (20 Year) > 5 Million ESALs
 - Initial number of gyrations (N_{initial}) – 8
 - Design number of gyrations (N_{design}) – 100
 - Maximum number of gyrations (N_{max}) – 160

Include the following data with mix design submission:

- Aggregate specific gravity and asphalt absorption.
- Sand equivalence, coarse aggregate fracture, flat and elongated particles, and percent manufactured sand values.

- Asphalt cement supplier/refinery, specific gravity and mixing and compaction temperatures, based on asphalt cement's temperature–viscosity properties.
- Job mix formula including aggregate gradation and blending proportions, and design asphalt content.
- Maximum Relative Density at each trial asphalt content.
- Where reclaimed asphalt pavement (RAP) is to be incorporated into the mix supply, RAP gradation, RAP asphalt cement content, and design recycle percentage.

Data to satisfy the requirements are given in Table 12 below.

TABLE 12: MIXTURE PHYSICAL PROPERTY REQUIREMENTS

PROPERTY	REQUIREMENTS		
	Aggregate Nominal Maximum Size		
	20 mm	12.5 mm	10 mm
Relative Density at N _{initial} (% of MRD)	89 max.	89 max.	89 max.
Relative Density at N _{max} (% of MRD)	98 max.	98 max.	98 min.
Air Voids (%) ¹	3.8 – 4.2	3.8 – 4.2	3.8 – 4.2
Voids in Mineral Aggregate (%) ¹	13 min.	14 min.	15 min.
Voids Filled With Asphalt (%) ¹	65-75	65 – 75	73-76
Tensile Strength Ratio (%) ²	75 min.	75 min.	75 min.
Dust to Binder Ratio ³	0.6-1.2	0.6 - 1.2	0.6-1.2

MRD - Maximum Relative Density

¹ at the design number of gyrations

² tested in accordance with AASHTO T283, including the optional freeze cycle

³ for coarse graded mixtures, the dust proportion range is increased to 0.8-1.6

3) Job Mix Formula

Subject to approval by The City/Developer Designate, the aggregate proportioning (including RAP), target gradation, asphalt content, and air void content from the Mix Design will become the Job Mix Formula for the supply of hot mix asphalt.

Once established, no alterations to the Job Mix Formula will be permitted unless a new Job Mix Formula is submitted by the Contractor and approved by The City/Developer Designate.

If the sum of any alterations to the Job Mix Formula is more than any one of the following limits, a new Mix Design shall be submitted for approval:

- ± 5 % passing the 5.0 mm sieve size
- ± 1 % passing the 0.080 mm sieve size
- ± 0.3 % asphalt content



Any alteration to the Job Mix Formula shall not result in properties that do not meet the requirements of this Specification.

Properties of the revised Job Mix Formula shall conform to all requirements of this Specification.

4) Production Tolerances

- All mixtures shall be supplied to the project within the range of tolerances specified.
- Asphalt cement content ± 0.3 % of Job Mix Formula value.
- Temperature: Mix temperature at the point of plant discharge shall not vary from that specified in the Job Mix Formula by more than ± 10 °C.
- The tolerance for Aggregate Gradation is given in Table 13 below.

TABLE 13: AGGREGATE GRADATION TOLERANCE

Aggregate Passing Sieve Size (mm)	Tolerance (% By Mass)
Max. size to 5.0	+4.0
2.5 & 1.25	+3.0
0.630, 0.160 & 0.315	+2.0
0.080	+1.0

- Air Voids: +1.0 % of the Job Mix Formula value.
- Mixture Properties: Relative Density at Ninitial and Nmax, Voids Filled with Asphalt, Voids in Mineral Aggregate and Dust to Binder Ratio as per requirements identified in Table 12: Mixture Physical Property Requirements.
- Moisture in Mix: Maximum permissible moisture, at point of plant discharge, is 0.3 % by mass of mix.

307.02.03 – Sampling and Testing

1) General

The Engineer shall have access to all production processes and materials used to monitor material quality as often as necessary. Such inspection and testing shall not in any way relieve the Contractor of the responsibility for meeting the requirements of this Specification.

At least three (3) weeks prior to commencing work, the Engineer shall be advised of the proposed source of aggregates and access shall be provided for sampling, and provide samples of asphalt cement shall be provided in accordance with section 307.01.00 – Asphalt Binder.

2) Quality Control

Quality control is the Contractor's responsibility throughout every stage of the work, from aggregate processing to the final accepted product. Tests performed by the Engineer will not be considered quality control tests.

The Contractor shall be responsible for the production of materials and construction that meet all specified requirements.

All quality control shall be conducted by qualified personnel. The Contractor shall bear the cost of all quality control testing and consulting services. Pre-Production testing and sampling and minimum frequencies are described in Table 14 below.

TABLE 14: PRE-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirement	Test Standard	Minimum Frequency
Asphalt Cement Certification	-	One per Contract or for change in supplier (minimum once per year)
Aggregate Physical Property Requirements	Table 9	Once per year, or for change in source
Crushed Coarse Aggregate Gradation Analysis and Fracture Content	ASTM C 136 ASTM D 5821	One for every 1 000tonne of each class of material processed into the stockpile, or one analysis for each material every production day when the production rate is less than 1 000tonne (Recommended)
Manufactured Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Natural Fine Aggregate Gradation	ASTM C 117 ASTM C 126	
Blend Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Reclaimed Asphalt Pavement (RAP) Asphalt Content and Extracted Aggregate Gradation	ASTM D 2172 ASTM C 117 ASTM C 136	One for every 500 tonnes delivered to stockpile, or one for each location when the delivery rate is less than 500 tonnes (Recommended)
Trial Mix Design by Superpave Method	AASHTO	One per mix type every three years, or as required for a change in asphalt cement supply, aggregate gradation or aggregate source or as required by the Contract Specifications. See Note below.
Plant Calibration	-	As required

Note: A laboratory/plant job mix formula verification is required each year when a trial mix design is not conducted.



Post-Production testing and sampling and minimum frequencies are described in Table 15 below.

TABLE 15: POST-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirements	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Asphalt Content and Aggregate Gradation)	ASTM D 6307 ASTM C 117 ASTM C 136	One for every 500 tonnes of each mix type is supplied under this Specification. See Note 1.
Hot Mix Asphalt Volumetric Analysis (Laboratory Compacted Density and Void Properties) where Asphalt Content and Aggregate Gradation are known.	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 3203 AASHTO T312	One for every Lot of each mix type supplied under this Specification. See Note 1.
Quality Control Charts (including three test running average for Binder Content, Aggregate Gradation, Laboratory Compacted Density and Void Properties)	-	For each hot mix analysis. Test results and updated three test running average to be submitted to The City/Developer Designate as they become available.
Hot Mix Asphalt Temperature	-	Minimum frequency not specified.
Cold Feed Aggregate Analysis	ASTM C117 ASTM C 136	Minimum frequency not specified.
Maximum Relative Density of Hot Mix Asphalt	ASTM D 2041	Minimum frequency not specified.
Compaction Monitoring (Core or Nuclear Density)	ASTM D 2726 ASTM D 2950	Minimum frequency not specified. See Note 2

Note 1: Where an individual test indicates non-compliance, another test shall be initiated immediately.

Note 2: Coring is subject to the approval of the Engineer.

Pre-Production Quality Control test data as specified in Table 14 shall be reported to the Pavements, Soil, and Asset Management (PSAM) Engineer and The City/Developer Designate one week prior to commencing the project or as requested.

Post-Production Quality Control test data as specified in Table 15 shall be reported to the Pavements, Soil, and Asset Management (PSAM) Engineer and The City/Developer Designate daily as the Work proceeds.

3) Quality Control Compliance with Specified Tolerances

- Asphalt Content, Aggregate Gradation and Mixture Properties

The test data derived by post-production quality control mix testing, described in section – Sampling and Testing, in point 2) Quality Control, shall be compared to the tolerances outlined in section 307.02.02 – Products in point 4) of this specification. the Contractor shall suspend mix production when the three (3) test running average for any property is outside of the specified tolerance limits.

Supply shall not commence again until it is demonstrated that corrective action has been taken.

- Hot Mix Asphalt Temperature

Plant mix that does not meet temperature requirements of Section 307.02.02 – Products at the point of plant discharge shall be subject to rejection at the discretion of The City/Developer Designate.

4) Acceptance Sampling and Testing

Within this Specification, certain requirements, limits and tolerances are specified regarding supplied materials and workmanship. Compliance with these requirements shall be determined from acceptance testing as described in this section.

Acceptance testing is the responsibility of and at the sole discretion of the Engineer. Initial acceptance testing will be undertaken free of cost to the Contractor.

Sampling and acceptance testing is described in Table 16 below.

TABLE 16: ACCEPTANCE TESTING REQUIREMENTS - CATEGORY A & B PROJECTS

Acceptance Testing	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Binder Content, Aggregate Gradation, Laboratory Compacted Density, Maximum Relative Density and Void Properties)	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 2041 ASTM D 3203 AASHTO T 312	For each mix type, one test for each 3500 m ² of placement, or three tests per lot, whichever is greater. See Note below.
Compaction Testing (Core Density) and Thickness Determination. Nuclear Density Testing for Category B Project Compaction subject to the approval of The City / Developer Designate.	ASTM D 2726 ASTM D 3549	For each mix type, one test for each 2000 m ² of placement, or three tests per lot, whichever is greater.
Hot Mix Asphalt Temperature	-	No minimum frequency.

Note: For Category B Projects, the Engineer may, at their discretion, acquire the minimum number of mix samples but reduce the number of tests to a minimum of one. Should non-compliance be indicated by the sample(s) tested, the Engineer Designate reserves the option to test the remaining samples.

5) Acceptance Sampling Procedures:

- Loose mix samples shall be acquired from the work site in accordance with Alberta Transportation Test (ATT) procedure ATT-37. Auger samples may be used if approved by both the Engineer and the Contractor.
- The timing of mix sampling shall be stratified, with each sample representing a similar production quantity.
- Core locations will be selected using stratified random sampling procedures as described in ATT-56 Part II. The Lot will be divided into segments meeting or exceeding the minimum frequency in Table 16 and approximately equal area. A test site will be located in each segment using random numbers to determine the longitudinal and transverse coordinates.
- Areas within 3 m of transverse joints or 0.3 m of a mat edge are excluded from compaction acceptance sampling and testing.

6) Reporting Protocols

- Test reporting accuracy shall be as stipulated in the referenced test procedures, including:
 - Gradation to the nearest whole number, except the percent passing the 80 µm sieve, shall be reported to the nearest 0.1 %.
 - Binder content to the nearest 0.01 %
 - Air voids and compaction to the nearest 0.1 %
 - Thickness to the nearest whole mm.
 - Lot averages shall be reported to the same accuracy as test results.

7) Appeal of Acceptance Testing Results

General

- The Contractor may appeal the acceptance testing results for Compaction Standard, Asphalt Content or Air Voids for any Lot subject to rejection or unit price reduction. The notice of appeal shall be in writing and submitted to the Engineer within 48 hours of receiving the acceptance testing results.
- Appeals will only be considered if the cause can be shown and the requirements of Table 15 have been satisfied.
- Quality Control tests initiated after the Contractor receives the acceptance test results will not be considered when evaluating cause for appeal.
- For Category A Projects, only Quality Control testing during production for the subject project will be considered when evaluating cause for appeal. For Category B Projects, Quality Control test results from production prior to the subject project may be considered when assessing a cause for appeal.

Asphalt Content Appeal

- The Engineer shall develop a stratified random sampling plan with the same number of segments as the original number of samples for the subject Lot. A sufficient core sample will be acquired from each segment to enable asphalt content determinations.
- For asphalt content appeal testing, the testing shall be undertaken by an independent testing laboratory selected by the Contractor and approved by the Engineer.
- The average of the appeal test results will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
- If the average appeal test result verifies that any unit price reduction or rejection applies for that Lot, the Contractor will bear the appeal sampling and testing costs. If the result shows that a penalty or rejection no longer applies, the sampling and appeal costs will be the Owner's responsibility.

Compaction Standard or Air Void Appeals

- The testing laboratory conducting the project acceptance sampling and testing will routinely retain companion samples to determine maximum relative density and/or SGC density.
- For compaction standard or air void appeal testing, the Contractor will have the option for the testing to be done by the testing laboratory undertaking the project acceptance testing, or an independent testing laboratory selected by the Engineer.
- The average of the appeal tests will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
- If the new compaction standard verifies that any unit price reduction or rejection applies for that Lot, the Contractor will bear the appeal sampling and testing costs. If the result shows that a unit price reduction no longer applies, the appeal testing costs will be the Owner's responsibility.
- If the new average air void content result verifies that any unit price reduction applies for that Lot, the Contractor will bear the costs of the appeal testing. If the results show that a unit price reduction no longer applies, the sampling and appeal costs will be the Owner's responsibility.

Core Density and Thickness Appeals

- Core density and thickness appeals will only be considered if a case can be made that the stratified random sampling plan was biased or testing was in error. Appeal cores shall be taken at a frequency of one per 1000 m² area.
- Acceptance shall be based solely on the results of the appeal core testing.

Nuclear Density Appeals

- Nuclear density appeals must show cause for appeal and are subject to a core density assessment in accordance with this Specification.

307.02.04 – Execution**1) Continuity of Production**

While work is in progress on any project for which this Specification is in effect, and at the sole discretion of the Engineer, the plant may be limited to producing only the mix type required for that project.

2) Mix Production**Preparation of Mineral Aggregate**

- The mineral aggregates shall be at as low a temperature as is consistent with proper mixing and compaction and in no case to exceed 165°C, without the Engineer's approval.

Composition of Mixture

- The mineral aggregate, reclaimed asphalt pavement and/or additives (where applicable) and asphalt cement shall be mixed in such a manner to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.
- RAP shall be incorporated such that it does not come in direct contact with the burner flame.
- Plant emissions shall not exceed the limits set by Alberta Environment.

3) Preparation for Paving

- The Contractor shall provide the Engineer with a minimum of six hours' notice of the intention to commence paving over any previously approved primed or tacked surface.
- The hot asphalt mixture shall be laid upon a dry, firm surface that is true to grade and cross-section and free from all loose or foreign material. No hot mix shall be placed on asphalt that has not sufficiently cooled or when the surface is wet, or when other conditions prevent proper spreading, finishing or compaction.
- If undercutting and subsequent backfill with asphalt concrete are done, the backfill operation shall be performed sufficiently before the paving operation to allow the asphalt concrete time to cool down enough to support equipment.

4) Hot Mix Asphalt Placing Temperature

- No hot mix asphalt shall be dispatched to the field unless the temperature, as issued by Environment Canada, is rising and meets the following minimum temperature requirements:
 - Lift Thickness less than 50 mm, 7°C.
 - Lift Thickness greater than 50 mm and less than 70 mm, 4°C.
 - Lift Thickness greater than 70 mm, 2°C.
- A tolerance will be permitted for plant start-up.
- No surface lift asphalt mix shall be placed regardless of temperature or thickness until the road surface is 5°C or higher.

5) Hours of Operation

- No loads of hot mix asphalt shall be dispatched from the plant after sunset or during hours of darkness unless loads can be placed and compacted in accordance with these specifications. Suitable artificial illumination is provided, all subject to the Engineer's approval.

6) Transportation of Hot Mix Asphalt

- Trucks shall be equipped with tarpaulins of sufficient weights and sizes to cover the entire open area of the truck box. Regardless of weather conditions, tarpaulins shall be used.

- Vehicles used to transport hot mix asphalt from the plant to the worksite shall have tight metal boxes previously cleaned of all foreign matter. The inside surface may be lightly lubricated with a soap solution just before loading. Excess lubrication shall not be permitted.
- For purposes of checking asphalt mixture temperatures, trucks shall have an accessible 10 mm diameter hole drilled into the driver's side of the truck box, at a distance of 0.3 metres from the bottom of the box and 150 mm clear of the reinforcing ribs.
- The speed and weight of hauling trucks shall be regulated so that, in the opinion of the Engineer, no damage will occur to any portion of the work underway. Any damage to the tack coat, prime coat or the existing surface caused by the Contractor's equipment shall be repaired by the Contractor at their own expense.

7) Hot Mix Asphalt Spreaders

- The spreading machine shall be self-propelled and capable of placing a uniform layer of asphalt mix to the depth and grades as shown on the plans or as indicated by the Engineer.
- The screed shall include a tamping bar or vibratory strike-off device for use when required. The screed shall strike off the mix to the depth and cross-section specified and produce a finished surface of uniform texture.
- Control of the screed shall be by automatic sensing devices. A sensor shall accomplish longitudinal control, which follows a string-line, ski, or other references. The grade sensor shall be moveable, and mounts provided to establish grade control on either side of the paver. A slope control sensor shall also be provided to maintain the proper transverse slope of the screed. Use automatic grade control for paving operations.

8) Hand Tools

- Only lutes shall be used during the spreading operation, and when the asphalt is worked by hand in areas, the paver cannot reach.
- Tamping irons may be used to consolidate the material along structures inaccessible to the rollers. Mechanical compaction equipment, satisfactory to the Engineer, may be used instead of tamping irons.
- To check the finished surface, Contractors must provide and carry on each paving machine a 3 m straight edge and slope measuring level.

9) Pre-Levelling for Asphalt Concrete

- Pre-levelling uneven surfaces over which asphalt concrete is to be placed shall be accomplished by using asphalt concrete level course placed with a grader, paver, hand or by a combination of these methods as directed by the Engineer.



- After placement, the asphalt concrete used for pre-levelling shall be compacted thoroughly with pneumatic-tired rollers.

10) Paving Operations

- The asphalt concrete shall be placed to the design thickness as shown on the contract drawings. On new construction where an established reference is lacking, a string-line reference will be required. Adjacent mats on the same lift shall be controlled by use of the grade sensor. No relaxation of the above procedure will be permitted without the Engineer's written approval.
- The spreader shall be operated in such a manner as to distribute the asphalt concrete mix to the proper cross-section, width and thickness without causing segregation of the mix. Segregated areas which may occur shall be corrected immediately. The forward motion of the spreader shall be controlled so that no irregularities in the pavement surface are caused by excessive speed. The mixture placement rate shall be uniform and coordinated with the production rate of the asphalt plant and avoid intermittent operation of the spreader.
- Any failure of the machine or operation to produce a smooth, uniformly dense mat, free from irregularities, shall be corrected immediately to the Engineer's satisfaction.

11) Areas Inaccessible to the Paving Machine

- Areas inaccessible to the paving machine may be paved by other methods, as approved by the Engineer.
- In small areas or where using mechanical equipment is not practical, the mix may be spread and finished by hand. The asphalt mixture shall be dumped on the area and immediately distributed into place by shovels and spread with lutes in a loose uniform layer of uniform density and correct depth. The material must be handled to avoid segregation.

12) Compaction

- For all asphalt mixture types, the asphalt mixture shall be compacted to a minimum of 93 % of Maximum Relative Density (MRD).
- For Category B projects, the MRD Standard shall be the average of the three most recent tests.
- The Contractor shall supply sufficient compaction equipment to:
 - Provide a compaction rate that will be sufficient for, or exceed the placing rate of the spreader.
 - Ensure the specified compaction is attained before the temperature of the mat falls below 80°C.

13) Longitudinal and Transverse Joints

- Longitudinal and transverse joints shall be made in a manner consistent with industry standards. Coarse aggregate removed from the hot mix during joint preparation shall not be broadcast onto the mat.
- Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 150 mm, and transverse joints shall be offset at least 2 m.
- Longitudinal joints shall not be located within travel lanes unless approved by the Engineer.
- Edges, where additional pavement is to be placed, shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.
- The exposed edges of all cold asphalt joints and the face of the concrete curb and gutter shall be cleaned and painted with a thin coat of asphalt tack.
- At the end of each day's paving of the surface course and upper lift of the base course mix, the uncompleted paving mats shall be provided with vertically cut transverse joints. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to ensure a thorough and continuous bond between the old and new surfaces.

14) Opening to Traffic

- Prior to opening to traffic, paving mats shall be sufficiently cool to resist deformation or surface scuffing.
- At the Engineer's discretion, additional means of cooling (e.g., application of water) to completed pavements may be required prior to opening to traffic.
- At the Engineer's discretion, traffic may be prohibited from travelling on newly paved surfaces for any length of time deemed necessary.

307.02.05 – End Product Acceptance or Rejection**1) General**

- The Contractor shall provide a finished product conforming to the quality and tolerance requirements of this Specification. Where no tolerances are specified, the standard of workmanship shall be in accordance with accepted industry standards.
- Acceptance of any Lot at full payment will occur if there are no obvious defects. The Lot mean results for asphalt content, pavement density, air voids and thickness meet or exceed the specified tolerances.
- Unit price reductions will only be applied based on full acceptance testing in accordance with Table 16.



2) Asphalt Content

- The Lot Mean Asphalt Content must be within ± 0.30 % of the approved JMF value for full payment.
- Payment adjustments for asphalt content shall be in accordance with Table 17 below.

TABLE 17: PAYMENT ADJUSTMENTS FOR ASPHALT CONTENT

Asphalt Content Deviation from JMF Value (%)	Payment Adjustment Factor
+0.30 or less	1.00
+0.31 to +0.50	As per Chart A
Greater than +0.50	Reject (See Note below.)

Note: Subject to removal and replacement at the discretion of the Engineer.

3) Pavement Compaction

- For full or increased payment, the Lot Mean Pavement Compaction must be equal to or greater than 93 % of the Lot Mean Maximum Relative Density.
- Payment adjustments for pavement compaction as given in Table 18 below.

TABLE 18: PAYMENT ADJUSTMENTS FOR PAVEMENT COMPACTION

Pavement Compaction % of Maximum Relative Density	Payment Adjustment Factor
93.5 to 95.5 (Note 1)	1.02 (Note 2)
93.0 to 93.4	1.00
90.0 to 92.9	As per Chart B
Less than 90.0	Reject (Note 3)

Note 1: Where no individual test result is less than 93 %; otherwise, the payment adjustment factor is 1.00.

Note 2: For Category A Projects only.

Note 3: Subject to removal and replacement at the Engineer’s discretion.

4) Air Void Content

- For full payment, the Lot Mean Air Voids must be within ± 1.0 % of the JMF value, as specified in section 307.02.02 – Products.
- Payment adjustments for air void content are as follows:

TABLE 19: PAYMENT ADJUSTMENTS FOR AIR VOID CONTENT

Air Void Content % Deviation from JMF Value	Payment Adjustment Factor
Less than 1.0	1.00
1.0 to 2.0	As per Chart C
Greater than 2.0 (Lower Lifts)	0.80
Greater than 2.0 (Upper Lifts)	0.60

5) Thickness (New Construction and Top Lift Only)

- Pavement of any type deficient in thickness by more than 6% shall be removed and replaced by pavement of specified thickness at the Contractor's expense.
- The Lot Mean Thickness for any Lot will be based on the acceptance cores described in Table 16: Acceptance Testing Requirements - Category A & B Projects. Core thickness shall be determined in accordance with ASTM D 3549.
- If the deficiency of any individual core exceeds 6 %, additional cores may be extracted in the proximity to the location of the core of excessive deficiency, to identify the extremities of the pavement area subject to be removed and replaced. The Contractor shall pay for such additional coring.
- For full payment, the Lot Mean Thickness must not be deficient by greater than 2 %.
- Payment adjustments for thickness are as follows:

TABLE 20: PAYMENT ADJUSTMENTS FOR THICKNESS

Thickness Deficiency (% of Specified Thickness)	Payment Adjustment Factor (Note 1)	
	Total Thickness (Single or Multiple Lifts)	Top Lift Thickness (Multiple Lifts)
2 % or Less	1.00	1.00
2 % to 6 % Deficient	As Per Chart D	As Per Chart D
More than 6 % Deficient	Reject (Note 2)	Reject (Note 2)

Note 1: A single Thickness Payment Adjustment Factor shall be applied, Total Thickness or Top Lift Thickness, whichever results in the greatest adjustment.

Note 2: Subject to removal and replacement at the discretion of the Engineer.

6) Smoothness

- The completed asphalt concrete surface shall be true to the dimensional and tolerance requirements of the specifications and drawings. Unless detailed otherwise in the contract documents, the tolerances in both profile and crown are:
 - Base Course - 10 mm in 3 m

- Surface Course - 5 mm in 3 m

7) Segregation

- The finished surface shall have a uniform texture and be free of segregated areas. A segregated area is defined as an area of pavement where the texture differs visually from the texture of the surrounding pavement.
- The Engineer shall evaluate all segregation to determine repair requirements.
- The severity of segregation shall be rated as follows:
 - Slight - The matrix of asphalt cement and fine aggregate is in place between the coarse aggregate particles; however, there is more stone in comparison to the surrounding acceptable mix.
 - Moderate - Significantly more stone than the surrounding mix and exhibit a lack of surrounding matrix.
 - Severe - Appears as an area of very stony mix, stone against stone, with very little or no matrix.
 - Segregated areas shall be repaired by the Contractor as directed by the Engineer. The following methods of repair are identified:
 - Slight - squeegee asphalt to completely fill the surface voids.
 - Moderate - slurry seal for full mat width.
 - Severe - removal and replacement or overlay.
- All repairs shall be regular in shape and finished using good workmanship practices to provide an appearance acceptable to the Engineer.
- Any other methods of repair proposed by the Contractor will be subject to the approval of the Engineer.
- The Contractor shall carry out repairs at their expense.

307.02.06 – Measurement and Payment

1) Measurement

- Asphalt Concrete - Marshall supplied will be measured in square metres or tonnes of material placed, as detailed in the Tender Form.
- The Unit Price for Asphalt Concrete – Marshall shall be full compensation for all materials, labour, tools, equipment and incidentals necessary to complete the work in accordance with these specifications.
- The material shall be scaled and recorded by the Contractor on duplicate weight slips. Weight slips must be supplied at delivery, and a copy must be provided to the Owner.

- The weight scale shall be inspected and certified by Weights and Measures Inspection Services of the Federal Department of Consumer and Corporate Affairs, at the Contractors' expense and as often as the Engineer may direct.

2) Payment

- The Unit Price applicable to each Lot quantity of asphalt concrete will be calculated as follows:

$$\text{LOT UNIT PRICE} = \text{CONTRACT UNIT PRICE} \times \text{PA}_{\text{AC}} \times \text{PA}_{\text{COM}} \times \text{PA}_{\text{AV}} \times \text{PA}_{\text{T}}$$

Where:

PA_{AC} = Asphalt Content Payment Adjustment

PA_{COM} = Compaction Payment Adjustment

PA_{AV} = Air Void Payment Adjustment

PA_{T} = Thickness Payment Adjustment

- For subdivision development Category B Projects, the Unit Price for asphalt concrete will be calculated based on an assumed price of \$150 per tonne.

3) Determination of Pavement Smoothness

The City Engineer will determine major Road Smoothness Specification "A" or "B".

- The finished pavement surface shall be tested by The City of Calgary to determine the longitudinal profile and compute the International Roughness Index's (IRI) of each driving lane. Left and Right wheel path IRI's will be averaged to produce the Mean IRI or Mean International Roughness Index (MIRI). The Mean IRI will be used to determine acceptance limits and payment adjustments.
- Each lane of the project will be profiled and divided into Lots. A Lot is defined as 1 km (1000 m) in length of the final pavement surface. Partial Lots less than 100 m will be included as part of the previous Lot, and partial Lots greater than 100 m will be used as fractions to determine acceptance and payment adjustments as required.
- Lane lengths of less than 300m will not be subject to the smoothness specification.
- Sections that will be filtered and not included in the determination of final acceptability or payment adjustments include all traffic-controlled intersections, railway crossings, bridge decks, tie-ins, and required run-in or run-out distances for profiling vehicle sensor stabilization. Sections will be filtered at the time of performing final profiling. A preceding or exiting distance of at least 5m, not to exceed 10m, is included at each filtered section's beginning and end. The preceding and exiting filtered distance will be measured from the beginning of the filtered section to the front axle of the test vehicle when entering the filtered section and from the end of the filtered section to the rear axle of the test vehicle when exiting the filtered section. Speed file will be enabled to filter any low-speed sections during final profiling. The final smoothness

of these filtered areas, including new pavement construction, overlay projects, and tie-ins to existing sections, will be assessed individually and at The City Engineer's discretion.

- In areas where the existing curb and gutter profile or non-City owned or controlled utility manhole elevations are inconsistent and may affect the final smoothness of the pavement, consideration will be given upon receiving written notice from the Contractor before final top lift or overlay paving commences. The Contractor is expected to use due diligence in attaining smoothness requirements, and correct/regulate for minor inconsistencies (0 to 20 mm above) along the lip of gutter profiles and, blend in the surface areas around all manholes without excessive roughness. Sections or areas will be assessed on an individual basis and by The City Engineer's discretion.
- Pavement surface profiling may be performed both before and after project completion. Quality assurance will then be assessed by comparing the before and after measurements and determining the overall improvement achieved. Considerable improvement of pavement smoothness should be evident. If deficient, this will become a significant factor in the final acceptance of the project.
- For the measuring process, if required, the Contractor shall provide The City with a chalk guideline in the centre or edge of all driving lanes immediately prior to measurement.

4) Acceptance Limits Mean IRI (MIRI) – Lots

- The acceptance limit for each lane will be determined by the following:
 - The MIRI value will be used to determine if the Lot or Partial Lot will be accepted and if it will be subject to any payment adjustment.
 - The Lot or Partial Lot MIRI will not exceed 2.50 for "A" and 2.90 for "B" Major Roads.
 - No apparent defects, including roller marks, tire marks, cracking or tearing, excessive bleeding, and surface segregation.
- Lot Assessment and the final acceptance of each Lot will be at The City Engineer's discretion.

5) Payment Adjustments for “A” Major Road – Lots

TABLE 21: PAYMENT ADJUSTMENTS FOR MAJOR ROAD BASED ON SMOOTHNESS SPECIFICATIONS “A”

Lot Mean IRI (m/km)	Payment Adjustment
<0.81	+\$1 000
0.81-0.90	+\$800
0.91-1.00	+\$400
1.01-1.10	+\$200
1.11 -1.20	+\$100
1.21-1.60	0
1.61-1.70	-\$100
1.71-1.80	-\$200
1.81-1.90	-\$400
1.91-2.00	-\$600
2.01-2.10	-\$800
2.11-2.20	-\$1 000
2.21-2.30	-\$1 200
2.31-2.40	-\$1 500
2.41-2.50	-\$2 000
>2.50	-\$2 500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

6) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “A” Major Roads

Localized roughness will be determined using the evaluation software TxDOT Designation:

- Tex-1001-S as provided in ProVAL 2.7 and later versions.

The software will:

- Produce a single averaged wheel path profile.
- Apply a 10 m moving average filter to the single average wheel path profile.
- Determine the difference between the averaged wheel path and the 10 m moving average filtered profiles for every profile point.



- Identify deviations greater than 0.9 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).

Each deviation between:

- 0.90 – 1.09 cm will result in a \$200 penalty.
- 1.10 – 1.19 cm will result in a \$300 penalty
- 1.20 – 1.29 cm will result in a \$400 penalty.
- 1.30 – 1.39 cm will result in a \$500 penalty.
- 1.40 – 1.49 cm will result in a \$600 penalty.
- 1.50 – 1.59 cm will result in an \$800 penalty.
- 1.60 – 1.69 cm will result in a \$1000 penalty.
- 1.70 – 1.79 cm will result in a \$1200 penalty.
- 1.80 cm and above will result in a \$1500 penalty and be subject to remedial work.

Individual areas of localized roughness will be established by a linear lane length of not greater than 3 m per deviation as per Tex-1001-S analysis. Where multiple areas of localized roughness occur within a 3 m linear lane length, the resulting penalty will be considered from the most severe deviation. Deviations with a lane length greater than 3m will be split to establish multiple deviations.

Remedial work will be subject to review and approval by The City Engineer.

No positive payment adjustment for corrective work to meet localized roughness limits will be applied.

7) Payment Adjustments for “B” Major Road - Lots

TABLE 22: PAYMENT ADJUSTMENTS FOR MAJOR ROADS BASED ON SMOOTHNESS SPECIFICATIONS “B”

Lot Mean IRI (m/km)	Payment Adjustment
<0.81	+\$1000
0.81-0.90	+\$800
0.91-1.00	+\$600
1.01-1.10	+\$400
1.11-1.20	+\$200
1.21 -1.30	+\$100
1.31-1.70	0
1.71-1.80	-\$100
1.81-1.90	-\$200
1.91-2.00	-\$400
2.01-2.10	-\$600
2.11-2.20	-\$800
2.21-2.40	-\$1000
2.41-2.60	-\$1200
2.61-2.80	-\$1500
2.81-2.90	-\$2000
>2.90	-\$2500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

8) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “B” Major Roads

Localized roughness will be determined using the evaluation software TxDOT Designation: Tex-1001-S as provided in ProVAL 2.7 and later versions.

The software will:

- Produce a single averaged wheel path profile.
- Apply an 8 m moving average filter to the single average wheel path profile.
- Determine the difference between the averaged wheel path and the 8 m moving average filtered profiles for every profile point.
- Identify deviations greater than 1.0 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).



Each deviation between:

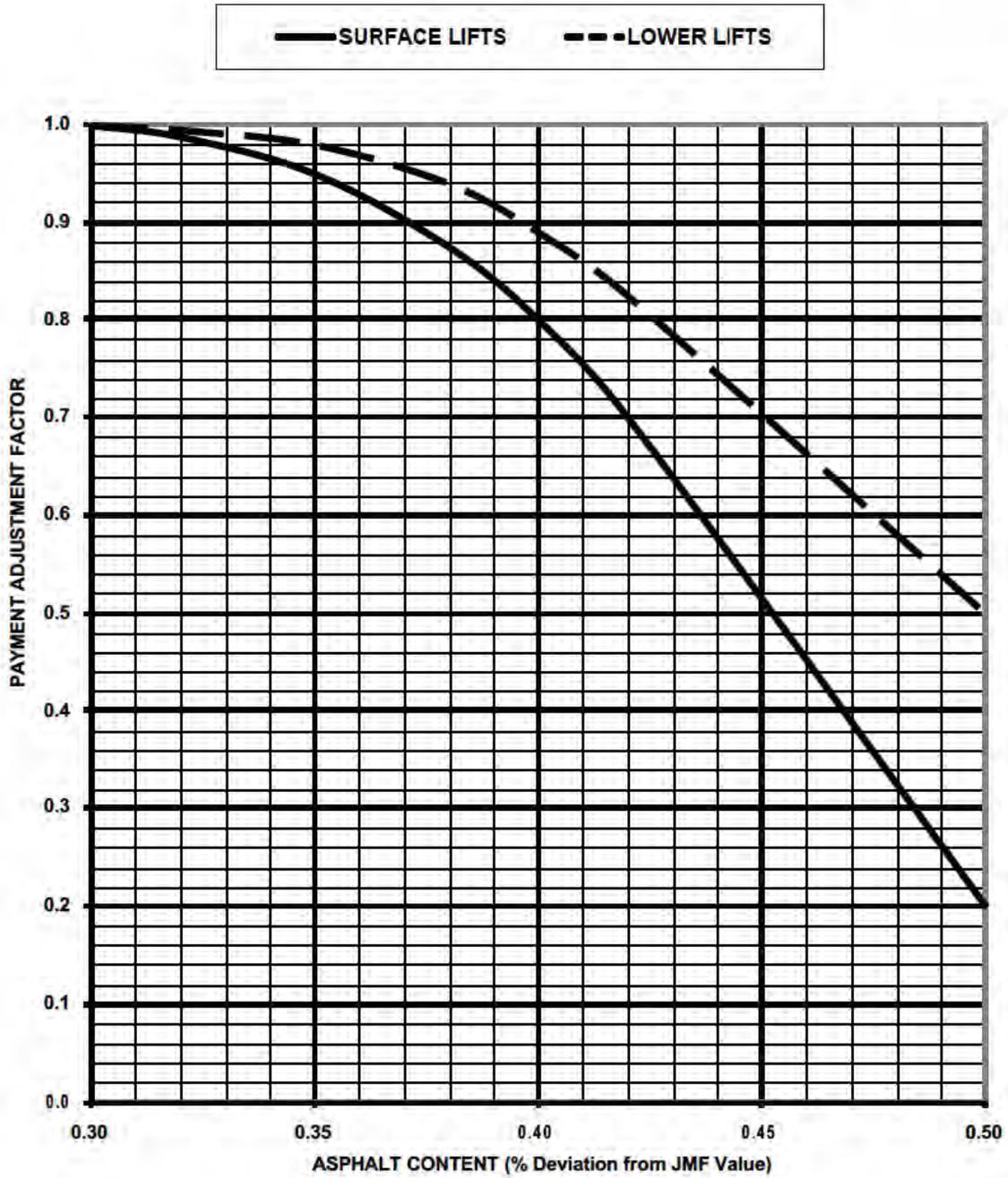
- 1.00 – 1.19 cm will result in a \$200 penalty.
- 1.19 – 1.29 cm will result in a \$300 penalty.
- 1.30 – 1.39 cm will result in a \$400 penalty.
- 1.40 – 1.49 cm will result in a \$500 penalty.
- 1.50 – 1.59 cm will result in a \$600 penalty.
- 1.60 – 1.69 cm will result in a \$800 penalty.
- 1.70 – 1.79 cm will result in a \$1000 penalty.
- 1.80 – 1.89 cm will result in a \$1200 penalty.
- 1.90 cm and above will result in a \$1500 penalty and be subject to remedial work.

Individual areas of localized roughness will be established by a linear lane length of not greater than 3 m per deviation as per Tex-1001-S analysis. Where multiple areas of localized roughness occur within a 3 m linear lane length, the resulting penalty will be considered from the most severe deviation. Deviations with a lane length greater than 3 m will be split to establish multiple deviations”.

Remedial work will be subject to review and approval by The City Engineer.

No positive payment adjustment for corrective work to meet localized roughness limits will be applied.

CHART A ASPHALT CONTENT
PAYMENT ADJUSTMENT FACTOR





**CHART B COMPACTION
PAYMENT ADJUSTMENT FACTOR**

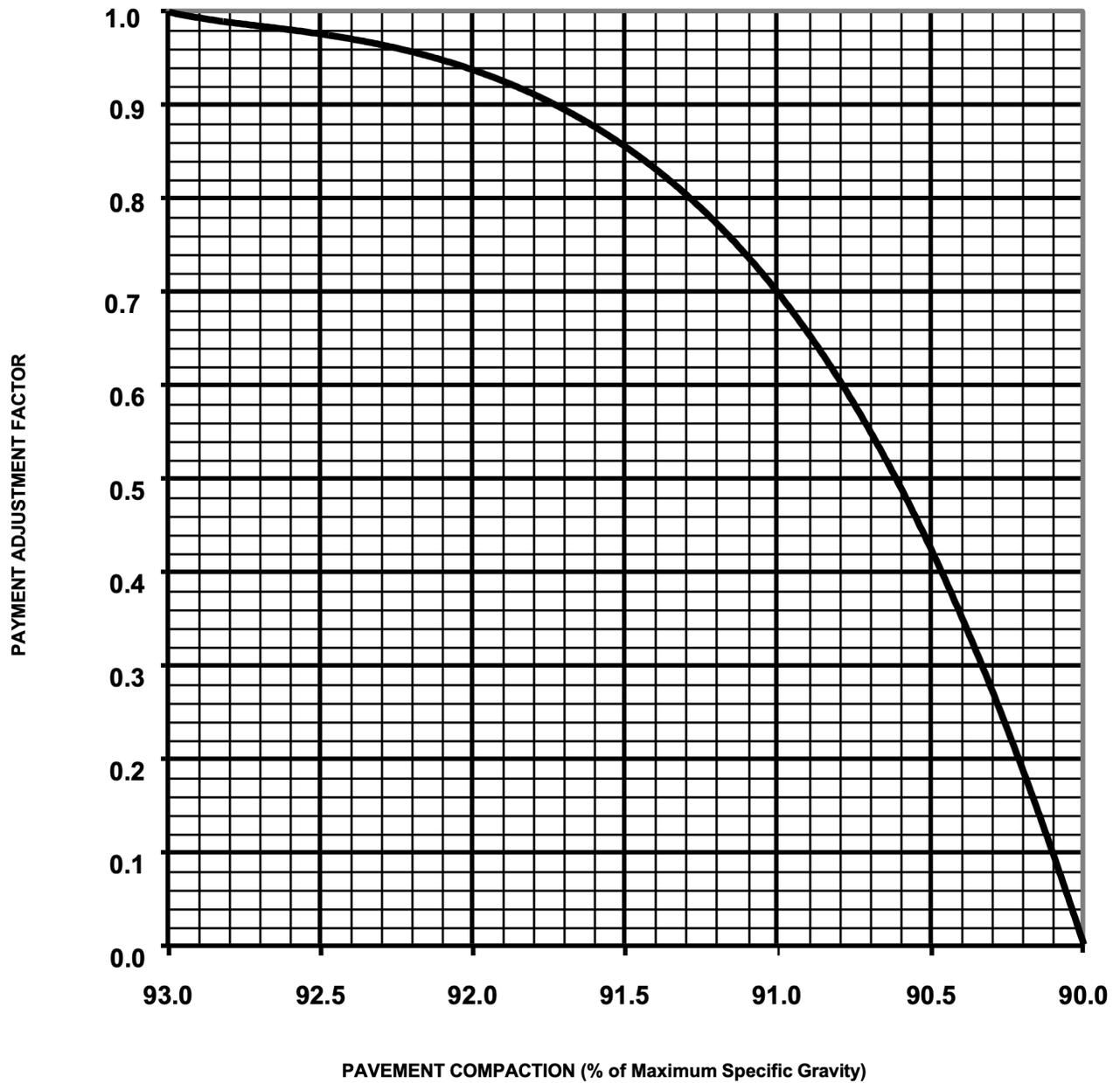
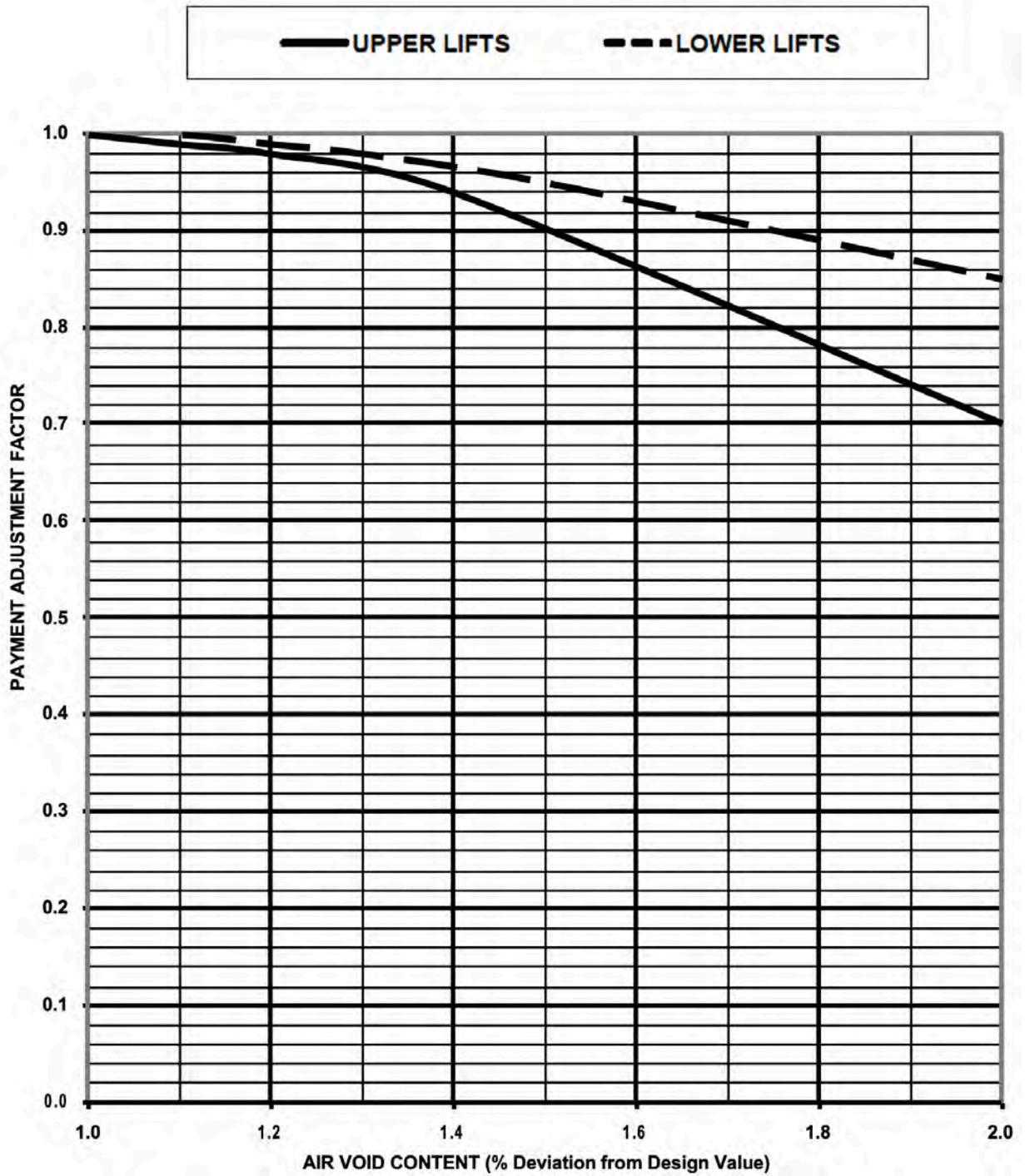
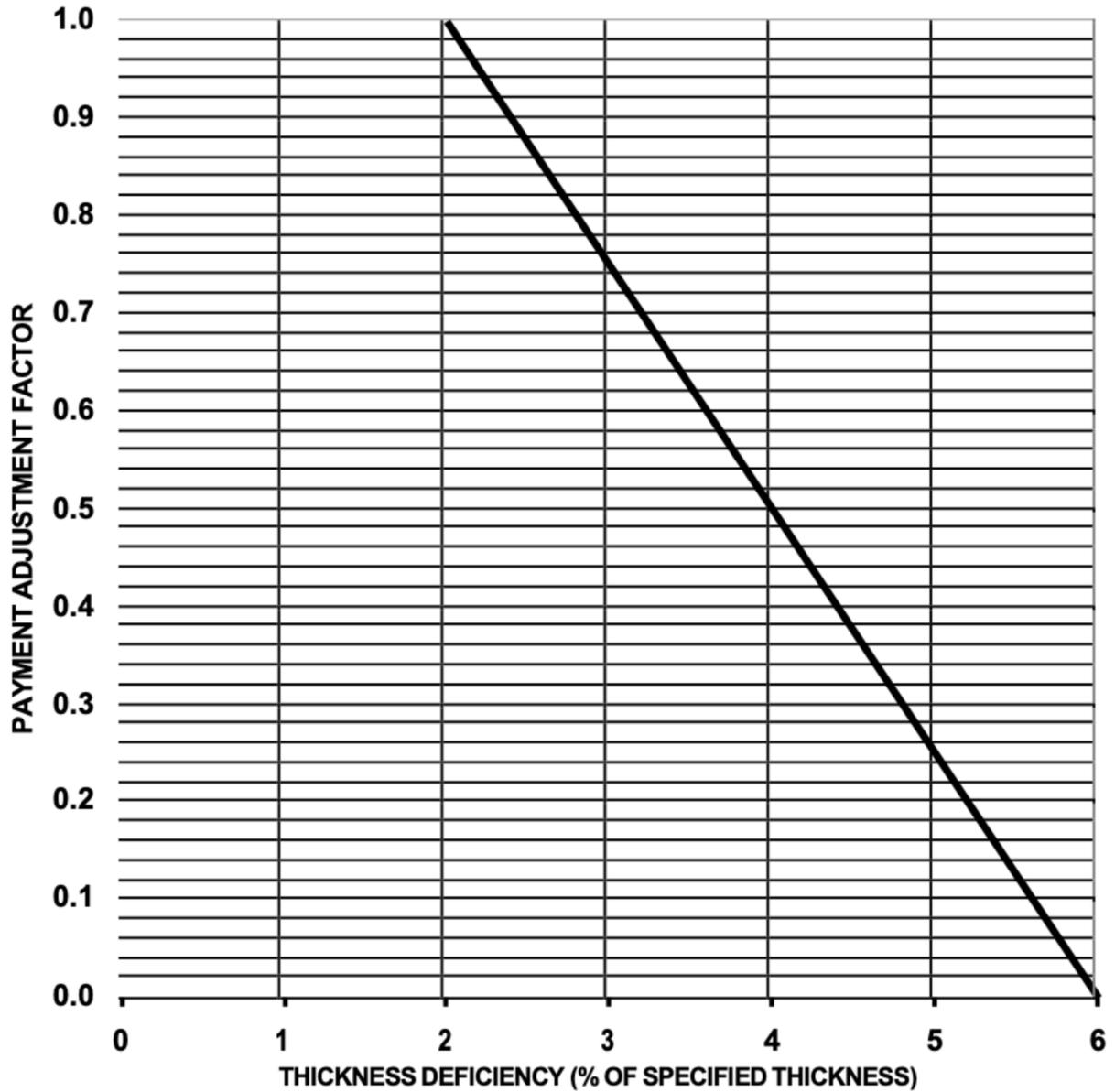


CHART C AIR VOID CONTENT
PAYMENT ADJUSTMENT





**CHART D AVERAGE THICKNESS
PAYMENT ADJUSTMENT FACTOR**



307.03.00 – Asphalt Concrete - Marshall

307.03.01 – General

1) Description

This section specifies the requirements for the supply of Marshall designed asphalt concrete paving.

This Specification describes the mix property criteria and construction requirements for Marshall asphalt concrete in terms of mix type as identified in the Contract and Tender Form.

The work includes the supply of aggregates and asphalt cement, reclaimed asphalt pavement and liquid anti-strip agents, where applicable; asphalt plant mixing, transporting, placement finishing, and compaction to all Specification requirements.

The work includes all materials certification, quality control, verification and mix design testing, analysis and reporting to be completed as required in this Specification.

2) Warm Mix Asphalt Technologies

The City of Calgary Pavements, Soil, and Asset Management (PSAM) Engineer will consider Warm Mix Asphalt (WMA) proposals on a case-by-case basis. The properties of the WMA mix design must satisfy all the requirements for the specified mixture type.

The Contractor must provide a detailed proposal, identifying as a minimum the following:

- The type of process or additive and specifics regarding previous experience.
- Quality Control / Quality Assurance considerations specific to the WMA process.
- Proposed WMA design program, performance testing program and binder rheology assessment program.
- Economic considerations.

Subject to review and approval of the WMA Proposal, the Contractor will undertake the necessary work in accordance with the proposal and these Specifications. Final approval will be subject to satisfying the proposal requirements and the Specifications and is solely at the discretion of the Pavements, Soil, and Asset Management (PSAM) Engineer.

3) Related Work

Asphalt Binder – please refer to section 307.01.00 – Asphalt Binder.

4) Definitions

Please refer to section Specification Definitions.



307.03.02 – Products

1) Materials

- Asphalt Binder – refer to section 307.01.00 – Asphalt Binder.
- Aggregates:
 - Coarse aggregate is aggregate retained on the 5.0 mm sieve; fine aggregate is aggregate passing the 5.0 mm sieve.
 - Aggregate materials shall be crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material, and other deleterious materials.
 - Gradations to be within limits specified when tested to ASTM C-136 and ASTM C-117 with sieve sizes to CAN/CGSB 8-GP-2M rather than ASTM E11.
- Aggregate shall be processed to meet the following requirements:
 - Natural fines shall be pre-screened and stockpiled with not more than 10 % of material retained on the 5.0 mm sieve and 100 % passing the 10.0 mm sieve.
 - Aggregate delivered to the crushing plant shall be pre-screened and contain no more than 5 % passing the 5.0 mm sieve.
- Crushed aggregates shall be separated and stockpiled in accordance with the following:
 - Coarse fraction to contain no more than 40 % of material passing the 5.0 mm sieve.
 - Fine fraction or manufactured sand contains no more than 20 % of material retained on the 5.0 mm sieve. Physical properties of aggregates to meet the requirements in Table 23 below.

TABLE 23: AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

PROPERTY	TEST STANDARD	REQUIREMENT
Los Angeles Abrasion, Grading B (% Loss)	C131	30 max.
Magnesium Sulphate Soundness (% Loss)	C88	12.0 max. 12.0 max.
Coarse Aggregate:		
Fine Aggregate:		
Lightweight Particles (%)	C123	1.5 max.

- Blend Sand:
 - Shall consist of natural or manufactured sand passing the 5.0 mm sieve.

- Stockpile volumes shall be maintained to ensure a minimum of 5,000 tonnes of plant mix production at all times.
- Blended Aggregate Requirements:
 - Aggregate Gradation Requirements, including RAP, to meet the requirements of Table 25 below.

TABLE 24: BLENDED AGGREGATE GRADATION REQUIREMENTS

SIEVE SIZE (mm)	Percent Passing Sieve Size			
	Mix Type A	Mix Type B	Mix Type C	Mix Type M
25	100			
20	95 - 83		100	
16	90 - 74	100	100-97	
12.5	80-64	100-95	95-80	100
10	72-56	95-85	85-70	100-95
5	58-40	75-60	70-55	85-65
2.5	46-30	60-45	55-36	-
1.25	40-22	45-28	45-26	-
0.630	33-15	36-20	38-18	-
0.315	27-10	28-15	28-12	-
0.160	18-8.0	18-6.0	16-8.0	-
0.080	8.0-4.0	8.0-4.0	8.0-4.0	8.0-4.0

TABLE 25: BLENDED AGGREGATE GRADATION REQUIREMENTS FOR POLYMER MODIFIED BRIDGE MASTIC MIXES

SIEVE SIZES (Square Openings)	Single and Rehabilitation Lifts	Multiple Lifts	
		Membrane	Overlay
Percent Passing by Weight			
12.5 mm			100
10 mm	100		-
5 mm	90 – 95	100	50 – 70
2.5 mm	70 – 76	70 – 80	-
160 µm	8 – 16	-	-
80 µm	4 – 8	6 – 10	6 – 8



2) Coarse Aggregate Fracture

- Of coarse fraction (retained on 5.0 mm sieve size), the percentage of fractured particles (2 or more faces) shall be, by mass:
 - Mix Type A – 60 % minimum.
 - Mix Type B – 70 % minimum.
 - Mix Type C – 90 % minimum.
 - Bridge Mastic Mix – 70 % minimum.

3) Manufactured Sand (TLT 314)

- Of total fine fraction (passing 5.0 mm sieve size), manufactured sand shall be, by mass:
 - Mix Type A - 50 % minimum.
 - Mix Type B - 50 % minimum.
 - Mix Type C – 75 % minimum.
 - Bridge Mastic Mix – 80 % minimum
- For mixes incorporating RAP, 50 % of the RAP sand portion shall be considered manufactured sand.
- The sand equivalent value (ASTM D2419, Mechanical Method) determined for the fine aggregate portion shall be:
 - Mix Type A – 40 % minimum.
 - Mix Types B and C – 45 % minimum.

4) Reclaimed Asphalt Pavement (RAP)

- Reclaimed Asphalt Pavement (RAP) may be used as follows:
 - A RAP portion of up to 20 % binder contribution, as a percent of the total binder content, will be allowed without the need for a binder rheology assessment.
 - Other material additives will be considered subject to submission of proposed binder rheology and/or aggregate assessment program and subject to the Engineer's approval.

5) Mix Design

- An asphalt mix design must be prepared and submitted to the Engineer for review and approval at least one week prior to the Work. The Contractor shall use qualified engineering and testing services licensed to practice in the Province of Alberta.
- The trial mix design shall be performed in accordance with the Asphalt Institute Mix Design Methods for Asphalt Concrete MS-2.

- Design of Mix:
 - Mix Type A – 75 Blow Marshall
 - Mix Type B – 50 Blow Marshall
 - Mix Type C – 75 Blow Marshall
 - Mix Type M – 50 Blow Marshall
 - Polymer Modified Bridge Mastic Mixes – 50 Blow Marshall
- The mix design submission shall contain, as a minimum:
 - Aggregate specific gravity and asphalt absorption.
 - Sand equivalence, coarse aggregate fracture, flat and elongated particles, and percent manufactured sand values.
 - Asphalt cement supplier/refinery, specific gravity and mixing and compaction temperatures, based on asphalt cement's temperature–viscosity properties.
 - Job mix formula including aggregate gradation and blending proportions, and design asphalt content.
 - Maximum Relative Density at each trial asphalt content.
 - Where reclaimed asphalt pavement (RAP) is to be incorporated into the mix supply, RAP gradation, RAP asphalt cement content, and design recycle percentage.
 - Data to satisfy the requirements of the following:

TABLE 26: MIXTURE PHYSICAL PROPERTY REQUIREMENTS

PROPERTY	REQUIREMENTS			
	MIX TYPE			
	Mix Type A	Mix Type B	Mix Type C	Mix Type M
Marshall Stability (kN)	10 min.	8 min.	12 min.	6 min.
Marshall Flow (mm)	2.0 – 4.0	2.0 - 4.0	2.0 - 4.0	2.0 - 4.0
Air Voids (%)	4.3 - 4.7	3.3 - 3.7	3.8 - 4.2	2.8 - 3.2
Voids in Mineral Aggregate (%)	12 min.	14 min.	13.5 min.	15 min.
Voids Filled with Asphalt (%)	60 - 70	70 - 80	65 - 80	70 - 85
Film Thickness (µm)	6.0 min.	7.0 min.	7.0 min.	7.0 min.
Tensile Strength Ratio (%) ¹	70 min.	75 min.	75 min.	-

¹Tested in accordance with AASHTO T283, including the optional freeze cycle.

6) Polymer Modified Bridge Mastic Mixes

TABLE 27: POLYMER MODIFIED BRIDGE MASTIC MIXES – PROPERTY REQUIREMENTS

PROPERTY	Single lift and Rehabilitation	Membrane	Overlay
Binder Content (%)	8.5 min	9.5 min	6.5 min
Marshall Stability (N)	6.0 min	5.2 min	7.0 min
Flow (250 µm)	20 max	20 max	20 max
VMA (%)	14 min	18 min	14 min
Air Voids (%)	2 - 4	3 max	3 - 5
Permeability @ 70 kPa (cm/s)	10 ⁻⁷ max	10 ⁻⁷ max	10 ⁻⁷ max
Film Thickness (µm)	8.0 min	8.0 min	7.0 min

7) Job Mix Formula

- Subject to approval by the Engineer, the aggregate proportioning (including RAP), target gradation, asphalt content and air void content from the Mix Design will become the Job Mix Formula for the supply of hot mix asphalt.
- Once established, no alterations to the Job Mix Formula will be permitted unless a new Job Mix Formula is submitted by the Contractor and approved by the Engineer.
- If the sum of any alterations to the Job Mix Formula is more than any one of the following limits, a new Mix Design shall be submitted for approval.
 - ± 5 % passing the 5.0 mm sieve size.
 - ± 1% passing the 0.080 mm sieve size.
 - ± 0.3 % asphalt content.
 - Properties of the revised Job Mix Formula shall conform to all requirements of this Specification.

8) Production Tolerances

- All mixtures shall be supplied to the project within the range of tolerances specified.
- Asphalt cement content: ± 0.3 % of Job Mix Formula value.
- Temperature: Mix temperature at the point of plant discharge shall not vary from that specified in the Job Mix Formula by more than ±10°C.
- Aggregate Gradation:

TABLE 28: AGGREGATE GRADATION - TOLERANCES

Aggregate Passing Sieve Size (mm)	Tolerance (% By Mass)
Max. size to 5.0	± 4.0
2.5 & 1.25	± 3.0
0.630, 0.160 & 0.315	± 2.0
0.080	± 1.0

- Air Voids: ±1.0 % of the Job Mix Formula value.
- Mixture Properties: Voids Filled with Asphalt, Voids in Mineral Aggregate and Film Thickness as per requirements identified in Table 26.
- Moisture in Mix: Maximum permissible moisture, at point of plant discharge, is 0.3 % by mass of mix.

307.03.03 – Sampling and Testing

1) General

- The Engineer shall have access to all production processes and materials used for the work to monitor material quality as often as deemed necessary. Such inspection and testing shall not in any way relieve the Contractor of the responsibility for meeting the requirements of this Specification.
- At least three (3) weeks prior to commencing work, the Engineer shall be advised of the proposed source of aggregates and access shall be provided for sampling, and provide samples of asphalt cement shall be provided in accordance with section 307.01.00 – Asphalt Binder.

2) Quality Control

- Quality control is the Contractor's responsibility throughout every stage of the work, from aggregate processing to the final accepted product. Tests performed by the Engineer will not be considered quality control tests.
- The Contractor shall be responsible for the production of materials and construction that meet all specified requirements.
- All quality control shall be conducted by qualified personnel. The Contractor shall bear the cost of all quality control testing and consulting services.
- Pre-Production testing and sampling and minimum frequencies are described in Table 29: Pre-Production Quality Control Requirements.



- Pre-Production Quality Control test data specified in Table 29 shall be reported to the Engineer one week prior to commencing the project or as requested.
- Post-Production testing and sampling and minimum frequencies are described in Table 30: Post-Production Quality Control Requirements.
- Post-Production Quality Control test data specified in Table 30 shall be reported to the Engineer daily as the work proceeds.

TABLE 29: PRE-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirement	Test Standard	Minimum Frequency
Asphalt Cement Certification	-	One per Contract or for change in supplier (minimum once per year)
Aggregate Physical Property Requirements Table 24	Table 24	Once per year, or for change in source
Crushed Coarse Aggregate Gradation Analysis and Fracture Content	ASTM C 136 ASTM D 5821	One for every 1 000 tonnes of each class of material processed into the stockpile, or one analysis for each material every production day when the production rate is less than 1 000 tonnes (Recommended)
Manufactured Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Natural Fine Aggregate Gradation	ASTM C 117 ASTM C 126	
Blend Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Reclaimed Asphalt Pavement (RAP) Asphalt Content and Extracted Aggregate Gradation	ASTM D 2172 ASTM C 117 ASTM C 136	One for each 500 tonnes delivered to stockpile, or one for each location when the delivery rate is less than 500 tonnes (Recommended)
Trial Mix Design by Marshall Method	Asphalt Institute MS-2	One per mix type every 3 years, or as required for a change in asphalt cement supply, aggregate gradation or aggregate source or as required by the Contract Specifications. ¹
Plant Calibration	-	As required

¹A laboratory/plant job mix formula verification is required each year when a trial mix design is not conducted.

TABLE 30: POST-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirements	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Asphalt Content, and Aggregate Gradation)	ASTM D 6307 ASTM C 117 ASTM C 136	One for every 500 tonne of each mix type supplied under this specification. See Note 1.
Hot Mix Asphalt Volumetric Analysis (Laboratory Compacted Density and Void Properties) where Asphalt Content and Aggregate Gradation are known.	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 3203 AASHTO T312	One for every Lot of each mix type supplied under this specification. ¹
Quality Control Charts (including 3 test running average for Binder Content, Aggregate Gradation, Laboratory Compacted Density and Void Properties)	-	For each hot mix analysis. Test results and updated 3 test running average to be submitted to the Engineer as they become available.
Hot Mix Asphalt Temperature	-	Minimum frequency not specified.
Cold Feed Aggregate Analysis	ASTM C117 ASTM C 136	Minimum frequency not specified.
Maximum Relative Density of Hot Mix Asphalt	ASTM D 2041	Minimum frequency not specified.
Compaction Monitoring (Core or Nuclear Density)	ASTM D 2726 ASTM D 2950	Minimum frequency not specified. ²

¹Where an individual test indicates non-compliance, another test shall be initiated immediately.

²Coring is subject to the approval of the Engineer.

3) Quality Control Compliance with Specified Tolerances

- Asphalt Content, Aggregate Gradation and Mixture Properties
 - The test data derived by Post-Production Quality Control mix testing, described in section 307.03.03 – Sampling and Testing, shall be compared to the tolerances outlined in section 307.03.03 – Sampling and Testing. The Contractor shall suspend mix production when the three (3) test running average for any property is outside the specified tolerance limits.
 - Supply shall not commence again until it is demonstrated that corrective action has been taken.
- Hot Mix Asphalt Temperature
 - Plant mix that does not meet the temperature requirements of section 307.03.02 – Products at the point of plant discharge shall be subject to rejection at the Engineer's discretion.



4) Acceptance Sampling and Testing

- Within this Specification, certain requirements, limits and tolerances are specified regarding supplied materials and quality. Compliance with these requirements shall be determined from acceptance testing as described in this section.
- Acceptance testing is the responsibility of and at the sole discretion of the Engineer.
- Initial acceptance testing will be undertaken free of cost to the Contractor.
- Sampling and acceptance testing is described in Table 31: Acceptance Testing Requirements - Category A & B Projects below.

TABLE 31: ACCEPTANCE TESTING REQUIREMENTS - CATEGORY A & B PROJECTS

Acceptance Testing	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Binder Content, Aggregate Gradation, Laboratory Compacted Density, Maximum Relative Density and Void Properties)	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 2041 ASTM D 3203 AASHTO T 312	For each mix type, one test for each 3 500 m ² . of placement, or three tests per lot, whichever is greater. ¹
Compaction Testing (Core Density) and Thickness Determination. Nuclear Density Testing for Category B Project Compaction subject to the approval of the Engineer.	ASTM D 2726 ASTM D 3549	For each mix type, one test for each 2 000m ² of placement, or three tests per lot, whichever is greater.
Hot Mix Asphalt Temperature	-	No minimum frequency.

¹For Category B Projects, the Engineer may, at their discretion, acquire the minimum number of mix samples but reduce the number of tests to a minimum of one. Should non-compliance be indicated by the sample(s) tested, the Engineer reserves the option to test the remaining samples.

5) Acceptance Sampling Procedures:

- Loose mix samples shall be acquired from the work site in accordance with Alberta Transportation Test (ATT) procedure ATT-37. Auger samples may be used if approved by both the Engineer and the Contractor.
- The timing of mix sampling shall be stratified, with each sample representing a similar production quantity.
- Core locations will be selected using stratified random sampling procedures as described in ATT-56 Part II. The Lot will be divided into segments meeting or exceeding the minimum frequency in Table 31: Acceptance Testing Requirements - Category A & B Projects and approximately equal area. A test site will be located in each segment using random numbers to determine the longitudinal and transverse coordinates.
- Areas within 3 m of transverse joints or 0.3 m of a mat edge are excluded from compaction acceptance sampling and testing.

6) Reporting Protocols

- Test reporting accuracy shall be as stipulated in the referenced test procedures, including:
 - Gradation to the nearest whole number, except the percent passing the 0.080 mm sieve, shall be reported to the nearest 0.1 %.
 - Binder content to the nearest 0.01 %.
 - Air voids and compaction to the nearest 0.1 %.
 - Thickness to the nearest whole mm.
- Lot averages shall be reported to the same accuracy as test results.

7) Appeal of Acceptance Testing Results

- **General**
 - The Contractor may appeal the acceptance testing results for Compaction Standard, Asphalt Content or Air Voids for any Lot subject to rejection or unit price reduction. The notice of appeal shall be in writing and submitted to the Engineer within 48 hours of receiving the acceptance testing results.
 - Appeals will only be considered if cause can be shown and the requirements of Table 30 have been satisfied.
 - Quality Control tests initiated after the Contractor's receipt of the acceptance test results will not be considered when evaluating cause for appeal.
 - For Category "A" Projects, only Quality Control testing during production for the subject project will be considered when evaluating cause for appeal. For Category "B" Projects, Quality Control test results from production prior to the subject project may be considered when evaluating cause for appeal.
- **Asphalt Content Appeal**
 - The Engineer shall develop a stratified random sampling plan with the same number of segments as the original number of samples for the subject Lot. A sufficient core sample will be acquired from each segment to enable asphalt content determinations.
 - For asphalt content appeal testing, the testing shall be undertaken by an independent testing laboratory selected by the Contractor and approved by the Engineer.
 - The average of the appeal test results will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
 - If the average appeal test result verifies that any unit price reduction or rejection applies for that Lot, the Contractor will bear the appeal sampling and testing costs. If the result shows that a penalty or rejection no longer applies, the sampling and appeal costs will be the Owner's responsibility.



- **Compaction Standard or Air Void Appeals**
 - The testing laboratory conducting the project acceptance sampling and testing will routinely retain companion samples sufficient for the determination of maximum relative density and/or SGC density.
 - For compaction standard or air void appeal testing, the Contractor will have the option for testing to be done by the laboratory undertaking the project acceptance testing, or an independent testing laboratory selected by the Engineer.
 - The average of the appeal tests will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
 - If the new compaction standard verifies that any unit price reduction or rejection applies for that Lot, the Contractor will bear the appeal sampling and testing costs. If the result shows that a unit price reduction no longer applies, the appeal testing costs will be the Owner's responsibility.
 - If the new average air void content result verifies that any unit price reduction applies for that Lot, the Contractor will bear the costs of the appeal testing. If the results show that a unit price reduction no longer applies, the sampling and appeal costs will be the Owner's responsibility.
- **Core Density and Thickness Appeals**
 - Core density and thickness appeals will only be considered if a case can be made that the stratified random sampling plan was biased or testing was in error. Appeal cores shall be taken at a frequency of one per 1 000sq.m area.
 - Acceptance shall be based solely on the results of the appeal core testing.
 - Nuclear Density Appeals.
 - Nuclear density appeals must show cause for appeal and are subject to a core density assessment in accordance with this Specification.

307.03.04 – Execution

1) Continuity of Production

- While work is in progress on any project for which this Specification is in effect, and at the sole discretion of the Engineer, the plant may be limited to producing only the mix type required for that project.

2) Mix Production**• Preparation of Mineral Aggregate**

- The mineral aggregates shall be at as low a temperature as is consistent with proper mixing and compaction and in no case to exceed 165°C, without the Engineer's approval.

• Composition of Mixture

- The mineral aggregate, reclaimed asphalt pavement and/or additives (where applicable) and asphalt cement shall be mixed in such a manner to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.
- RAP shall be incorporated such that it does not come in direct contact with the burner flame.
- Plant emissions shall not exceed the limits set by Alberta Environment.

3) Hot Mix Asphalt Placing Temperature

- No hot mix asphalt shall be dispatched to the field unless the temperature, as issued by Environment Canada, is rising and meets the following minimum temperature requirements:
 - Lift thickness less than 50 mm, 7°C.
 - Lift thickness greater than 50 mm and less than 70 mm, 4°C.
 - Lift thickness greater than 70 mm, 2°C.
- A tolerance will be permitted for plant start-up.
- No surface lift asphalt mix shall be placed regardless of temperature or thickness until the road surface is 5°C or higher.
- For the asphalt base lifts ≥ 100 mm – Compaction requirements shall govern.
- If the asphalt placing temperature is not in compliance with 307.03.04.4 of the Specifications, the Contractor shall meet the following requirements:
 - Provide notification to the Roads, Pavements, Soil, and Asset Management (PSAM) dispatcher of their intention of placing asphalt at 24 Hour answering service at 403-268-1602.
 - Provide asphalt cores retrieved from the locations identified by the Engineer's representative in accordance with Table 31.
 - End product acceptance or rejection shall be in accordance with Section 307.03.05.
 - No compensation will be made to the Contractor for any additional coring.



4) Hours of Operation

- No loads of hot mix asphalt shall be dispatched from the plant after sunset or during hours of darkness unless loads can be placed and compacted in accordance with these specifications. Suitable artificial illumination is provided, all subject to the Engineer's approval.

5) Transportation of Hot Mix Asphalt

- Trucks shall be equipped with tarpaulins of sufficient weights and sizes to cover the entire open area of the truck box. Regardless of weather conditions, tarpaulins shall be used.
- Vehicles used to transport hot mix asphalt from the plant to the worksite shall have tight metal boxes previously cleaned of all foreign matter. The inside surface may be lightly lubricated with a soap solution just before loading. Excess lubrication shall not be permitted.
- For purposes of checking asphalt mixture temperatures, trucks shall have an accessible 10 mm diameter hole drilled into the driver's side of the truck box, at a distance of 0.3 metres from the bottom of the box and 150 mm clear of the reinforcing ribs.
- The speed and weight of hauling trucks shall be regulated so that, in the opinion of the Engineer, no damage will occur to any portion of the work underway. Any damage to the tack coat, prime coat or the existing surface caused by the Contractor's equipment shall be repaired by the Contractor at their own expense.

6) Hot Mix Asphalt Spreaders

- The spreading machine shall be self-propelled and capable of placing a uniform layer of asphalt mix to the depth and grades as shown on the plans or as indicated by the Engineer.
- The screed shall include a tamping bar or vibratory strike-off device for use when required. The screed shall strike off the mix to the depth and cross-section specified and produces a finished surface of uniform texture.
- Control of the screed shall be by automatic sensing devices. A sensor shall accomplish longitudinal control, which follows a string-line, ski, or other references. The grade sensor shall be moveable, and mounts provided to establish grade control on either side of the paver. A slope control sensor shall also be provided to maintain the proper transverse slope of the scree. Use automatic grade control for paving operations.

7) Hand Tools

- Only lutes shall be used during the spreading operation, and when the asphalt is worked by hand in areas the paver cannot reach.
- Tamping irons may be used to consolidate the material along structures inaccessible to the rollers. Mechanical compaction equipment, satisfactory to the Engineer, may be used instead of tamping irons.

- To check the finished surface, Contractors must provide and carry on each paving machine a 3 m straight edge and slope measuring level.

8) Pre-Levelling for Asphalt Concrete

- Pre-levelling of uneven surfaces over which asphalt concrete is to be placed shall be accomplished by using asphalt concrete level course placed with a grader, paver, hand or by a combination of these methods as directed by the Engineer.
- After placement, the asphalt concrete used for pre-levelling shall be compacted thoroughly with pneumatic-tired rollers.

9) Paving Operations

- The asphalt concrete shall be placed to the design thickness as shown on the contract drawings. On new construction where an established reference is lacking, a string-line reference will be required. Adjacent mats on the same lift shall be controlled by use of the grade sensor. No relaxation of the above procedure will be permitted without written approval of the Engineer.
- The spreader shall be operated in such a manner as to distribute the asphalt concrete mix to the proper cross-section, width and thickness without causing segregation of the mix. Segregated areas which may occur shall be corrected immediately. The forward motion of the spreader shall be controlled so that no irregularities in the pavement surface are caused by excessive speed. The mixture placement rate shall be uniform and coordinated with the production rate of the asphalt plant and avoid intermittent operation of the spreader.
- Any failure of the machine or operation to produce a smooth, uniformly dense mat, free from irregularities, shall be corrected immediately to the Engineer's satisfaction.

10) Areas Inaccessible to the Paving Machine

- Areas inaccessible to the paving machine may be paved by other methods, as approved by the Engineer.
- In small areas or where mechanical equipment is not practical, the mix may be spread and finished by hand. The asphalt mixture shall be dumped on the area and immediately distributed into place by shovels and spread with lutes in a loose uniform layer of uniform density and correct depth. The material must be handled so as to avoid segregation.

11) Compaction

- For all asphalt mixture types, the asphalt mixture shall be compacted to a minimum of 93 % of Maximum Relative Density (MRD).
- For Category B projects, the MRD Standard shall be the average of the three most recent tests.



- The Contractor shall supply sufficient compaction equipment to to:
 - Provide a compaction rate that will be sufficient for, or exceed the placing rate of the spreader.
 - Ensure the specified compaction is attained before the temperature of the mat falls below 80°C.

12) Longitudinal and Transverse Joints

- Longitudinal and transverse joints shall be made in a manner consistent with industry standards. Coarse aggregate removed from the hot mix during joint preparation shall not be broadcast onto the mat.
- Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 150 mm, and transverse joints shall be offset at least 2 m.
- Longitudinal joints shall not be located within travel lanes unless approved by the Engineer.
- Edges, where additional pavement is to be placed, shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.
- The exposed edges of all cold asphalt joints and the face of the concrete curb and gutter shall be cleaned and painted with a thin coat of asphalt tack.
- At the end of each day's paving of the surface course and upper lift of the base course mix, the uncompleted paving mats shall be provided with vertically cut transverse joints. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to ensure a thorough and continuous bond between the old and new surfaces.

13) Opening to Traffic

- Prior to opening to traffic, paving mats shall be sufficiently cool to resist deformation or surface scuffing.
- At the sole discretion of the Engineer, additional means of cooling (e.g., application of water) to completed pavements may be required prior to opening to traffic.
- At the sole discretion of the Engineer, traffic may be prohibited from travelling on newly paved surfaces for any length of time deemed necessary.

307.03.05 – End Product Acceptance or Rejection

1) General

- The Contractor shall provide a finished product conforming to the quality and tolerance requirements of this Specification. Where no tolerances are specified, the standard of workmanship shall be in accordance with accepted industry standards.

- Acceptance of any Lot at full payment will occur if there are no obvious defects and the Lot mean results for asphalt content, pavement density, air voids and thickness meet or exceed the specified tolerances.
- Unit price reductions will only be applied based on full acceptance testing in accordance with Table 30: Post-Production Quality Control Requirements.

2) Asphalt Content

- The Lot Mean Asphalt Content must be within ± 0.30 % of the approved JMF value for full payment.
- Payment adjustments for asphalt content are as follows:

TABLE 32: PAYMENT ADJUSTMENT FACTORS FOR ASPHALT CONTENT

Asphalt Content Deviation form JMF Value (%)	Payment Adjustment Factor
± 0.30 or less	1.00
± 0.31 to ± 0.50	As per Chart A
Greater than ± 0.50	Reject ¹

¹Subject to removal and replacement at the discretion of the Engineer.

3) Pavement Compaction

- For full or increased payment, the Lot Mean Pavement Compaction must be equal to or greater than 93 % of the Lot Mean Maximum Relative Density.
- Payment adjustments for pavement compaction are as follows:

TABLE 33: PAYMENT ADJUSTMENT FACTORS FOR PAVEMENT COMPACTION

Pavement Compaction % of Maximum Relative Density	Payment Adjustment Factor
93.5 to 95.5 (Note 1)	1.02 (Note 2)
93.0 to 93.4	1.00
90.0 to 92.9	As per Chart B
Less than 90.0	Reject (Note 3)

Note 1: Where no individual test result is less than 93 %, otherwise the payment adjustment factor is 1.00.

Note 2: For Category A Projects only.

Note 3: Subject to removal and replacement at the discretion of the Engineer.

4) Air Void Content

- For full payment, the Lot Mean Air Voids must be within ± 1.0 % of the JMF value, as specified in section 307.03.02 – Products.



- Payment adjustments for air void content are described in Table 34: Payment Adjustment Factors for Air Void Content below.

TABLE 34: PAYMENT ADJUSTMENT FACTORS FOR AIR VOID CONTENT

Air Void Content % Deviation from JMF Value	Payment Adjustment Factor
Less than 1.0	1.00
1.0 to 2.0	As per Chart C
Greater than 2.0 (Lower Lifts)	0.80
Greater than 2.0 (Upper Lifts)	0.60

5) Thickness (New Construction and Top Lift Only)

- Pavement of any type deficient in thickness by more than 6% shall be removed and replaced by pavement of specified thickness at the Contractor’s expense.
- The Lot Mean Thickness for any Lot will be determined based on the acceptance cores described in Table 31: Acceptance Testing Requirements - Category A & B Projects Core thickness shall be determined in accordance with ASTM D 3549.
- If the deficiency of any individual core exceeds 6 %, additional cores may be extracted in the proximity to the core of excessive deficiency to identify the extremities of the pavement area subject to be removed and replaced. The Contractor shall pay for such additional coring.
- For full payment, the Lot Mean Thickness must not be deficient by greater than 2%.
- Payment adjustments for thickness are as follows:

TABLE 35: PAYMENT ADJUSTMENTS FOR THICKNESS

Thickness Deficiency (% of Specified Thickness)	Payment Adjustment Factor (Note 1)	
	Total Thickness (Single or Multiple Lifts)	Top Lift Thickness (Multiple Lifts)
2 % or Less	1.00	1.00
2 % to 6 % Deficient	As Per Chart D	As Per Chart D
More than 6 % Deficient	Reject (Note 2)	Reject (Note 2)

Note 1: A single Thickness Payment Adjustment Factor shall be applied, Total Thickness or Top Lift Thickness, whichever results in the greatest adjustment.

Note 2: Subject to removal and replacement at the discretion of the Engineer.

6) Smoothness

- The completed asphalt concrete surface shall be true to the dimensional and tolerance requirements of the specifications and drawings. Unless detailed otherwise in the contract documents, the tolerances in both profile and crown are:
 - Base Course - 10 mm in 3 m.
 - Surface Course - 5 mm in 3 m.

7) Segregation

- The finished surface shall have a uniform texture and be free of segregated areas. A segregated area is defined as an area of the pavement where the texture differs visually from the texture of the surrounding pavement.
- The Engineer shall evaluate all segregation to determine repair requirements.
- The severity of segregation shall be rated as follows:
 - Slight - The matrix of asphalt cement and fine aggregate is in place between the coarse aggregate particles; however, there is more stone in comparison to the surrounding acceptable mix.
 - Moderate - Significantly more stone than the surrounding mix and exhibit a lack of surrounding matrix.
 - Severe - Appears as an area of very stony mix, stone against stone, with very little or no matrix.
- Segregated areas shall be repaired by the Contractor as directed by the Engineer. The following methods of repair are identified.
 - Slight - squeegee asphalt to completely fill the surface voids.
 - Moderate - slurry seal for full mat width.
 - Severe - removal and replacement or overlay.
- All repairs shall be regular in shape and finished using good workmanship practices to provide an appearance acceptable to the Engineer.
- Any other methods of repair proposed by the Contractor will be subject to the approval of the Engineer.
- The Contractor shall carry out repairs at their expense.

307.03.06 – Measurement and Payment

1) Measurement

- Asphalt Concrete - Marshall supplied will be measured in square metres or tonnes of material placed, as detailed in the Tender Form.

- The Unit Price for Asphalt Concrete – Marshall shall be full compensation for all materials, labour, tools, equipment and incidentals necessary to complete the work in accordance with these specifications.
- The material shall be scaled and recorded by the Contractor on duplicate weight slips. Weight slips must be supplied at delivery, and a copy must be provided to the Owner.
- The weight scale shall be inspected and certified by Weights and Measures Inspection Services of the Federal Department of Consumer and Corporate Affairs, at the Contractors' expense and as often as the Engineer may direct.

2) Payment

The Unit Price applicable to each Lot quantity of asphalt concrete will be calculated as follows:

$$\text{LOT UNIT PRICE} = \text{CONTRACT UNIT PRICE} \times \text{PA}_{\text{AC}} \times \text{PA}_{\text{COM}} \times \text{PA}_{\text{AV}} \times \text{PA}_{\text{T}}$$

Where:

PA_{AC} = Asphalt Content Payment Adjustment

PA_{COM} = Compaction Payment Adjustment

PA_{AV} = Air Void Payment Adjustment

PA_{T} = Thickness Payment Adjustment

For subdivision development Category B Projects, the Unit Price for asphalt concrete will be calculated based on an assumed price of \$150.00 per tonne.

3) Determination of Pavement Smoothness

The City Engineer will determine major Road Smoothness Specification "A" or "B".

- The finished pavement surface shall be tested by The City of Calgary to determine the longitudinal profile and compute the International Roughness Index's (IRI) of each driving lane. Left and Right wheel path IRI's will be averaged to produce the Mean IRI or Mean International Roughness Index (MIRI). The Mean IRI will be used to determine acceptance limits and payment adjustments.
- Each lane of the project will be profiled and divided into Lots. A Lot is defined as 1 km (1 000 m) in length of the final pavement surface. Partial Lots less than 100 m will be included as part of the previous Lot, and partial Lots greater than 100 m will be used as fractions to determine acceptance and payment adjustments as required.
- Lane lengths of less than 300 m will not be subject to the smoothness specification.
- Sections that will be filtered and not included in the determination of final acceptability or payment adjustments include all traffic-controlled intersections, railway crossings; bridge decks; tie-ins; and required run-in or run-out distances for profiling vehicle sensor stabilization. Sections will be filtered at the time of performing final profiling. A preceding or exiting distance

of at least 5 m, not to exceed 10 m, is included at the beginning and the end of each filtered section. The preceding and exiting filtered distances will be measured from the beginning of the filtered section to the front axle of the test vehicle when entering the filtered section and from the end of the filtered section to the rear axle of the test vehicle when exiting the filtered section. Speed file will be enabled to filter any low-speed sections during final profiling. The final smoothness of these filtered areas, including new pavement construction, overlay projects and tie-ins to existing sections will be assessed individually and at The City Engineer's discretion.

- In areas where the existing curb and gutter profile or non-City owned or controlled utility manhole elevations are inconsistent and may affect the final smoothness of the pavement, consideration will be given upon receiving written notice from the Contractor before final top lift or overlay paving commences. The Contractor is expected to use due diligence in attaining smoothness requirements, and correct/regulate for minor inconsistencies (0 to 20 mm above) along the lip of gutter profiles and blend in the surface areas around all manholes without excessive roughness. Sections or areas will be assessed individually and at The City Engineer's discretion.
- Pavement surface profiling may be performed both before and after project completion. Quality assurance will then be assessed by comparing the before and after measurements and determining the overall improvement achieved. Considerable improvement of pavement smoothness should be evident. If deficient, this will become a significant factor in the final acceptance of the project.
- For the measuring process, if required, the Contractor shall provide The City with a chalk guideline in the centre or edge of all driving lanes immediately prior to measurement.

4) Acceptance Limits Mean IRI (MIRI) - Lots

- The acceptance limit for each lane will be determined by the following:
 - The MIRI value will be used to determine if the Lot or Partial Lot will be accepted and if it will be subject to any payment adjustment.
 - The Lot or Partial Lot MIRI will not exceed 2.50 for "A" and 2.90 for "B" Major Roads.
 - No apparent defects, including roller marks, tire marks, cracking or tearing, excessive bleeding, surface segregation.
- Lot Assessment and the final acceptance of each Lot will be at The City Engineer's discretion.



TABLE 36: PAYMENT ADJUSTMENTS FOR MAJOR ROADS BASED ON SMOOTHNESS SPECIFICATIONS “A”

Lot Mean IRI (m/km)	Payment Adjustment
<0.81	+\$1000
0.81-0.90	+\$800
0.91-1.00	+\$400
1.01-1.10	+\$200
1.11 -1.20	+\$100
1.21-1.60	0
1.61-1.70	-\$100
1.71-1.80	-\$200
1.81-1.90	-\$400
1.91-2.00	-\$600
2.01-2.10	-\$800
2.11-2.20	-\$1,000
2.21-2.30	-\$1,200
2.31-2.40	-\$1,500
2.41-2.50	-\$2,000
>2.50	-\$2,500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

5) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “A” Major Roads

- Localized roughness will be determined using the evaluation software TxDOT Designation: Tex-1001-S as provided in ProVAL 2.7 and later versions.
- The software will:
 - Produce a single averaged wheel path profile.
 - Apply a 10 m moving average filter to the single average wheel path profile.
 - Determine the difference between the averaged wheel path and the 10 m moving average filtered profiles for every profile point.
 - Identify deviations greater than 0.9 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).
- Each deviation between:
 - 0.90 – 1.09 cm will result in a \$200 penalty.
 - 1.10 – 1.19 cm will result in a \$300 penalty
 - 1.20 – 1.29 cm will result in a \$400 penalty.

- 1.30 – 1.39 cm will result in a \$500 penalty.
- 1.40 – 1.49 cm will result in a \$600 penalty.
- 1.50 – 1.59 cm will result in a \$800 penalty.
- 1.60 – 1.69 cm will result in a \$1000 penalty.
- 1.70 – 1.79 cm will result in a \$1200 penalty.
- 1.80 cm and above will result in a \$1500 penalty and be subject to remedial work.

Individual areas of localized roughness will be established by a linear lane length of not greater than 3m per deviation as per Tex-1001-S analysis. Where multiple areas of localized roughness occur within a 3 m linear lane length, the resulting penalty will be considered from the most severe deviation. Deviations with a lane length greater than 3m will be split to establish multiple deviations”.

Remedial work will be subject to review and approval by The City Engineer.

No positive payment adjustment for corrective work to meet localized roughness limits will be applied.

6) Payment Adjustments for “B” Major Road - Lots

TABLE 37: PAYMENT ADJUSTMENTS FOR MAJOR ROADS BASED ON SMOOTHNESS SPECIFICATIONS “B”

Lot Mean IRI (m/km)	Payment Adjustment
<0.81	+\$1 000
0.81-0.90	+\$800
0.91-1.00	+\$600
1.01-1.10	+\$400
1.11-1.20	+\$200
1.21 -1.30	+\$100
1.31-1.70	0
1.71-1.80	-\$100
1.81-1.90	-\$200
1.91-2.00	-\$400
2.01-2.10	-\$600
2.11-2.20	-\$800
2.21-2.40	-\$1 000
2.41-2.60	-\$1 200
2.61-2.80	-\$1 500
2.81-2.90	-\$2 000
>2.90	-\$2 500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

7) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “B” Major Roads

Localized roughness will be determined using the evaluation software TxDOT Designation: Tex-1001-S as provided in ProVAL 2.7 and later versions.

The software will:

- Produce a single averaged wheel path profile.
- Apply an 8 m moving average filter to the single average wheel path profile.
- Determine the difference between the averaged wheel path and the 8 m moving average filtered profiles for every profile point.
- Identify deviations greater than 1.0 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).

Each deviation between:

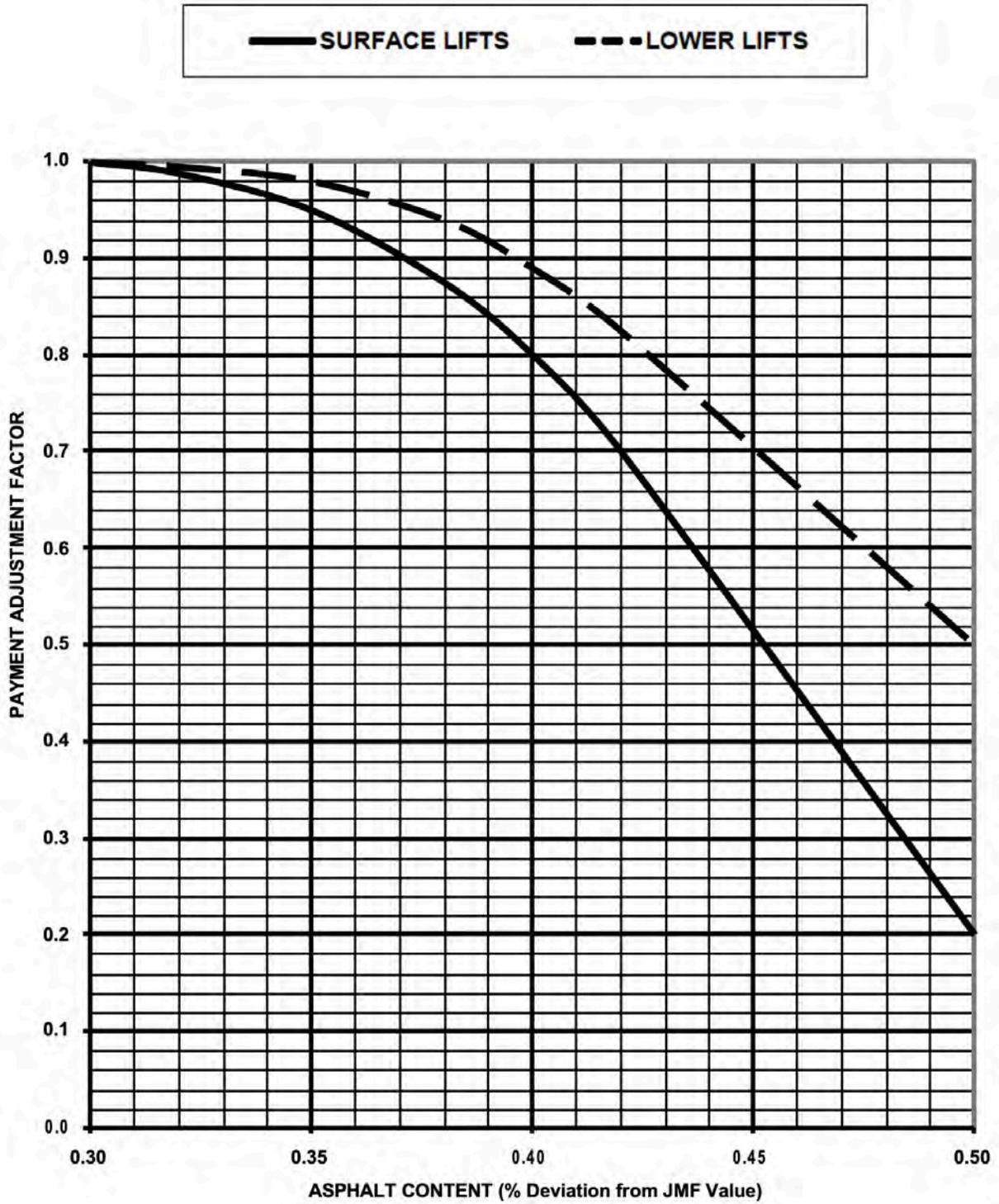
- 1.00 – 1.19 cm will result in a \$200 penalty.
- 1.19 – 1.29 cm will result in a \$300 penalty.
- 1.30 – 1.39 cm will result in a \$400 penalty.
- 1.40 – 1.49 cm will result in a \$500 penalty.
- 1.50 – 1.59 cm will result in a \$600 penalty.
- 1.60 – 1.69 cm will result in a \$800 penalty.
- 1.70 – 1.79 cm will result in a \$1000 penalty.
- 1.80 – 1.89 cm will result in a \$1200 penalty.
- 1.90 cm and above will result in a \$1500 penalty and be subject to remedial work.

Individual areas of localized roughness will be established by a linear lane length of not greater than 3m per deviation as per Tex-1001-S analysis. Where multiple areas of localized roughness occur within a 3m linear lane length, the resulting penalty will be considered from the most severe deviation. Deviations with a lane length greater than 3 m will be split to establish multiple deviations.

Remedial work will be subject to review and approval by The City Engineer.

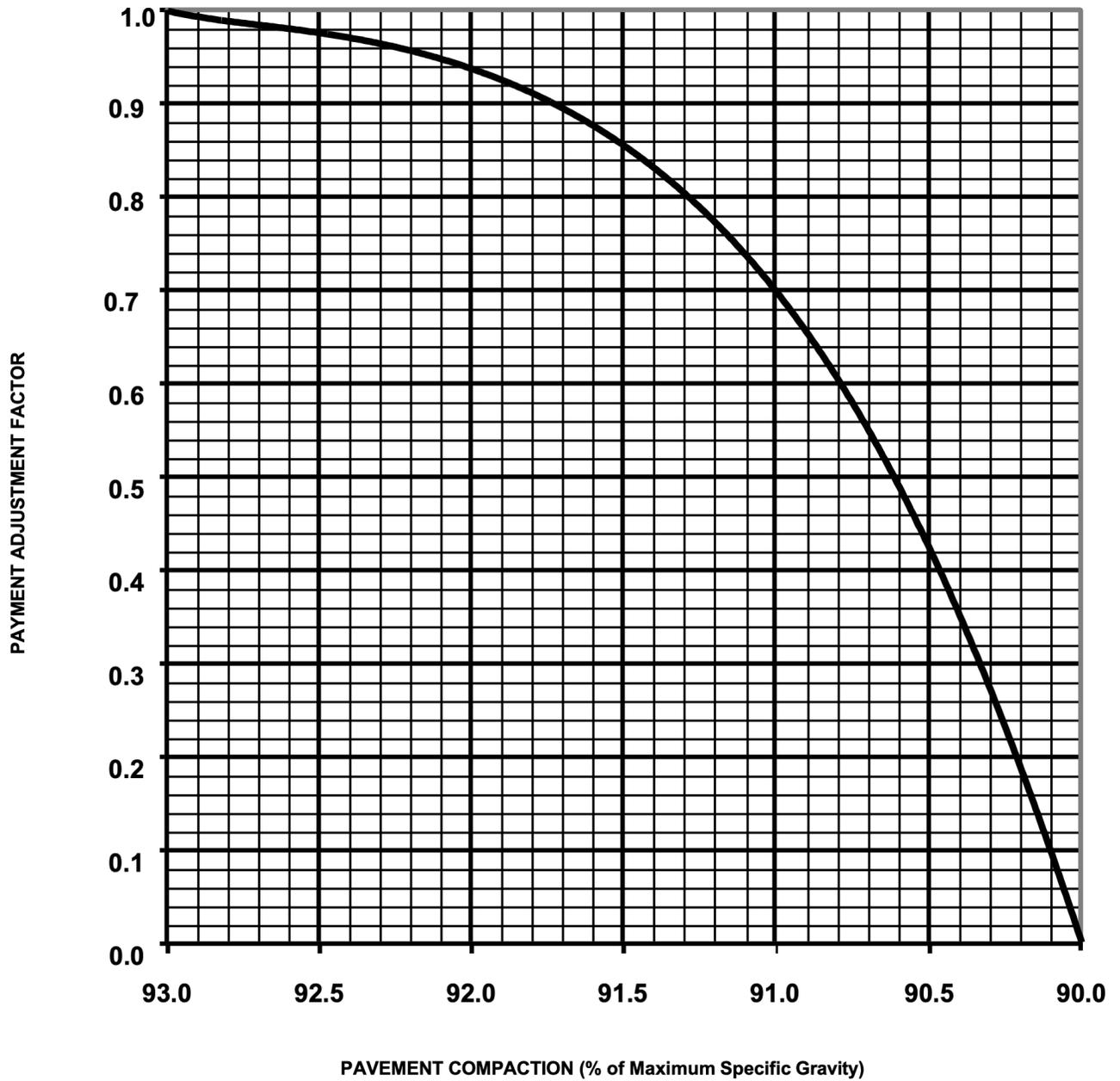
No positive payment adjustment for corrective work to meet localized roughness limits will be applied.

**CHART A ASPHALT CONTENT
PAYMENT ADJUSTMENT FACTOR**

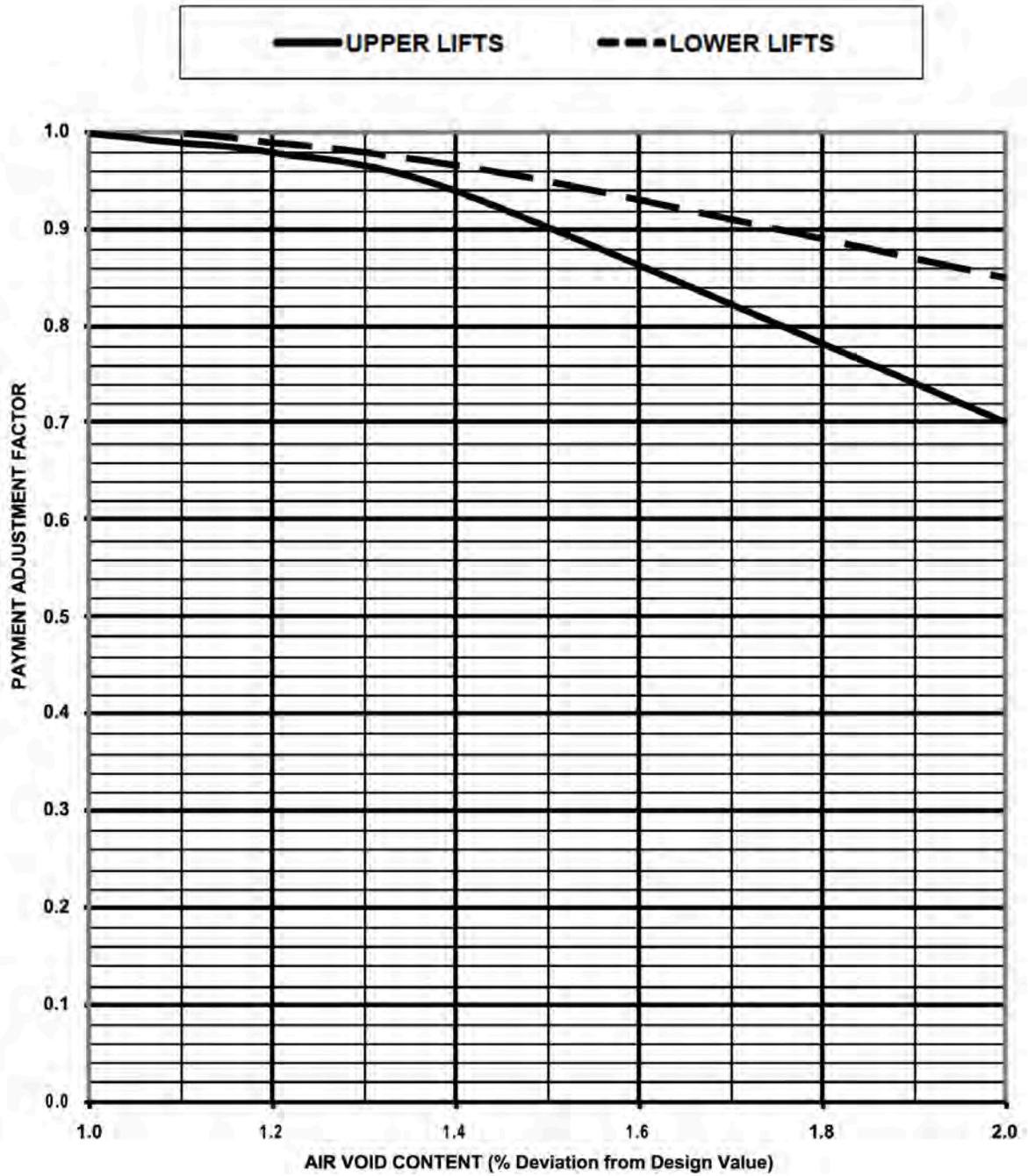




**CHART B COMPACTION
PAYMENT ADJUSTMENT FACTOR**

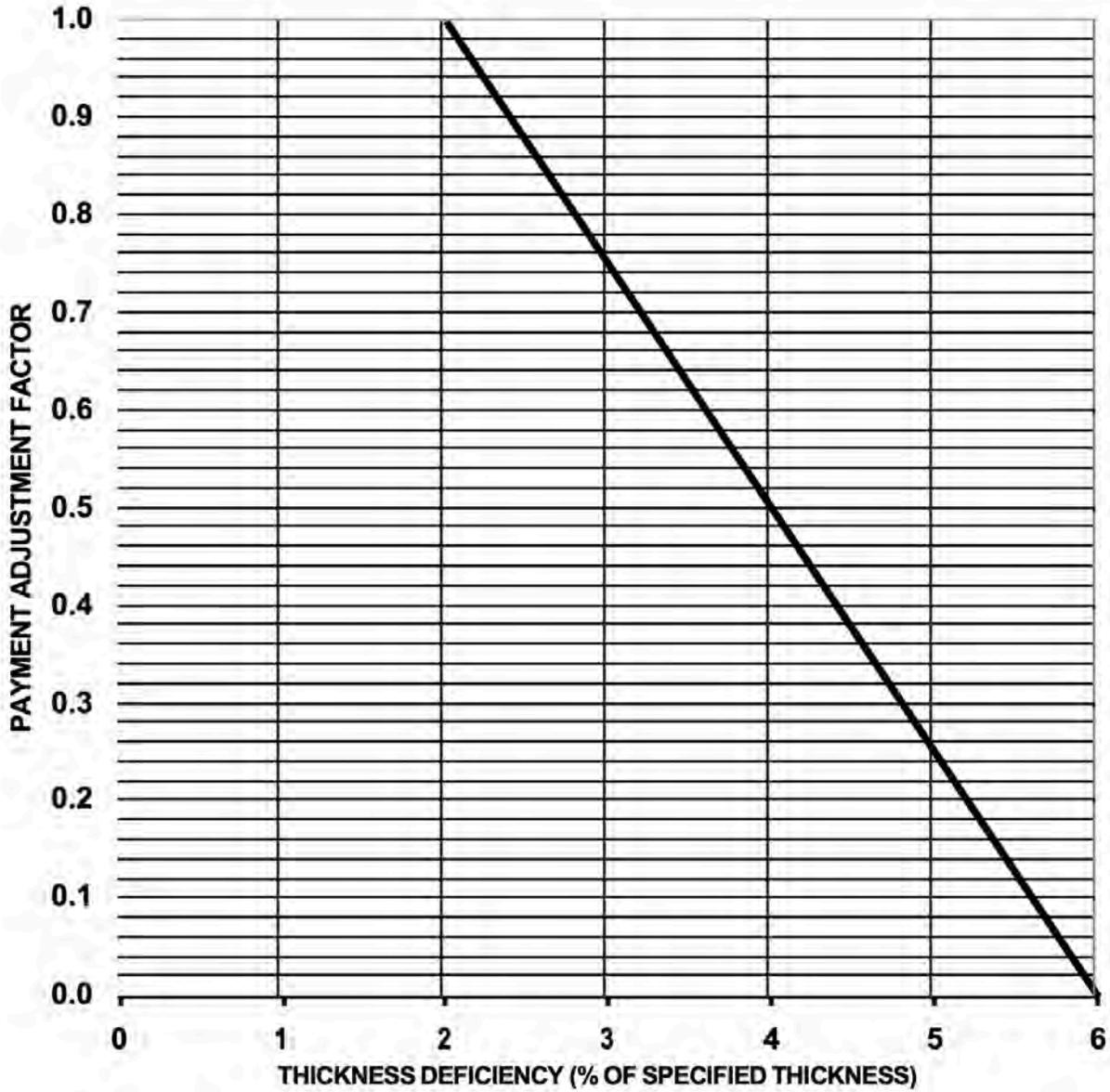


**CHART C AIR VOID CONTENT
PAYMENT ADJUSTMENT**





**CHART D AVERAGE THICKNESS
PAYMENT ADJUSTMENT FACTOR**



307.04.00 – Stone Matrix Asphalt

307.04.01 – General

1) Description

This section specifies the requirements for the supply of Stone Matrix Asphalt (SMA) paving.

This specification describes the mix property criteria and construction requirements for Stone Matrix Asphalt (SMA).

The work includes the supply of aggregates and asphalt binder, additives and liquid anti-strip, where applicable; asphalt plant mixing, transporting, placement finishing and compaction to all requirements of this specification.

The work includes all materials certification, quality control, verification and mix design testing, analysis and reporting to be completed as required in this specification.

2) Related Work

- Asphalt Binder – please refer to section 307.01.00 – Asphalt Binder.

3) Definitions

Please refer to section Specification Definitions.

307.04.02 – Products

1) Materials

- Asphalt Binder – please refer to section 307.01.00 – Asphalt Binder.
- Aggregates:
 - Coarse aggregate is aggregate retained on the 5.0 mm sieve; fine aggregate passes the 5.0 mm sieve.
 - Aggregate materials shall be crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps cementation, organic material, frozen material, and other deleterious materials.
 - Gradations to be within limits specified when tested to ASTM C-136 and ASTM C-117 with sieve sizes to CAN/CGSB 8-GP-2M rather than ASTM E11.
 - Aggregate shall be processed to meet the following requirements:
 - Natural fines shall be pre-screened and stockpiled with not more than 10 % of material retained on the 5.0 mm sieve and 100 % passing the 10.0 mm sieve.
 - Aggregate delivered to the crushing plant shall be pre-screened and contain no more than 5 % passing the 5.0 mm sieve.
 - Crushed aggregates shall be separated and stockpiled in accordance with the following:



- Coarse fraction to contain no more than 40 % of material passing the 5.0 mm sieve.
- Fine fraction or manufactured sand contains no more than 20 % of material retained on the 5.0 mm sieve.
- o Physical properties of aggregates to meet the requirements in Table 38 below.

TABLE 38: AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

PROPERTY	TEST STANDARD	REQUIREMENT
Los Angeles Abrasion, Grading B (% Loss)	C131	30 max.
Magnesium Sulphate Soundness (% Loss) Coarse Aggregate: Fine Aggregate:	C88	12.0 max. 12.0 max.
Lightweight Particles (%)	C123	1.5 max.

- o Blended Aggregate Requirements:
 - Aggregate Gradation Requirements, including RAP, for SMA mixtures, to meet the requirements of Table 39 below.

TABLE 39: BLENDED AGGREGATE GRADATION REQUIREMENTS

SIEVE SIZE (mm)	Nominal Maximum Aggregate Size Percent Passing					
	20 mm		12.5 mm		10 mm	
	Min	Max	Min	Max	Min	Max
25	100					
20	90	100	100			
12.5	50	88	90	100	100	
10.0	25	60	50	80	70	95
5.0	20	28	20	35	30	50
2.5	16	24	16	24	20	30
0.080	8.0	11.0	8.0	11.0	8.0	12.0

- Coarse Aggregate Fracture: Of coarse fraction (retained on 5.0 mm sieve size), the percentage of fractured particles shall be 95 percent by mass.
- Flat and Elongated Particles: Of coarse fraction (retained on 5.0 mm sieve size), the percentage of flat and elongated particles greater than a 5:1 ratio shall be by mass less than 10.0 percent, and particles greater than a 3:1 ratio shall be by mass less than 20 percent.

- Manufactured Sand: Of total fine fraction (passing 5.0 mm sieve size), manufactured sand shall be 70 percent by mass.
- For mixes incorporating RAP, 50 % of the RAP sand portion shall be considered manufactured sand.
- The sand equivalent value (ASTM D2419, Mechanical Method) determined for the fine aggregate portion shall be a minimum of 45 percent.
- The fine aggregate angularity (ASTM C1252 Un-compacted Void Content) of minus 2.5 mm fraction shall be a minimum of 45 percent.
- Reclaimed Asphalt Pavement (RAP) may be used as follows:
 - A RAP portion of up to 20 % binder contribution, as a percent of the total binder content, will be allowed without the need for a binder rheology assessment.
 - Other material additives will be considered subject to submission of proposed binder rheology and/or aggregate assessment program and the Engineer's approval.

2) Stabilizer

- A cellulose fibre stabilizer shall be added to the mixture. The dosage rate shall be 0.3 % by total mixture mass and sufficient to prevent draindown.
- Cellulose fibres may be in loose or pellet form with properties conforming to Table 40 below.



TABLE 40: CELLULOSE FIBRE QUALITY REQUIREMENTS

Property	Requirement
Sieve Analysis	
Method A – Alpine Sieve ¹ Analysis	
Fibre Length	6 mm (0.25 in) maximum
Passing 0.150 mm (No. 100) sieve	70 ± 10 %
Method B – Mesh Screen ² Analysis	
Fibre Length	6 mm (0.25 in) maximum
Passing 0.850 mm (No.20) sieve	85 ± 10 %
0.425 mm (No.40) sieve	65 ± 10 %
0.106 mm (No. 140) sieve	30 ± 10 %
Ash Content ³	18 ± 5 % non-volatiles
pH ⁴	7.5 ± 1.0
Oil Absorption ⁵	5.0 ± 1.0 (times fibre mass)
Moisture Content ⁶	Less than 5 % (by mass)

References ^{1,2,3,4,5,6} as described in AASHTO Provisional Standard MP 8-04, "Standard Specification for Designing Stone Matrix Asphalt (SMA)".

3) Mix Design

- An asphalt mix design must be prepared and submitted to the Engineer for review and approval at least one week before the Work. The Contractor shall use qualified engineering and testing services licensed to practice in the Province of Alberta.
- The mix design shall be performed in accordance with AASHTO Provisional Standard MP 8, Designing Stone Matrix Asphalt (SMA).
- Design of Mix:
 - Gyrotory Compaction Requirements: 75 gyrations
- Include the following data with mix design submission:
 - Aggregate specific gravity and asphalt absorption.
 - Sand equivalent, coarse aggregate fracture, flat and elongated particles, and percent manufactured sand values.
 - Asphalt cement supplier/refinery, specific gravity and mixing and compaction temperatures, based on asphalt cement's temperature–viscosity properties.
 - Job mix formula including aggregate gradation and blending proportions, and design asphalt content.

- Maximum Relative Density at each trial asphalt content.
- Data to satisfy the requirements of the following:

TABLE 41: MIXTURE PHYSICAL PROPERTY REQUIREMENTS

Property	Requirement
Air Voids (%)	3.8 – 4.2
Voids in Mineral Aggregate (%)	17 min.
VCA MIX (%) ¹	< VCA DRC ¹
Tensile Strength Ratio (%) ³	80 min
Draindown (%)	0.30 max

¹VCA MIX - Voids in Coarse Aggregate (Mix)

²VCA DRC - Voids in Coarse Aggregate (Dry Rodded Condition)

³Tested in accordance with AASHTO T283, including optional freeze cycle

4) Job Mix Formula

- Subject to approval by the Engineer, the aggregate proportioning (including RAP), target gradation, asphalt content and air void content from the Mix Design will become the Job Mix Formula for the supply of hot mix asphalt.
- Once established, no alterations to the Job Mix Formula will be permitted unless a new Job Mix Formula is submitted by the Contractor and approved by the Engineer.
- If the sum of any alterations to the Job Mix Formula is more than any one of the following limits, a new Mix Design shall be submitted for approval.
 - 5 % passing the 5.0 mm sieve size
 - 1% passing the 0.080 mm sieve size
 - ± 0.3 % asphalt content
 - Any alteration to the Job Mix Formula shall not result in properties that do not meet the requirements of this Specification.
 - Properties of the revised Job Mix Formula shall conform to all requirements of this specification.

5) Production Tolerances

- All mixtures shall be supplied to the project within the range of tolerances as specified.
- Asphalt cement content: ± 0.3 % of Job Mix Formula value.
- Temperature: Mix temperature at point of plant discharge shall not vary from that specified in the Job Mix Formula by more than $\pm 10^{\circ}\text{C}$.
- Tolerance for Aggregate Gradation shall not be beyond the limits found in Table 42 below.

TABLE 42: AGGREGATE GRADATION

AGGREGATE PASSING Sieve Size (mm)	TOLERANCE (% by mass)
Max. size to 5.0	± 4.0
2.5 & 1.25	± 3.0
0.630, 0.160 & 0.315	± 2.0
0.080	± 1.0

- Air Voids: ± 1.0 % of the Job Mix Formula value.
- Mixture Properties as per requirements identified in Table 41.
- Moisture in Mix: Maximum permissible moisture at the point of plant discharge is 0.3 % by mass of mix.

307.04.03 – Sampling and Testing

1) General

- The Engineer shall have access to all production processes and materials used for the work to monitor material quality as often as deemed necessary. Such inspection and testing shall not in any way relieve the Contractor of the responsibility for meeting the requirements of this specification.
- At least three (3) weeks before commencing work, the Engineer shall be advised of the proposed source of aggregates, access shall be provided for sampling, and samples of asphalt cement shall be provided in accordance with section 307.01.00 – Asphalt Binder.

2) Quality Control

- Quality control is the Contractor's responsibility throughout every stage of the work, from aggregate processing to the final accepted product. Tests performed by the Engineer will not be considered quality control tests.
- The Contractor shall be responsible for the production of materials and construction that meet all specified requirements.
- All quality control shall be conducted by qualified personnel. The Contractor shall bear the cost of all quality control testing and consulting services.
- Pre-Production testing and sampling and minimum frequencies are described in Table 43 below.

TABLE 43: PRE-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirement	Test Standard	Minimum Frequency
Asphalt Cement Certification	-	One per Contract or for change in supplier (minimum once per year)
Aggregate Physical Properties Table 2.1.2.5	Table 2.1.2.5	Once per year, or for change in source
Crushed Coarse Aggregate Gradation Analysis and Fracture Content	ASTM C 136 ASTM D 5821	One for every 1 000 tonnes of each class of material processed into the stockpile, or one analysis for each material every production day when the production rate is less than 1 000 tonnes (Recommended)
Manufactured Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Natural Fine Aggregate Gradation	ASTM C 117 ASTM C 126	
Blend Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Reclaimed Asphalt Pavement (RAP) Asphalt Content and Extracted Aggregate Gradation	ASTM D 2172 ASTM C 117 ASTM C 136	One for every 500 tonnes delivered to stockpile, or one for each location when the delivery rate is less than 500 tonnes (Recommended)
Trial Mix Design	AASHTO	One per mix type every three years, or as required for a change in asphalt cement supply, aggregate gradation or aggregate source or as required by the Contract Specifications. ¹
Plant Calibration	-	As required

¹A laboratory/plant job mix formula verification is required each year when a trial mix design is not conducted.

- Post-Production testing, sampling, and minimum frequencies are described in Table 44: Recommended Post-Production Quality Control Requirements below.



TABLE 44: RECOMMENDED POST-PRODUCTION QUALITY CONTROL REQUIREMENTS

Quality Control Requirement	Test Standard	Minimum Frequency
Quality Control Requirements	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Asphalt Content and Aggregate Gradation)	ASTM D 6307 ASTM C 117 ASTM C 136	One for every 500 tonnes of each mix type supplied under this specification. ¹
Hot Mix Asphalt Volumetric Analysis (Laboratory Compacted Density and Void Properties) where Asphalt Content and Aggregate Gradation are known.	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 3203 AASHTO T312	One for every Lot of each mix type supplied under this specification. ¹
Quality Control Charts (including 3 test running average for Binder Content, Aggregate Gradation, Laboratory Compacted Density and Void Properties)	-	For each hot mix analysis. Test results and updated 3 test running average to be submitted to the Engineer as they become available.
Hot Mix Asphalt Temperature	-	Minimum frequency not specified.
Cold Feed Aggregate Analysis	ASTM C117 ASTM C 136	Minimum frequency not specified.
Maximum Relative Density of Hot Mix Asphalt	ASTM D 2041	Minimum frequency not specified.
Compaction Monitoring (Core or Nuclear Density)	ASTM D 2726 ASTM D 2950	Minimum frequency not specified. ²

¹Where an individual test indicates non-compliance, another test shall be initiated immediately.

²Coring is subject to the approval of the Engineer.

- Pre-Production Quality Control test data as specified in Table 43: Pre-Production Quality Control Requirements shall be reported to the Engineer one week prior to commencing the project or as requested.
- Post-Production Quality Control test data as specified in Table 44: Recommended Post-Production Quality Control Requirements shall be reported to the Engineer daily as the Work proceeds.

3) Quality Control Compliance with Specified Tolerances

- Asphalt Content, Aggregate Gradation and Mixture Properties
- The test data derived by Post-Production Quality Control mix testing, described in section 307.04.03 – Sampling and Testing, shall be compared to the tolerances outlined in section 307.04.02 – Products. The Contractor shall suspend mix production when the three (3) test running average for any property is outside of the specified tolerance limits.

- Supply shall not start again until demonstrated corrective action has been taken.
- Hot Mix Asphalt Temperature
- Plant mix that does not meet the temperature requirements of section 307.04.02 – Products at the point of plant discharge shall be subject to rejection at the Engineer's discretion.

4) Acceptance Sampling and Testing

- Within this specification, certain requirements, limits and tolerances are specified regarding supplied materials and workmanship. Compliance with these requirements shall be determined from acceptance testing as described in this section.
- Acceptance testing is the responsibility of and is performed at the sole discretion of the Engineer.
- Initial acceptance testing will be undertaken free of cost to the Contractor.
- Sampling and acceptance testing is described in Table 45: Acceptance Testing Requirements – Category A & B Projects below.

TABLE 45: ACCEPTANCE TESTING REQUIREMENTS – CATEGORY A & B PROJECTS

Acceptance Testing	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Binder Content, Aggregate Gradation, Laboratory Compacted Density, Maximum Relative Density and Void Properties)	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 2041 ASTM D 3203 AASHTO T 312	For each mix type, one test for each 3 500 m ² of placement, or three tests per lot, whichever is greater. ¹
Compaction Testing (Core Density) and Thickness Determination. Nuclear Density Testing for Category B Project Compaction subject to the approval of the Engineer	ASTM D 2726 ASTM D 3549	One test for each 2 000 m ² of placement for each mix type, or three tests per lot, whichever is greater.
Hot Mix Asphalt Temperature	-	No minimum frequency.

¹For Category "B" Projects, the Engineer may, at their discretion, acquire the minimum number of mix samples but reduce the number of tests to a minimum of one. Should non-compliance be indicated by the sample(s) tested, the Engineer reserves the option to test the remaining samples.

- Acceptance Sampling Procedures:
 - Loose mix samples shall be acquired from the work site in accordance with Alberta Transportation Test (ATT) procedure ATT-37. Auger samples may be used if approved by both the Engineer and the Contractor.
 - The timing of mix sampling shall be stratified, with each sample representing a similar production quantity.
 - Core locations will be selected using stratified random sampling procedures, as described in ATT-56 Part II. The Lot will be divided into segments meeting or

exceeding the minimum frequency in Table 45 and approximately equal area. A test site will be located in each segment using random numbers to determine the longitudinal and transverse coordinates.

- Areas within 3 m of transverse joints or 0.3 m of a mat edge are excluded from compaction acceptance sampling and testing.
- Reporting Protocols
 - Test reporting accuracy shall be as stipulated in the referenced test procedures, including:
 - Gradation to the nearest whole number, except the percent passing the 0.080 mm sieve, shall be reported to the nearest 0.1 %.
 - Binder content to the nearest 0.01 %
 - Air voids and compaction to the nearest 0.1 %
 - Thickness to the nearest whole mm.
 - Lot averages shall be reported to the same accuracy as test results.

5) Appeal of Acceptance Testing Results

- **General**

- The Contractor may appeal the acceptance testing results for Compaction Standard, Asphalt Content or Air Voids for any Lot subject to rejection or unit price reduction. The notice of appeal shall be in writing and submitted to the Engineer within 48 hours of receiving the acceptance testing results.
- Appeals will only be considered if cause can be shown and the requirements of Table 44: Recommended Post-Production Quality Control Requirements have been satisfied.
- Quality Control tests initiated after the Contractor's receipt of the acceptance test results will not be considered when evaluating cause for appeal.
- For Category "A" Projects, only Quality Control testing during production for the subject project will be considered when evaluating cause for appeal. For Category "B" Projects, Quality Control test results from production prior to the subject project may be considered when evaluating cause for appeal.

- **Asphalt Content Appeal**

- The Engineer shall develop a stratified random sampling plan with the same number of segments as the original number of samples for the subject Lot. A sufficient core sample will be acquired from each segment to enable asphalt content determinations.
- For asphalt content appeal testing, the testing shall be undertaken by an independent testing laboratory selected by the contractor and approved by the Engineer.

- The average of the appeal test results will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
- If the average appeal test result verifies that any unit price reduction or rejection applies for that Lot, the costs of the appeal sampling and testing will be borne by the Contractor. If the result shows that a penalty or rejection no longer applies, the sampling and appeal costs will be the Owner's responsibility.
- **Compaction Standard or Air Void Appeals**
 - The testing laboratory conducting the project acceptance sampling and testing will routinely retain companion samples sufficient to determine maximum relative density and/or SGC density.
 - For compaction standard or air void appeal testing, the Contractor will have the option for the testing to be done by the testing laboratory undertaking the project acceptance testing or an independent testing laboratory selected by the Engineer.
 - The average of the appeal tests will be used for acceptance and unit price adjustment and shall be binding on both the Owner and the Contractor.
 - If the new compaction standard verifies that any unit price reduction or rejection applies for that Lot, the Contractor will bear the appeal sampling and testing costs. If the result shows that a unit price reduction no longer applies, the appeal testing costs will be the Owner's responsibility.
 - If the new average air void content result verifies that any unit price reduction applies for that Lot, the Contractor will bear the costs of the appeal testing. If the results show that a unit price reduction no longer applies, the sampling and appeal costs will be the Owner's responsibility.
- **Core Density and Thickness Appeals**
 - Core density and thickness appeals will only be considered if a case can be made that the stratified random sampling plan was biased or testing was in error. Appeal cores shall be taken at a frequency of one per 1,000 m² area.
 - Acceptance shall be based solely on the results of the appeal core testing.
- **Nuclear Density Appeals**
 - Nuclear density appeals must show cause for appeal, and are subject to a core density assessment in accordance with this Specification.

307.04.04 – Execution

1) Continuity of Production

- During the period that work is in progress on any project for which this specification is in effect, and at the sole discretion of the Engineer, the plant may be limited to producing only the mix type required for that project.

2) Mix Production

- **Preparation of Mineral Aggregate**
 - The mineral aggregates shall be at as low a temperature as is consistent with proper mixing and compaction and in no case to exceed 165°C, without the Engineer's approval.
- **Composition of Mixture**
 - The mineral aggregate, reclaimed asphalt pavement and/or additives (where applicable) and asphalt cement shall be mixed in such a manner to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.
 - RAP shall be incorporated such that it does not come in direct contact with the burner flame.
 - Plant emissions shall not exceed the limits set by Alberta Environment.

3) Preparation for Paving

- The Contractor shall provide the Engineer with a minimum of six hours' notice of the intention to commence paving over any previously approved primed or tacked surface.
- The hot asphalt mixture shall be laid upon a dry, firm surface, true to grade and cross-section, and free from all loose or foreign material. No hot mix shall be placed on asphalt that has not sufficiently cooled or when the surface is wet, or when other conditions prevent proper spreading, finishing or compaction.
- If undercutting and subsequent backfill with asphalt concrete are done, the backfill operation shall be performed sufficiently in advance of the paving operation to allow the asphalt concrete time to cool down enough to support equipment.

4) Hot Mix Asphalt Placing Temperature

- No hot mix asphalt shall be dispatched to the field unless the temperature, as issued by Environment Canada, is rising and meets the following minimum temperature requirements:
 - Lift Thickness less than 50 mm, 7°C
 - Lift Thickness greater than 50 mm and less than 70 mm, 4°C
 - Lift Thickness greater than 70 mm, 2°C

- A tolerance will be permitted for plant start-up.
- No surface lift asphalt mix shall be placed regardless of temperature or thickness until the road surface is 5°C or higher.

5) Hours of Operation

- No loads of hot mix asphalt shall be dispatched from the plant after sunset or during hours of darkness unless loads can be placed and compacted in accordance with these specifications, and suitable artificial illumination is provided, all subject to the Engineer's approval.

6) Transportation of Hot Mix Asphalt

- Trucks shall be equipped with tarpaulins of sufficient weights and sizes to cover the entire open area of the truck box. Regardless of weather conditions, tarpaulins shall be used.
- Vehicles used to transport hot mix asphalt from the plant to the worksite shall have tight metal boxes previously cleaned of all foreign matter. The inside surface may be lightly lubricated with a soap solution just before loading. Excess lubrication shall not be permitted.
- For purposes of checking asphalt mixture temperatures, trucks shall have an accessible 10 mm diameter hole drilled into the driver's side of the truck box, at a distance of 0.3 m from the bottom of the box and 150 mm clear of the reinforcing ribs.
- The speed and weight of hauling trucks shall be regulated so that, in the opinion of the Engineer, no damage will occur to any portion of the work underway. Any damage to the tack coat, prime coat or the existing surface caused by the Contractor's equipment shall be repaired by the Contractor at their own expense.

7) Hot Mix Asphalt Spreaders

- The spreading machine shall be self-propelled and capable of placing a uniform layer of asphalt mix to the depth and grades as shown on the plans or as indicated by the Engineer.
- The screed shall include a tamping bar or vibratory strike-off device for use when required. The screed shall strike off the mix to the depth and cross-section specified and produces a finished surface of uniform texture.
- Control of the screed shall be by automatic sensing devices. A sensor shall accomplish longitudinal control, which follows a string-line, ski, or other references. The grade sensor shall be moveable, and mounts provided to establish grade control on either side of the paver. A slope control sensor shall also be provided to maintain the proper transverse slope of the screed. Use automatic grade control for paving operations.

8) Hand Tools

- Only lutes shall be used during the spreading operation, and when the asphalt is worked by hand in areas the paver cannot reach.

- Tamping irons may be used to consolidate the material along structures inaccessible to the rollers. Mechanical compaction equipment, satisfactory to the Engineer, may be used instead of tamping irons.
- To check the finished surface, Contractors must provide and carry on each paving machine a 3 m straight edge and slope measuring level.

9) Pre-Levelling for Asphalt Concrete

- Pre-levelling of uneven surfaces over which asphalt concrete is to be placed shall be accomplished using asphalt concrete level course placed with a grader, paver, hand, or by a combination of these methods as directed by the Engineer.
- After placement, the asphalt concrete used for pre-levelling shall be compacted thoroughly with pneumatic-tired rollers.

10) Paving Operations

- The asphalt concrete shall be placed to the design thickness as shown on the contract drawings. On new construction where an established reference is lacking, a string-line reference will be required. No relaxation of the above procedure will be permitted without the Engineer's written approval.
- The spreader shall be operated in such a manner as to distribute the asphalt concrete mix to the proper cross-section, width and thickness without causing segregation of the mix. Segregated areas which may occur shall be corrected immediately. The forward motion of the spreader shall be controlled so that no irregularities in the pavement surface are caused by excessive speed. The mixture placement rate shall be uniform and coordinated with the production rate of the asphalt plant and avoid intermittent operation of the spreader.
- Any failure of the machine or operation to produce a smooth, uniformly dense mat, free from irregularities, shall be corrected immediately to the Engineer's satisfaction.

11) Areas Inaccessible to the Paving Machine

- Areas inaccessible to the paving machine may be paved by other methods, as approved by the Engineer.
- In small areas or where mechanical equipment is not practical, the mix may be spread and finished by hand. The asphalt mixture shall be dumped on the area and immediately distributed into place by shovels and spread with lutes in a loose uniform layer of uniform density and correct depth. Material must be handled to avoid segregation.

12) Compaction

- For all asphalt mixture types, the asphalt mixture shall be compacted to a minimum of 93% of Maximum Relative Density (MRD).

- For Category “B” projects, the MRD Standard shall be the average of the three most recent tests.
- The Contractor shall supply sufficient compaction equipment to:
 - Provide a compaction rate that will be sufficient for, or exceed the placing rate of the spreader.
 - Ensure the specified compaction is attained before the temperature of the mat falls below 80°C.

13) Longitudinal and Transverse Joints

- Longitudinal and transverse joints shall be made in a manner consistent with industry standards. Coarse aggregate removed from the hot mix during joint preparation shall not be broadcast onto the mat.
- Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 150 mm, and transverse joints shall be offset at least 2 m.
- Longitudinal joints shall not be located within travel lanes unless approved by the Engineer or their designate.
- Edges, where additional pavement is to be placed, shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.
- The exposed edges of all cold asphalt joints and the face of the concrete curb and gutter shall be cleaned and painted with a thin coat of asphalt tack.
- At the end of each day’s paving of the surface course and upper lift of the base course mix, the uncompleted paving mats shall be provided with vertically cut transverse joints. Joints between old and new pavements or between successive days’ work shall be carefully made in such a manner as to ensure a thorough and continuous bond between the old and new surfaces.

14) Opening to Traffic

- Prior to opening to traffic, paving mats shall be sufficiently cool to resist deformation or surface scuffing.
- At the sole discretion of the Engineer, additional means of cooling (e.g. application of water) to completed pavements may be required prior to opening to traffic.
- At the sole discretion of the Engineer, traffic may be prohibited from travelling on newly paved surfaces for any length of time deemed necessary.



307.04.05 – End Product Acceptance or Rejection

1) General

- The Contractor shall provide a finished product conforming to the quality and tolerance requirements of this specification. Where no tolerances are specified, the standard of workmanship shall be in accordance with accepted industry standards.
- Acceptance of any Lot at full payment will occur if there are no obvious defects and the Lot mean results for asphalt content, pavement density, air voids and thickness meet or exceed the specified tolerances.
- Unit price reductions will only be applied based on full acceptance testing in accordance with Table 45: Acceptance Testing Requirements – Category A & B Projects.

2) Asphalt Content

For full payment, the Lot Mean Asphalt Content must be within $\pm 0.30\%$ of the approved JMF value, as specified in section 307.04.02 – Products.

Payment adjustments for asphalt content are as given in Table 46: Payment Adjustments for Asphalt Content.

TABLE 46: PAYMENT ADJUSTMENTS FOR ASPHALT CONTENT

Asphalt Content Deviation from JMF Value (%)	Payment Adjustment Factor
± 0.30 or less	1.00
± 0.31 to ± 0.50	As per Chart A
Greater than ± 0.50	Reject ¹

¹Subject to removal and replacement at the discretion of the Engineer.

3) Pavement Compaction

- For full or increased payment, the Lot Mean Pavement Compaction must be equal to or greater than 93 % of the Lot Mean Maximum Relative Density.
- Payment adjustments for pavement compaction are as given in Table 47: Payment Adjustments for Pavement Compaction.

TABLE 47: PAYMENT ADJUSTMENTS FOR PAVEMENT COMPACTION

Pavement Compaction % of Maximum Relative Density	Payment Adjustment Factor
93.5 to 95.5 ^{Note 1}	1.02 ^{Note 2}
93.0 to 93.4	1.00
90.0 to 92.9	As per Chart B
Less than 90.0	Reject ^{Note 3}

Note 1: Where no individual test result is less than 93 %, otherwise the payment adjustment factor is 1.00.

Note 2: For Category A Projects only.

Note 3: Subject to removal and replacement at the discretion of the Engineer.

4) Air Void Content

- For full payment, the Lot Mean Air Voids must be within ± 1.0 % of the JMF value, as specified in section 307.04.02 – Products.
- Payment adjustments for air void content as given in Table 48: Payment Adjustments for Air Void Content.

TABLE 48: PAYMENT ADJUSTMENTS FOR AIR VOID CONTENT

Air Void Content % Deviation from JMF Value	Payment Adjustment Factor
Less than 1.0	1.00
1.0 to 2.0	As per Chart C
Greater than 2.0 (Lower Lifts)	0.80
Greater than 2.0 (Upper Lifts)	0.60

5) Thickness (New Construction and Top Lift Only)

- Pavement of any type deficient in thickness by more than 6% shall be removed and replaced by pavement of specified thickness at the Contractor's expense.
- The Lot Mean Thickness for any Lot will be determined based on the acceptance cores described in Table 45: Acceptance Testing Requirements – Category A & B Projects. Core thickness shall be determined in accordance with ASTM D 3549.
- If the deficiency of any individual core exceeds 6%, additional cores may be extracted in the proximity to the core of excessive deficiency to identify the extremities of the pavement area subject to be removed and replaced. The Contractor shall pay for such additional coring.
- For full payment, the Lot Mean Thickness must not be deficient by greater than 2%.
- Payment adjustments for thickness are as follows:

TABLE 49: PAYMENT ADJUSTMENTS FOR THICKNESS

Thickness Deficiency (% of Specified Thickness)	Payment Adjustment Factor ^{Note 1}	
	Total Thickness (Single or Multiple Lifts)	Top Lift Thickness (Multiple Lifts)
2% or Less	1.00	1.00
2% to 6% Deficient	As Per Chart D	As Per Chart D
More than 6% Deficient	Reject ^{Note 2}	Reject ^{Note 2}



Note 1: A single Thickness Payment Adjustment Factor shall be applied, Total Thickness or Top Lift Thickness, whichever results in the greatest adjustment.

Note 2: Subject to removal and replacement at the discretion of the Engineer.

6) Smoothness

- The completed asphalt concrete surface shall be true to the dimensional and tolerance requirements of the specifications and drawings. Unless detailed otherwise in the contract documents, the tolerances in both profile and crown are:
 - Base Course - 10 mm in 3 m
 - Surface Course - 5 mm in 3 m

7) Segregation

- The finished surface shall have a uniform texture and be free of segregated areas. A segregated area is defined as an area of the pavement where the texture differs visually from the texture of the surrounding pavement.
- The Engineer shall evaluate all segregation to determine repair requirements.
- The severity of segregation shall be rated as follows:
 - Slight - The matrix of asphalt cement and fine aggregate is in place between the coarse aggregate particles; however, there is more stone than the surrounding acceptable mix.
 - Moderate - Significantly more stone than the surrounding mix and exhibit a lack of surrounding matrix.
 - Severe - Appears as an area of very stony mix, stone against stone, with very little or no matrix.
- Segregated areas shall be repaired by the Contractor as directed by the Engineer. The following methods of repair are identified.
 - Slight - squeegee asphalt to completely fill the surface voids.
 - Moderate - slurry seal for full mat width.
 - Severe - removal and replacement or overlay.
- All repairs shall be regular in shape and finished using good workmanship practices to provide an appearance acceptable to the Engineer.
- Any other methods of repair proposed by the Contractor will be subject to the approval of the Engineer.
- The Contractor shall carry out repairs at their expense.

307.04.06 – Measurement and Payment

1) Measurement

- Asphalt Concrete - Marshall supplied will be measured in square metres or tonnes of material placed, as detailed in the Tender Form.
- The Unit Price for Asphalt Concrete – Marshall shall be full compensation for all materials, labour, tools, equipment and incidentals necessary to complete the work in accordance with these specifications.
- The material shall be scaled and recorded by the Contractor on duplicate weight slips. Weight slips must be supplied at the time of delivery, and a copy supplied to the Owner.
- The weight scale shall be inspected and certified by Weights and Measures Inspection Services of the Federal Department of Consumer and Corporate Affairs, at the Contractors' expense and as often as the Engineer may direct.

2) Payment

- The Unit Price applicable to each Lot quantity of asphalt concrete will be calculated as follows:

$$\text{LOT UNIT PRICE} = \text{CONTRACT UNIT PRICE} \times \text{PA}_{\text{AC}} \times \text{PA}_{\text{COM}} \times \text{PA}_{\text{AV}} \times \text{PA}_{\text{T}}$$

Where:

PA_{AC} = Asphalt Content Payment Adjustment

PA_{COM} = Compaction Payment Adjustment

PA_{AV} = Air Void Payment Adjustment

PA_{T} = Thickness Payment Adjustment

- For subdivision development Category B Projects, the Unit Price for asphalt concrete will be calculated based on an assumed price of \$150 per tonne.

3) Determination of Pavement Smoothness

The City Engineer will determine major Road Smoothness Specification "A" or "B".

- The finished pavement surface shall be tested by The City of Calgary to determine the longitudinal profile and compute the International Roughness Index's (IRI) of each
- driving lane. Left and Right wheel path IRI's will be averaged to produce the Mean IRI or Mean International Roughness Index (MIRI). The Mean IRI will be used to determine acceptance limits and payment adjustments.
- Each lane of the project will be profiled and divided into Lots. A Lot is defined as 1 km (1000 m) in length of final pavement surface. Partial Lots less than 100 m will be included as part of the previous Lot, and partial Lots greater than 100 m will be used as fractions to determine acceptance and payment adjustments as required.
- Lane lengths of less than 300 m will not be subject to the smoothness specification.

- Sections that will be filtered and not included in the determination of final acceptability or payment adjustments include all traffic-controlled intersections, railway crossings, bridge decks, tie-in,; and required run-in or run-out distances for profiling vehicle sensor stabilization. Sections will be filtered at the time of performing final profiling. A preceding or exiting distance of at least 5 m, not to exceed 10 m, is included at each filtered section's beginning and end. The preceding and exiting filtered distances will be measured from the beginning of the filtered section to the front axle of the test vehicle when entering the filtered section and from the end of the filtered section to the rear axle of the test vehicle when exiting the filtered section. Speed file will be enabled to filter any low-speed sections during final profiling. The final smoothness of these filtered areas, including new pavement construction, overlay projects and tie-ins to existing sections, will be assessed individually and at the discretion of The City Engineer.
- In areas where the existing curb and gutter profile or non-City owned or controlled utility manhole elevations are inconsistent and may affect the final smoothness of the pavement, consideration will be given upon receiving written notice from the Contractor before final top lift or overlay paving commences. The Contractor is expected to use due diligence in attaining smoothness requirements, and correct/regulate for minor inconsistencies (0 to 20 mm above) along the lip of gutter profiles and, blend in the surface areas around all manholes without excessive roughness. Sections or areas will be assessed on an individual basis and at the discretion of The City Engineer.
- Pavement surface profiling may be performed both before and after project completion. Quality assurance will then be assessed by comparing the before and after measurements and determining the overall improvement achieved. Considerable improvement of pavement smoothness should be evident. If deficient, this will become a significant factor in the final acceptance of the project.
- For the measuring process, if required, the Contractor shall provide The City with a chalk guideline in the centre or edge of all driving lanes immediately before measurement.

4) Acceptance limits Mean IRI (MIRI) - Lots

- The acceptance limit for each lane will be determined by the following:
 - The MIRI value will be used to determine if the Lot or Partial Lot will be accepted and if it will be subject to any payment adjustment.
 - The Lot or Partial Lot MIRI will not exceed 2.50 for "A" and 2.90 for "B" Major Roads.
 - There are no apparent defects, including roller marks, tire marks, cracking or tearing, excessive bleeding, and surface segregation.
- Lot Assessment and the final acceptance of each Lot will be at the discretion of The City Engineer.

TABLE 50: PAYMENT ADJUSTMENTS FOR MAJOR ROADS BASED ON SMOOTHNESS SPECIFICATIONS “A”

Lot Mean IRI (m/km)	Payment Adjustment per lot (1 lane-km)
<0.81	+\$1 000
0.81-0.90	+\$800
0.91-1.00	+\$400
1.01-1.10	+\$200
1.11 -1.20	+\$100
1.21-1.60	0
1.61-1.70	-\$100
1.71-1.80	-\$200
1.81-1.90	-\$400
1.91-2.00	-\$600
2.01-2.10	-\$800
2.11-2.20	-\$1000
2.21-2.30	-\$1200
2.41-2.40	-\$1500
2.61-2.50	-\$2000
>2.50	-\$2 500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

5) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “A” Major Roads

- Localized roughness will be determined using the evaluation software TxDOT Designation: Tex-1001-S as provided in ProVAL 2.7 and later versio
- The software will:
 - Produce a single averaged wheel path profile.
 - Apply a 10 m moving average filter to the single average wheel path profile.
 - Determine the difference between the averaged wheel path and the 10 m moving average filtered profiles for every profile point.
 - Identify deviations greater than 0.9 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).
- Each deviation between:
 - 0.90 – 1.09 cm will result in a \$200 penalty.
 - 1.10 – 1.19 cm will result in a \$300 penalty
 - 1.20 – 1.29 cm will result in a \$400 penalty.



- 1.30 – 1.39 cm will result in a \$500 penalty.
 - 1.40 – 1.49 cm will result in a \$600 penalty.
 - 1.50 – 1.59 cm will result in an \$800 penalty.
 - 1.60 – 1.69 cm will result in a \$1000 penalty.
 - 1.70 – 1.79 cm will result in a \$1200 penalty.
 - 1.80 cm and above will result in a \$1500 penalty and be subject to remedial work.
- Individual areas of localized roughness will be established by a linear lane length of not greater than 3 m per deviation as per Tex-1001-S analysis.
 - Remedial work will be subject to review and approval by The City Engineer.
 - No positive payment adjustment for corrective work to meet localized roughness limits will be applied.

6) Payment Adjustments for “B” Major Road - Lots

TABLE 51: PAYMENT ADJUSTMENTS FOR MAJOR ROADS BASED ON SMOOTHNESS SPECIFICATIONS “B”

Lot Mean IRI (m/km)	Payment Adjustment per lot (1 lane-km)
<0.81	+\$1 000
0.81-0.90	+\$800
0.91-1.00	+\$600
1.01-1.10	+\$400
1.11-1.20	+\$200
1.21 -1.30	+\$100
1.31-1.70	0
1.71-1.80	-\$100
1.81-1.90	-\$200
1.91-2.00	-\$400
2.01-2.10	-\$600
2.11-2.20	-\$800
2.21-2.40	-\$1000
2.41-2.60	-\$1200
2.61-2.80	-\$1500
2.81-2.90	-\$2000
>2.90	-\$2500 Reject or Corrective Work ¹

¹Acceptance of Lots, partial Lots and / or corrective work will be subject to review and approval by The City Engineer. No positive payment adjustment for corrective work to achieve an acceptable Mean IRI will be applied.

7) Localized Roughness (Bumps & Dips) Acceptance Limits – Payment Adjustments for “B” Major Roads

Localized roughness will be determined using the evaluation software TxDOT Designation: Tex-1001-S as provided in ProVAL 2.7 and later versions.

The software will:

- Produce a single averaged wheel path profile.
- Apply an 8 m moving average filter to the single average wheel path profile.
- Determine the difference between the averaged wheel path and the 8 m moving average filtered profiles for every profile point.
- Identify deviations greater than 1.0 cm as a detected area of localized roughness (positive deviations are “bumps” and negative deviations are “dips”).

Each deviation between:

- 1.00 – 1.19 cm will result in a \$200 penalty.
- 1.19 – 1.29 cm will result in a \$300 penalty.
- 1.30 – 1.39 cm will result in a \$400 penalty.
- 1.40 – 1.49 cm will result in a \$500 penalty.
- 1.50 – 1.59 cm will result in a \$600 penalty.
- 1.60 – 1.69 cm will result in an \$800 penalty.
- 1.70 – 1.79 cm will result in a \$1000 penalty.
- 1.80 – 1.89 cm will result in a \$1200 penalty.
- 1.90 cm and above will result in a \$1500 penalty and be subject to remedial work.

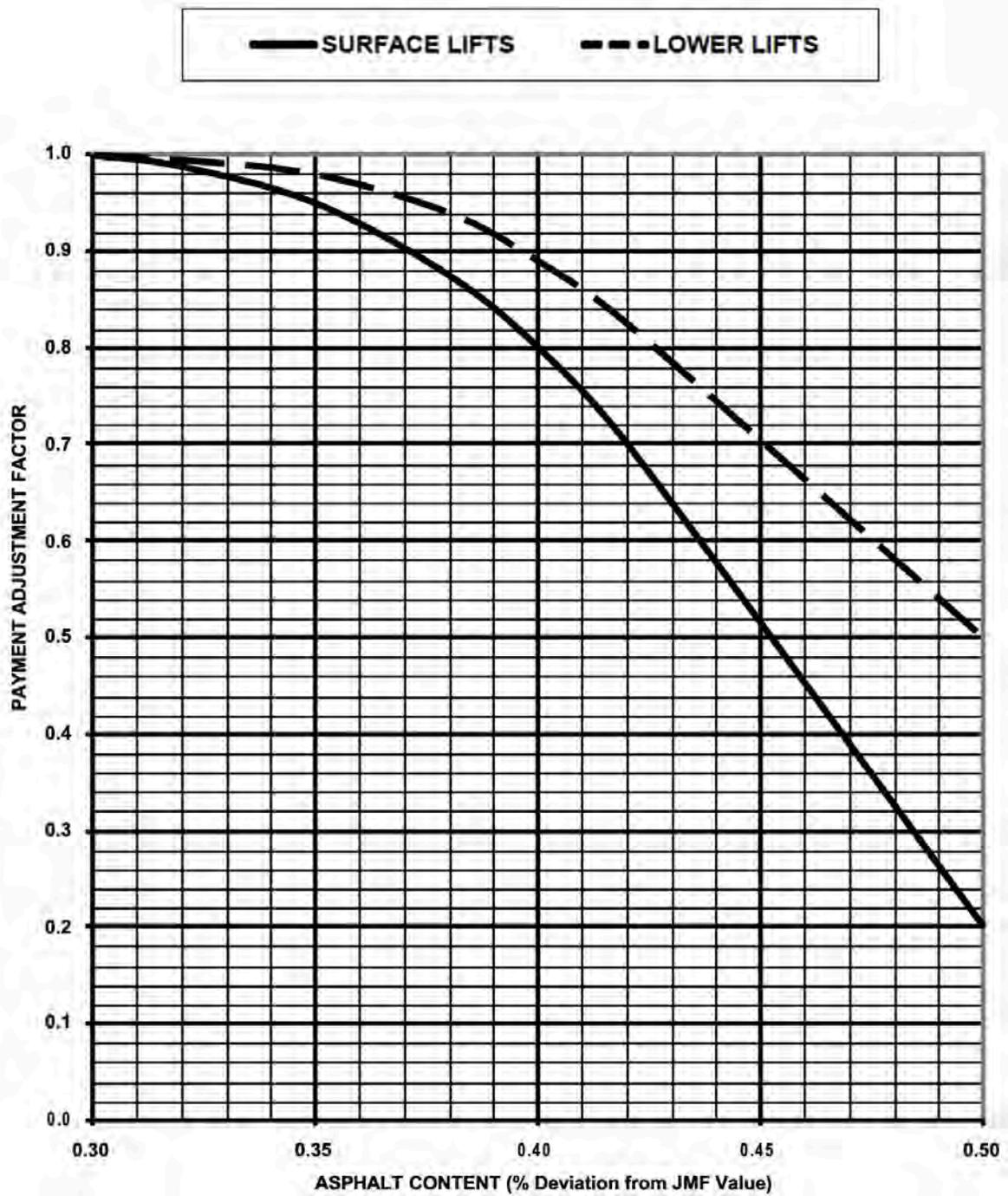
Individual areas of localized roughness will be established by a linear lane length of not greater than 3m per deviation as per Tex-1001-S analysis.

Remedial work will be subject to review and approval by The City Engineer.

No positive payment adjustment for corrective work to meet localized roughness limits will be applied.



CHART A ASPHALT CONTENT
PAYMENT ADJUSTMENT FACTOR



**CHART B COMPACTION
PAYMENT ADJUSTMENT FACTOR**

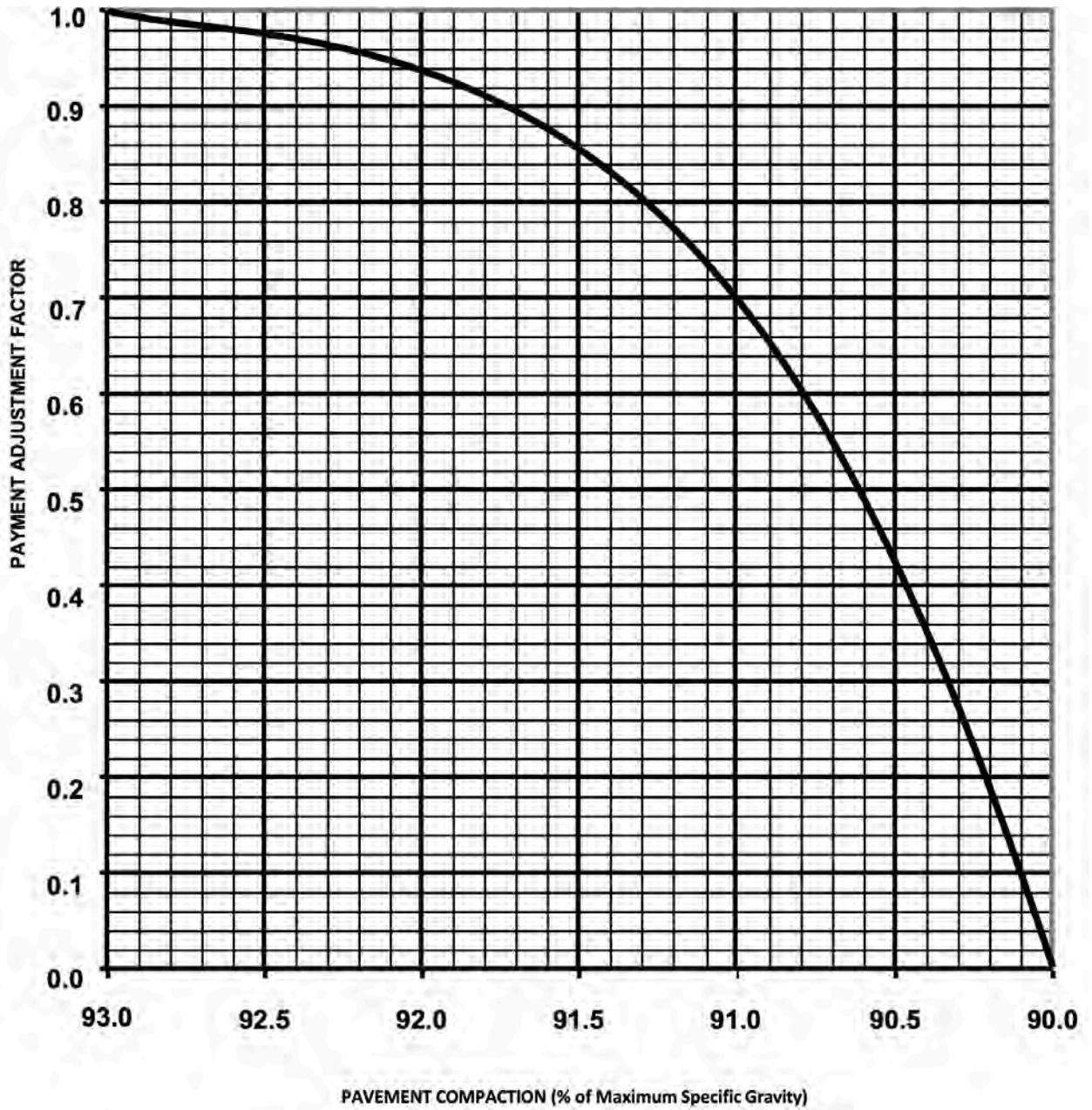
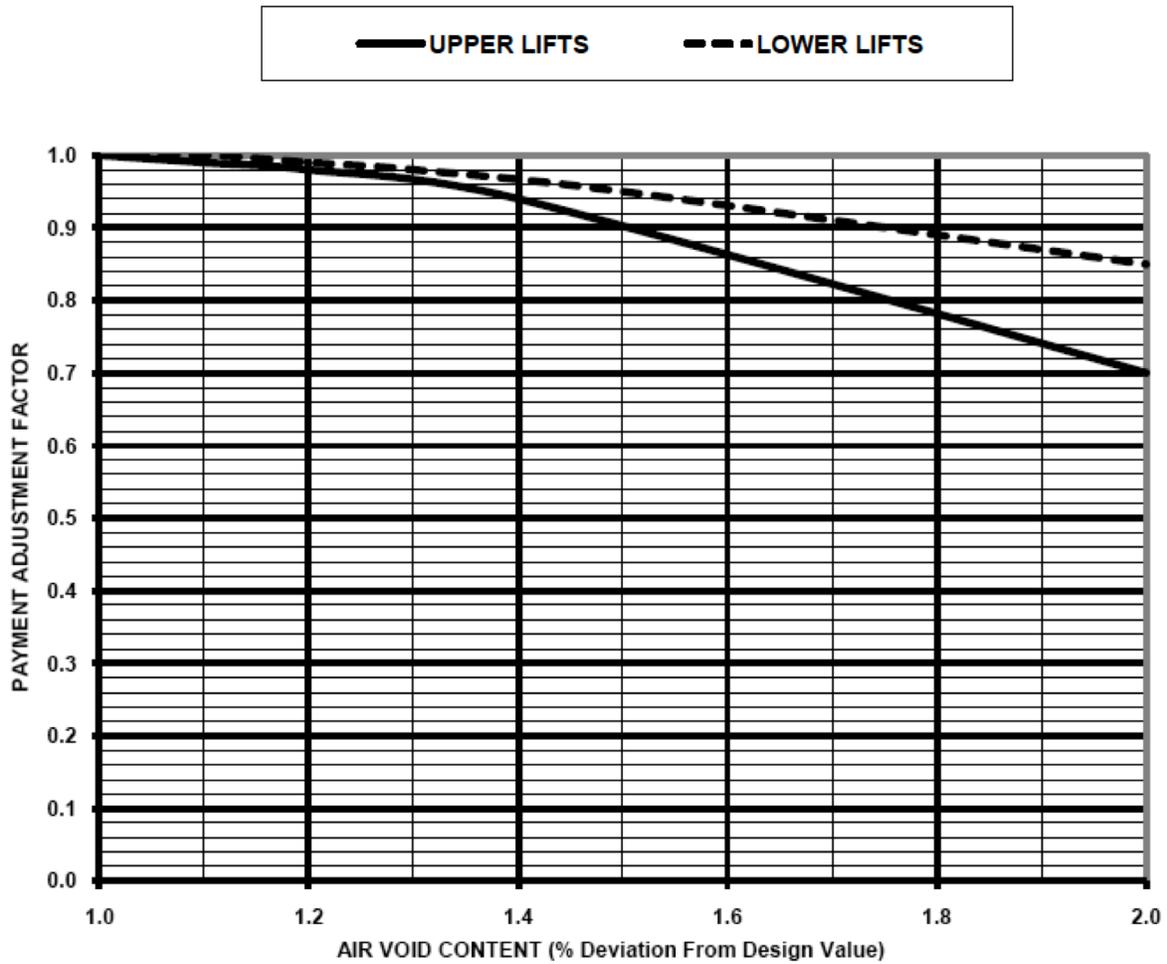
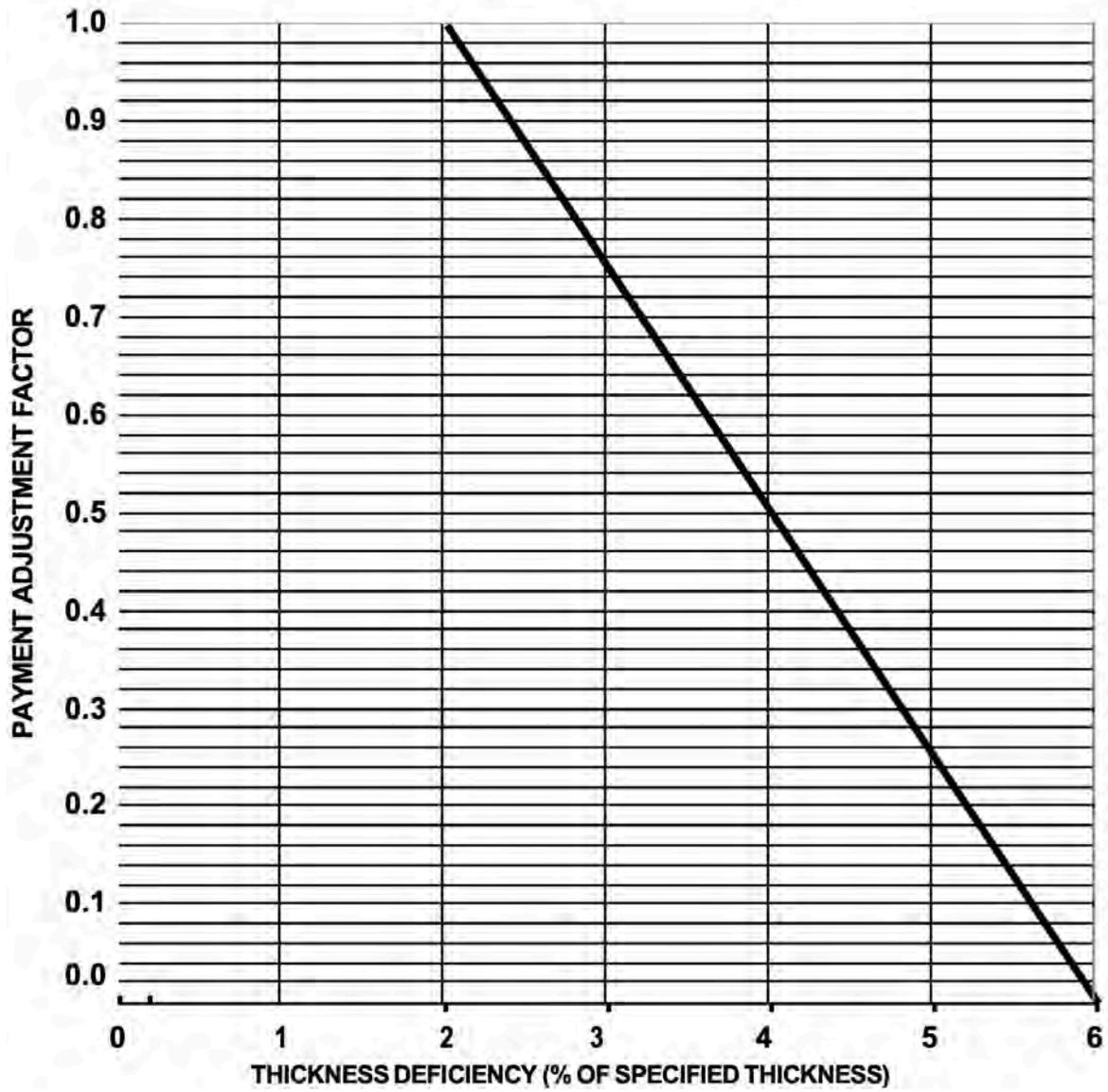




CHART C
AIR VOID CONTENT PAYMENT ADJUSTMENT FACTOR



**CHART D AVERAGE THICKNESS
PAYMENT ADJUSTMENT FACTOR**





308.00.00 – Pavement Design

308.01.00 – General

This section presents the guidelines for the design of flexible pavements to meet the required design life, traffic loading, subgrade strength, and environmental factors.

Prior to constructing surface improvements, a pavement design shall be submitted, with a cover letter, by the developer, City Project Manager, or their Consulting Engineer to The City of Calgary, Transportation, Roads, Pavements, Soil, and Asset Management (PSAM) for approval.

Pavement designs shall include a review of subgrade drainage and/or water table concerns and provide continuous sub-drains and recommendations for separation membranes if required.

A transverse subdrain, connected to the storm sewer system, shall be installed at the joint wherever a gravel-based road with a downhill grade joins a road constructed with full-depth pavement.

The subgrade shall be graded without a quarter-crown to provide positive drainage from the center of the roadway to the curb and gutter. On super-elevated roadways, the subgrade shall conform to the super-elevated grades.

308.01.01 – Road Classifications

All roadway sections within The City of Calgary limits, for pavement design, are classified as follows:

TABLE 52: ROAD CLASSIFICATION FOR PAVEMENT DESIGNS

CTP Classification	Standard Specification Roads Construction
Skeletal Road	Major Roads
Arterial Street	
Local Arterial Street	
Industrial Arterial Street	
Urban Boulevard	
Parkway	
Neighbourhood Boulevard	Industrial Roads
Industrial Street	
Primary Collector Street	Transit Collector Roads
Collector Street	
Activity Centre Street	
Residential Street	Residential Roads
Residential Entrance Street	
Lane (Alley)	Lane

308.01.02 – Design Methodology

AASHTO pavement design methodology (1993) shall be used for new construction of major and industrial roadways.

Standard minimum pavement structures, as per section 308.02.00 – Minimum Pavement Sections, shall be used for transit collectors, non-transit collectors, and residential roads.

All pavement designs shall include provisions of longitudinal sub-drains along the edge of the pavement structure to provide positive subsurface drainage. The subdrain shall be a minimum 100 mm diameter and consist of a perforated flexible plastic drainpipe connecting to catchbasin locations or other stormwater outfalls.

The design pavement structure for the governing lane shall be applied to adjacent lanes.

308.02.00 – Minimum Pavement Sections

Minimum pavement structures for Primary Collectors, Collectors and Residential roadways shall be as per Table 53: Minimum Pavement Sections - Transit Collector Roads, Non-Transit Collector Roads and Residential Roads.

TABLE 53: MINIMUM PAVEMENT SECTIONS - TRANSIT COLLECTOR ROADS, NON-TRANSIT COLLECTOR ROADS AND RESIDENTIAL ROADS

Roadway Classification	Minimum Asphalt Concrete Thickness (mm) ¹	Minimum Granular Base Thickness (mm)	Minimum Sub-base Thickness (mm)
Transit Collector Roads	160	100	300
Non-Transit Collector Roads	140	100	200
Residential Roads	80	100	200

¹Including initial and final stage paving of 30 mm for Residential Roads and 40 mm for other road classification.

TABLE 54: OPTIONAL MINIMUM PAVEMENT SECTIONS FOR COLD WEATHER PAVING - TRANSIT COLLECTOR ROADS, NON-TRANSIT COLLECTOR ROADS AND RESIDENTIAL ROADS (APPLICABLE ONLY FOR CONSTRUCTION AFTER SEPTEMBER 30)

Roadway Classification	Minimum Asphalt Concrete Thickness (mm) ¹	Minimum Granular Base Thickness (mm)	Minimum Sub-base Thickness (mm)
Transit Collector Roads	175	0	385
Non-Transit Collector Roads	170	0	270
Residential Roads	110	0	270

¹Including initial and final stage paving of 30 mm for Residential Roads and 40 mm for other road classification.

308.03.00 – Pavement Design – Major and Industrial Roadways

308.03.01 – Design Basis

Pavement designs for major and industrial roadways shall be based on the AASHTO Guide for Design of Pavement Structures (1993).

For new construction, pavement designs shall be based on a 20-year design period for major roadways and industrial roadways.

308.03.02 – Subgrade Support Characterization

Minimum design shall be based on the actual soaked CBR values of the representative soils compacted to a density equal to the density recommended for the subdivision. Samples shall be selected by qualified personnel from a testing agency to confirm that they are representative of site conditions and tested according to ASTM Standards.

CBR tests shall be based on a minimum of two tests for every 4 000 m² for each subgrade soil type. The Design CBR shall be the least of the undertaken tests for each subgrade area classified with one soil type. CBR tests must be conducted for major and industrial roadways.

Using CBR test results, the subgrade modulus M_R shall be determined using the following correlation equation:

$$M_R = 10.3 \times \text{Soaked CBR Value}$$

A summary of all laboratory test results, assumptions, and/or calculations made in the assessment of the subgrade support must be included in the pavement design report.

CBR test results can be supplemented with subgrade modulus information back-calculated from Falling Weight Deflectometer data for a prototype roadway section. The prototype roadway section should be deemed representative with similar soil type and moisture conditions and should be in the immediate vicinity of the subject roadway section to be designed.

308.03.03 – Traffic Inputs

Pavement design for major and industrial roadways shall be based on the higher of the current or predicted traffic loading in terms of Equivalent Single Axle Loadings (ESALs), based on the Average Annual Daily Traffic (AADT), truck percentage, truck type distribution (Single Units or Tractor-Trailer Combinations), and bus trips.

The following Load Equivalency Factors shall be used:

- Passenger (CAR) 0.0004
- Single Unit Trucks (SUT) 1.0
- Tractor-trailer Combinations (TTC) 2.0
- Transit buses (BUS) 3.0

The following traffic inputs shall be used as default in the traffic analysis:

- Directional Distribution: 50 % in each direction.
- Growth Rate: 3 %.
- Lane Distribution: 100 % for one lane per direction, 80 % for two lanes per direction, and 65 % for three lanes per direction.
- Bus traffic shall be assigned to the outside lane only.

Revisions to the default traffic data inputs above may be used if justified by project-specific traffic information.

Using the traffic inputs, the Design ESALs (in terms of 80 kN single axle loads) shall be determined in accordance with the following:

$$ESALs/day/direction = \frac{AADT}{2} \times \left[\frac{\%CARS}{100} \times 0.0004 + \frac{\%SUT}{100} \times 1.0 + \frac{\%TTC}{100} \times 2.0 + \frac{\%BUS}{100} \times 3.0 \right]$$

Design ESALs = ESALs/day/direction X 365 X Traffic Growth Factor (TGF)

Where:

$$TGF = [(1+g)^n - 1]/g$$

g = Growth Rate/100, and n = Design Period (years)

ESALS shall be determined for:

- A 20-year design period for major roads and industrial roads.
- Design ESAL shall be determined based on a 30-year design life for all major road reconstruction and rehabilitation. Where the reconstruction and rehabilitation project involves realignment, intersection improvements, interchanges or widening, the adjacent pavement sections should be rehabilitated to provide a uniform service life. This does not apply to newly developed sections of roads adjacent to existing major roads.

308.03.04 – Design Inputs

The following shall be considered as the design inputs for the flexible pavement design to determine the required structural number:

- The Design ESALs as per 308.03.03.
- The Initial Serviceability, Terminal Serviceability, and Serviceability Loss shall be 4.2, 2.5, and 1.7, respectively.
- Reliability: 95 % for Major Roads and 85 % for Industrial Roads.
- The Overall Standard Deviation of 0.45.
- Subgrade Modulus value as per 308.03.02

Design Layer Coefficients as follows:

- Asphalt Concrete with Polymer Modified Binder 0.44



- Asphalt Concrete 0.40
- Full Depth Reclamation (FDR) or Cold In-Place Recycling (CIR) 0.30
- 25 mm minus Granular Base Course (GBC) 0.14
- 80 mm minus Granular Subbase (Processed) 0.11

For new construction, the design Drainage Coefficients used for Base or Sub-base layers shall be 1.0. The design Structure Number shall be equal to or greater than the required Structural Number. For pavement widening, the total design pavement structure thickness shall be equal to or greater than the adjacent pavement to allow for positive drainage.

308.03.05 – Minimum Pavement Thicknesses

The following minimum thicknesses shall be incorporated into major and industrial roadway pavement designs.

TABLE 55: MINIMUM PAVEMENT THICKNESS REQUIREMENTS, MAJOR ROADS AND INDUSTRIAL ROADS

Roadway Classification	Minimum Asphalt Concrete Thickness (mm) ¹	Minimum Granular Base Thickness (mm)	Minimum Total Granular Thickness (mm)
Major Roads (< 5 Million ESALs)	180	100	300
Major Roads (> 5 Million ESALs)	200	100	300
Major Roads (> 5 Million ESALs)	225 ²	100	300
Industrial Roads	160	100	300

¹Including initial construction and final stage paving.

²Curb placed on 60 mm Asphalt Concrete Base.

TABLE 56: OPTIONAL MINIMUM PAVEMENT THICKNESS REQUIREMENTS, MAJOR ROADS AND INDUSTRIAL ROADS FOR COLD WEATHER PAVING (APPLICABLE ONLY FOR CONSTRUCTION AFTER SEPTEMBER 30)

Roadway Classification	Minimum Asphalt Concrete Thickness (mm) ¹	Minimum Granular Base Thickness (mm)	Minimum Total Granular Thickness (mm)
Major Roads (< 5 Million ESALs)	210	0	370
Major Roads (> 5 Million ESALs)	230	0	370
Major Roads (> 5 Million ESALs)	255 ²	0	370
Industrial Roads	190	0	370

¹Including initial construction and final stage paving.

²Curb placed on 90 mm Asphalt Concrete Base.

308.04.00 – Allowable Deflections

All roadways constructed under these Specifications shall demonstrate an average deflection at or below the following allowable deflections:

- | • Road Classification | Maximum Deflection |
|-------------------------|--------------------|
| • Residential | 50 mils |
| • Residential Collector | 35 mils |
| • Industrial | 35 mils |
| • Major and Arterial | 25 mils |

The average deflection shall be based on a minimum of ten Benkelman Beam tests. Intervals between testing points shall not be greater than 50 metres.

309.00.00 – Special Surface Construction

309.01.00 – Asphalt Curbs

309.01.01 – General

The asphalt hot mix composition used in the construction of asphalt curbs shall comply with the Specifications requirements for asphalt concrete pavements. Aggregate gradation shall be within the limits of Mix B, Asphalt Concrete. A job mix of the aggregate gradation and asphalt content shall be determined, in the laboratory and in the field, to provide a finished curb of adequate stability and desired surface texture. If required, approved mineral filler shall be employed in the mix as directed by the Engineer.

309.01.02 – Asphalt Content

Asphalt content by weight of total mix shall be increased from 0.5 to 1.0 percent over that used for hot asphalt mixtures of the same aggregate gradation.

309.01.03 – Preparation of Curb Foundation

Asphalt curbs are placed on existing pavement surfaces. Except for newly laid asphalt pavements with the surface still tacky and free from dust, a light tack coat of emulsified asphalt SS-1 shall be applied, by brush, before placing the asphalt curb.

309.01.04 – Placing Curb Mix

Placement temperatures shall be according to temperature range as listed under "Temperature of the Paving Mix". The cross-section of the asphalt curb shall conform to standard curb moulds. Curbs shall be consistent and constructed smooth; any sharp breaks are not accepted.

No curb mix shall be placed or transported when the air temperature is below 4°C without the written permission of the Engineer.

1) Machine Placing

Asphalt curbing shall be placed by a self-propelled curbing machine that meets the Engineer's approval. Machine laid work requires no additional compaction. In areas where compaction is inadequate, the mix shall be adjusted, the machine loaded with additional weight or other measures taken to provide adequate compaction.

The curbing machine shall not be kept running while waiting for trucks. Curb mix shall be permitted to remain in the hopper while the machine is not in operation. The hopper shall be charged so as not to jar the curbing machine out of alignment.

2) Hand Placing

In areas inaccessible to the curbing machine, material shall be placed by hand in wood or metal forms constructed to the desired mould or cross-section of the asphalt curb. Material placed by hand shall be

tamped into place and satisfactorily screeded to a smooth finish so that it blends with machine placed curb in cross-section alignment and grade.

Forms are removed as soon as the proper shape of the material can be maintained.

309.01.05 – Joints

Asphalt curb construction should be a continuous operation in one direction to eliminate curb joints. However, where conditions are such that this is impossible, the joints between successive days of work should be carefully made to ensure a continuous bond between the old and new sections of the curb. All contact surfaces of the previously constructed curb should be painted with a thin, uniform coat of hot asphalt material prior to placing the fresh curb material to the old joint.

309.01.06 – Method of Measurement

Asphalt curb shall be measured by the number of linear metres of work completed and accepted. No deduction shall be made for flattening curbs for entrances.

309.02.00 – Asphalt Walkways and Bicycle Paths

309.02.01 – General

A walkway is used by pedestrians only, whereas a bicycle path may be used by both cyclists and pedestrians.

309.02.02 – Construction

In general, construction shall conform to Standard Drawing 454.1005.008.

Asphalt concrete shall comply with the requirements of the Specification for Mix B in section 307.03.00 – Asphalt Concrete - Marshall.

Mixing, placing, and compaction shall conform to the requirements of section 308.00.00 – Pavement Design. The minimum thickness of asphalt shall be 100 mm on a compacted subgrade. If the Contractor excavates below grade, they shall backfill with approved base gravel, compacted to the Engineer's satisfaction, at no expense to The City.

The finished asphalt surface shall be smooth, true to line, grade and cross-section.

309.02.03 – Width of Construction

Walkways and bicycle paths are to be constructed to a basic width of 2500 mm except as follows:

- In easements and rights-of-way adjacent to side property lines, the width shall be the entire width of the easement or right-of-way, or three metres, whichever is the lesser.
- Adjacent to rear property lines, the walkway or bicycle path shall be constructed on the centreline and the width requirements on the first point.

- Adjacent to rear property lines, with a park or Community reserve on one side, the walkway or bicycle path shall be constructed on the property line opposite the reserve site, to the width requirements in the first point.

309.03.00 – Driveway Aprons

309.03.01 – General

The following policies are in effect:

- All driveways aprons shall adhere to the provisions in section 311.00.00 – Concrete Sidewalk, Curb and Gutter.
- Concrete, asphalt and interlocking paving stones built to The City's standards by the developer, builder, or homeowner shall be acceptable for driveway aprons.
- In cases where the developer cannot secure the construction of the driveway to The City's Specifications prior to the F.A.C. inspection, they have the option to frame and gravel the driveway to obtain the F.A.C., provided the garage did not form part of the original builder's package and has only recently been constructed by the homeowner, or if the driveway apron is not to City Specifications.
- In those situations where the developer has to frame and gravel the driveway apron, they shall also issue a letter to the homeowner with a copy to the Development Office/Bylaw Enforcement Officer indicating that the driveway shall be completed to the above Specifications by the end of the following construction season.
- Minimum lateral clearance from the edge of the driveway apron to any obstacles, including fire hydrants, power poles, streetlights and trees, shall be 2.0 metres. Reduced clearance of 1.0 metre will be allowed if guard barriers are provided in accordance with the appropriate safety and design standards.
- Minimum lateral clearance from the edge of the driveway apron to any catch basins shall be 1.0 metre.

309.03.02 – Residential Asphalt Driveway Apron

1) General

Asphalt shall be placed between the curb and separate sidewalk to conform to dimensions shown on Standard Drawing 454.1010.004.

Granular material shall conform to the requirements outlined in section 303.00.00 – Granular Material.

The asphalt concrete shall be placed at a depth of 150mm and shall comply with the Specifications for Mix B in section 307.00.00 – Asphalt Concrete.

2) Design

The surface shall be a minimum of 75 mm of type "B" Asphalt Concrete. The granular base shall be a minimum of 100 mm thick of 25 mm crushed gravel.

3) Excavation

Excavation by hand or machine shall be performed to the proper line, grade and cross-section. All deleterious matter encountered at the sub-grade level shall be removed and replaced with approved base gravel. Before deposition of the asphalt concrete, the sub-grade shall be thoroughly compacted by approved mechanical tamping devices to the Engineer's satisfaction.

If the Contractor excavates below grade, they shall backfill with approved base gravel at no extra cost to The City.

Excavated material shall be disposed of as described in these Specifications under "Excavation".

4) Granular Backfill

When the grade line of the asphalt apron is such that the walkway cross-section is in fill or embankment over 150 mm deep, approved base gravel shall be used as fill material. Fills with 150 mm or less shall be made with 25 mm crush material. All granular materials are properly mechanically compacted to the Engineer's satisfaction. The base gravel shall be placed in 150 mm layers, and each layer or lift is properly compacted using vibratory compactors. Where necessary, water shall be used to aid compaction. The vibratory compactors shall be of an approved type as specified in section 308.00.00 – Pavement Design.

5) Asphalt Hot Mix

The asphalt hot mix wearing surface shall be placed to a minimum thickness of 150 mm and be adequately compacted by approved mechanical compactors or self-propelled rollers to the Engineer's satisfaction. The finished asphalt surface shall be smooth, true to line, grade and cross-section.

6) Forms

Side forms for asphalt driveway aprons shall be 1 x 6 lumber, properly seasoned and free from warps or other defects. The forms shall be well staked, braced or otherwise rigidly held to the established lines and grades. No asphalt hot mix shall be deposited against the forms until the forms and their placing have been approved by the Engineer. Forms shall not be removed after the asphalt wearing surface has been placed.

309.03.03 – Residential Paving Stone Driveway Apron**1) General**

The driveway shall be constructed between the curb and the sidewalk to conform with the dimensions shown on Standard Drawing 454.1010.004 and conform to the requirements outlined in section 315.00.00 – Architectural Pavements.

Lean concrete shall conform to the requirements outlined in section 310.00.00 – Portland Cement Concrete.

Interlocking paving stones shall conform to the requirements of ASTM C936-82.

The finished section shall consist of a minimum of 100 mm of lean concrete overlaid by a layer of sand between 15 mm and 20 mm overlaid by the paving stones.

2) Excavation

Excavation by hand or machine shall be performed to the proper line, grade and cross-section. All deleterious matter encountered at the sub-grade level shall be removed. If the Contractor excavates below grade, they shall backfill with approved base gravel at no extra cost to The City.

Excavated material shall be disposed of as described in the Specification under section 302.01.01 – Common Excavation.

3) Lean Mix Concrete

The lean mix concrete shall be placed to a minimum thickness of 100 mm. The surface shall be smooth and true to line, grade and cross-section.

4) Forms

Side forms for driveway aprons shall be 1 x 6 lumber, properly seasoned and free from warps or other defects. The forms shall be well staked, braced, or otherwise rigidly held to the established lines and grades. Forms shall not be removed after the interlocking paving stone surface has been placed.

309.04.00 – Roadway Paving Stones

309.04.01 – General

Construction shall conform to the requirements outlined in section 315.00.00 – Architectural Pavements.

The Engineer shall grant written approval prior to construction of road surface with paving stones.

Paving stones shall be set at a finished grade of 5 mm above the lip of the gutter.

A 150 mm border of Class "A" concrete shall be placed along the transverse edges of the paving stone surface.

Paving stones shall be placed on a 10 mm thick bedding of sand containing 6 percent bentonite.

Joints between paving stones shall be filled with sand containing 6 percent bentonite. Open areas between paving stones shall be filled with a non-shrink mortar.

The thickness of Class "A" concrete base shall be 150 mm for residential and collector streets 200 mm for arterial and Major roads.

309.04.02 – Maintenance Period

The paving stone area shall be subject to separate certification for acceptance by The City, with a maintenance period between the issuing of a C.C.C. and F.A.C. of five (5) years.

309.05.00 – Subdivision Roadway Entrance Features

309.05.01 – General

Subdivision roadway entrance features shall not be constructed on roadways classified as "major" streets. Unless prior written approval has been obtained from Roads to use an alternate material, all subdivision roadway entrance features shall be made with synthetic fibre concrete. Subdivision designs showing entrance features using imprinted asphalt pavement will be rejected.

The surface texture of subdivision roadway entrance features shall have a skid resistance greater than or equal to the skid resistance of asphalt pavement.

Entrance features shall be located such that no manholes, valves or other utility appurtenances are encased within.

Materials and construction shall conform to the requirements outlined in section 310.00.00 – Portland Cement Concrete.

310.00.00 – Portland Cement Concrete

310.01.00 – General

Portland cement concrete specification provides the materials and testing requirements for the following classes of concrete:

- 311.00.00 – Concrete Sidewalk, Curb and Gutter
- 312.00.00 – Portland Cement Pavement
- 315.00.00 – Architectural Pavements
- 316.00.00 – Noise Barriers

310.01.01 – Reference Standards

Perform cast-in-place concrete work in accordance with the following standards, except where specified otherwise.

- CSA A3000-08, Cementitious Materials Compendium.
- CSA A23.1-09, Concrete Materials and Methods of Concrete Construction.
- CSA A23.2-09, Test Methods and Standard Practices for Concrete.
- CSA A283-06 Qualification Code for Concrete Testing Laboratories.

310.02.00 – Materials

310.02.01 – Cementing Materials

Cement: to CSA A3001-08 - cementitious materials for use in concrete.

- Type GU (general use cement);
- Type HS (high sulphate-resistant cement), cementing materials combinations with equivalent performance may be used; and
- Type HSb (blended high sulphate-resistant cement or approved equivalent).

310.02.02 – Supplementary Cementing Materials

- Fly ash: to CSA A3001-08 – cementitious materials for use in concrete;
- Type F with the additional requirement for maximum CaO content of a maximum 12%.

310.02.03 – Aggregate

1) General

The Contractor must submit the current aggregate testing results for each aggregate source to be used under the Contract. The aggregate shall meet the requirements of CSA A23.1, Table 12 – Limits for deleterious substances and physical properties of aggregates and as per Table 57: Standard Aggregate Requirements below.

TABLE 57: STANDARD AGGREGATE REQUIREMENTS

Standard Requirements	Coarse Aggregate (%)	Fine Aggregate (%)	CSA Test Method
Clay lumps	0.3	1.0	A23.2-3A
Low-Density Granular Materials	0.5	0.5	A23.2-4A
Material Finer than 0.08 mm	1.0	3.0	
Flat and Elongated Particles Procedure A, ratio 4:1 Procedure B, flat/elongated	20 25/45 ¹	- -	A23.2-13A
Micro-Deval Test	17	20	A32.2-23A A23.2-29A
Unconfined Freeze-Thaw Test	6	-	A23.2-24A
Impact and Abrasion Loss	50	-	A23.2-16A A32.2-17A
MgSO ₄ Soundness Loss (alternative requirement)	12	16	A23.2-9A

¹For pavements and high-performance concrete maximum elongated particles in coarse aggregate - 40

All aggregate tests are to be conducted by an approved third-party laboratory certified in accordance with CSA A283 to Category II. As a minimum, testing to verify compliance with the requirements of CSA A23.1 shall be done every year.

The Contractor shall bear all costs associated with aggregate testing.

2) Fine Aggregate

Normal density fine aggregate shall consist of natural sand, manufactured sand, or a combination of thereof.

Fine aggregate shall be graded to limits specified in CSA A23.1, Table 10 – Grading limits for fine aggregate, Group FA1.

Fine aggregate tested in accordance with CSA A23.2-7A, Test for organic impurities in fine aggregates for concrete, is to produce a colour not darker than the standard colour (Organic Plate Number 3). Aggregate producing a colour darker than the standard colour will be rejected. The provisions of CSA A23.1, Section 4.2.3.3.3.2 shall not apply.

3) Coarse Aggregate

Normal density coarse aggregate shall consist of crushed stone, gravel, or a combination of these materials.

The sizes of coarse aggregate shall be selected from the standard sizes given in CSA A23.1, Table 12, Grading requirements for concrete aggregate, Group I. The standard size of the coarse aggregate is 20 mm to 5 mm, except where specified otherwise.

310.02.04 – Water

Water is clean and free from excessive amounts of oil, acid, alkali, soluble chlorides, organic matter, or sediment for concrete production and curing.

Any potable water is suitable for use in concrete production. Water deemed not potable may be used in the concrete production provided that a satisfactory history of strength and durability of concrete made with the water has been demonstrated.

310.02.05 – Admixtures

- (1) Air entraining admixtures shall conform to the requirements of ASTM C 260.
- (2) Water reducing admixtures and high range water reducing admixtures (superplasticizers) shall conform to the requirements of ASTM C 494.
- (3) Calcium chloride shall not be used as it promotes steel corrosion, if present, and reduces the long-term sulphate resistance of concrete. Set accelerating admixtures shall only be used if approved by The City.

310.02.06 – Fibres

1) Synthetic Fibre

Synthetic fibre reinforcement shall meet the requirements of ASTM C 1116, 4.1.3, Type III and shall be olefin macro fibres.

Macro synthetic fibre content shall be in the range of 1 kg/ m³ to 2 kg/ m³ for plastic shrinkage control and improved mechanical properties. Higher fibre volumes reduce workability and have a propensity to ball during mixing. When higher fibre content is required for a particular application, tests are necessary to verify that concrete with the desired amount of fibre can be properly mixed and placed.

Macro synthetic fibre length shall be between 38 mm and 50 mm.

2) Steel Fibre

Steel fibre reinforcement shall meet the requirements of ASTM C 1116, 4.1.1, Type I, and shall be carbon steel.

Steel fibre content shall be a minimum of 35 kg/ m³. Higher fibre volumes reduce workability and have a propensity to ball during mixing. When higher fibre content is required for a particular application, tests are necessary to verify that concrete with the desired amount of fibre can be properly mixed and placed.

Steel fibre length shall be between 38 mm and 50 mm and be continuously deformed or have ends mechanically deformed.

310.02.07 – Curing Membrane

Liquid membrane-forming curing compound: to ASTM C309.

- Type 1 – Clear or translucent without dye; and
- Type 2 – White pigmented.

Liquid curing membrane shall be applied to the concrete as soon as possible after completing and/or texturing activities. The time of the application shall not exceed 30 minutes after finishing.

310.03.00 – Submittals

- Submit the proposed mix design for all concrete mix types to the Engineer for approval four weeks before the commencement of the Contract. Mix design documentation shall include all components of the mix and quantities of the materials used.
- Submit copies of mill certificate test reports of cement and fly ash.
- Submit the test results for each aggregate source to be used for compliance with section 310.02.03 – Aggregate.
- Submit data on all proposed concrete admixtures.
- Submit data on proposed fibres.
- Submit the results of trial batch testing for each type of concrete for compliance with concrete properties specified in relevant sections of this Specification. Any change in the materials and/or quantities shall require new trial batch testing.

310.04.00 – Concrete Properties

All concrete shall comply with the CSA A23.1, Table 1, Table 2, and Table 4 requirements for the class of exposure C-2, non-structurally reinforced concrete exposed to chlorides with or without freezing and thawing conditions. The minimum requirements for the class of exposure C-2 are as given in Table 58: Requirements for Class of Exposure C-2.

TABLE 58: REQUIREMENTS FOR CLASS OF EXPOSURE C-2

Minimum Cement Content (kg/m ³)	Maximum Water to Cementing Materials Ratio	Minimum Compressive Strength at 28 Days (MPa)	Air Content (%)
310	0.45	32	5 – 8*

*Based on 20 mm maximum aggregate size.

Mix properties and performance characteristics for each concrete type are contained in relevant sections of this Specification.

310.04.01 – Seasonal Requirement

Concrete placed before September 30 shall attain the minimum allowable compressive strength in 28 days. For concrete placed after September 30 and before May 1, minimum allowable compressive strength shall be attained in seven days. Curing should be in accordance with CSA A23.1-09, Table 20 Additional Curing Requirements – Curing Type 2.

As a minimum, The City requires the following for the late-season construction:

- The Contractor shall be responsible for taking all necessary measures to protect freshly laid concrete from adverse weather conditions to the Engineer's satisfaction.
- The Contractor shall adequately cover and protect the freshly laid concrete and cure for a minimum of five days curing above 5°C.
- The Engineer may ask for coring of the in-place concrete for verification of the concrete properties compliance.
- Section 311.01.08 and all other sections of the Standard Specifications not covered in the above bullets shall be applicable.

310.05.00 – Concrete Production and Delivery

Concrete proportioning, mixing, and delivery shall be in accordance with CSA A23.1, Section 5, production and delivery.

Concrete suppliers shall submit certification of concrete production facilities in accordance with the Alberta Ready Mixed Concrete Association (ARMCA) audit checklist and instructions for each plant supplying concrete under the Contract.

310.06.00 – Quality Assurance

310.06.01 – General

Approval of the mix design and inspection and testing by The City shall not relieve the Contractor of responsibility for the quality of concrete used in the work.

Quality control is the sole responsibility of the Contractor.

All concrete supplied for City Contracts is to conform to CSA A23.1-09 and as modified in the Specification.

All concrete supplied for City Contracts shall be tested by The City or by a certified Testing Laboratory appointed by the Engineer. All concrete testing personnel shall be certified by ACI or CSA/CCIL.

Upon request of The City of Calgary Engineer, the Supplier shall provide concrete production records for the concrete used in work.

310.06.02 – Concrete Testing

- Concrete sampling shall be conducted in accordance with CSA A23.2-1C, Sampling Plastic Concrete.
- Making and curing concrete compression test specimens shall be conducted in accordance with CSA A23.2-3C. Concrete with the measured slump greater than 40 mm may be consolidated by rodding in accordance with Table 2 of CSA A231-3C. Concrete with a measured slump equal to or less than 40 mm shall be consolidated by vibration.
- Air content and slump of plastic concrete shall be determined in accordance with CSA A23.2-4C and CSA A23.2-5C.
- Concrete cylinders shall be made and cured in accordance with CSA A23.2-3C, making and curing concrete compression and flexural test specimens.

Concrete compressive strength shall be determined in accordance with CSA A23.2-9C. Plastic and hardened concrete test results shall include the information listed in Section 8 of A23.2-9C.

- Additional air and slump tests on-site shall be undertaken as required by the Engineer.
- Each test consists of three cylinders, broken at 28 days. The average breaking strength of the two cylinders with the most closely related breaking strengths determines the compressive strength of the test sample.
- Air and slump tests shall be taken in every case when cylinders are cast.
- When there is a risk of frost and no power on-site to heat curing boxes, a concrete sample can be transported to a moulding and curing site to cure the freshly moulded specimens, according to CSA A23.1. This should be considered an emergency only and should be well documented on the test report, including the reason and the time delay.

310.06.03 – Compliance Verification

Concrete shall be subjected to verification testing conducted on cores extracted from sections deemed unacceptable by low compressive strength confirmed by the concrete compliance program and/or visual inspection of concrete placed showing surface distresses. The verification process shall include air void characteristics (spacing factor) and compressive strength of concrete. The Engineer shall determine the area of the concrete to be removed. Alternatively, the Contractor may undertake additional verification of both spacing factor and compressive strength of concrete to delineate the area of non-compliance. The Contractor shall bear the cost of further testing.

- At the Engineer's discretion, three 100 mm diameter cores (where possible) may be extracted and tested for compressive strength in accordance with CSA A23.2-14C, obtaining and testing drilled cores for compressive strength testing. The provisions of CSA A23.1, 4.4.6.6.2 shall apply:



- The compressive strength of the concrete in the area of the structure represented by the core test shall be considered adequate if the average of each set of three cores is equal to at least 85 % of the specified strength and no single core is less than 75 % of the specified strength.
- At the Engineer's discretion, a 100 mm diameter core may be extracted and tested for air void characteristics in accordance with ASTM C457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete. The magnification factor shall be in accordance with CSA A23.1, 4.3.2 between 100 and 125. The determination shall be conducted on the concrete interior to determine the concrete parameters and/or on the core surface for finishing characteristics determination.
 - The acceptance of the air void system shall be in accordance with CSA A23.1, 4.3.3.3. The spacing factor of a single core exceeding 230 μm and air content in the hardened concrete less than 3 % shall result in a rejection of the concrete represented by the core.

The determination of the surface air void characteristics shall be paid by The City. The testing of the concrete interior is optional, and the Contractor shall bear the cost.

310.06.04 – Payment Adjustments

Pay adjustments will be made for non-compliance with the specified durability characteristics and compressive strength. Durability and strength penalties apply independently and, if the concrete is deficient in more than one consideration, multiple penalties shall apply.

When concrete fails to meet criteria for the performance characteristic, the penalty shall be assessed at the Engineer's discretion in accordance with Table 59: Payment Adjustments for Durability and Strength of Concrete.

TABLE 59: PAYMENT ADJUSTMENTS FOR DURABILITY AND STRENGTH OF CONCRETE

Payment Adjustments			
Spacing Factor		Low Strength	
Between 0.230 mm and 0.260 mm	50 % deduction	3.5 MPa to 4.5 MPa below specified	50 % deduction
> 0.260 mm	90 % deduction or remove and replace	> 4.5 MPa below specified	90 % deduction or remove and replace



311.00.00 – Concrete Sidewalk, Curb and Gutter

311.01.00 – General

Portland cement concrete sidewalk, curb and gutter, medians, traffic islands, gores, driveway crossings, and aprons shall be constructed in accordance with these Specifications and the Standard Drawings. The type of construction used and the location shall be as shown on the construction plans or as directed by the Engineer and be in accordance with the provisions of this chapter.

Standard face curb shall be required around schools and at bus stops.

Wheelchair ramps are compulsory at all intersections, where sidewalks cross either curb and gutter or curb and at community mailbox locations.

The required mix properties shall be as per section 310.03.00 – Submittals and as shown in Table 60: Mix Properties of Concrete Sidewalk, Curb and Gutter below.

TABLE 60: MIX PROPERTIES OF CONCRETE SIDEWALK, CURB AND GUTTER

Type of Cement ¹	Supplementary Cementing Materials	Maximum Water-to-Cementing Materials Ratio	Nominal Maximum Coarse Aggregate Size	Air Content	Slump
GU, GUb or HSb	Type F ² Up to 20 % ³	0.45	20 mm	5 % to 8%	As required by method of placement

¹ Minimum cementing material content as per section 310.04.00 – Concrete Properties and to achieve both strength and durability properties of concrete.

² CaO content of type F fly ash shall not exceed 12 %.

³ By mass of total cementing materials.

The required performance characteristics shall be as shown below.

TABLE 61: PERFORMANCE CHARACTERISTICS OF CONCRETE SIDEWALK, CURB AND GUTTER

Compressive Strength at 28 Days ¹	Maximum Air Void Spacing Factor
32 MPa	230 µm

¹ For concrete placed between September 30 and May 1, minimum specified compressive strength shall be achieved in seven days.

311.01.01 – Standard Drawings

Standard Drawings shall be taken to show absolute minimum section dimensions. Any shortfall from this shall be cause for removal and replacement.

311.01.02 – Protection of work

The Contractor shall supply and place all necessary material to protect the work from rain, dust, frost, or hot weather conditions. The Contractor shall mist concrete elements with water at their own expense if deemed necessary by the Engineer to protect the work.

The Contractor shall barricade the work and keep people, animals, and vehicles off the work for a period of five days after the finishing of the concrete is completed. Any damage occurring to the work during this five

day period regardless of origin shall be replaced or repaired by the Contractor to the satisfaction of the Engineer within one month after notice is given to the Contractor.

Where the Engineer considers damage to any private walk, driveway, steps, fence, gate, posts, or other private property is caused by negligence on the part of the Contractor, the Contractor, at their own expense and within two weeks of the notice being given, shall repair or replace the specific damage to the satisfaction of the Engineer. The Engineer's decision on all matters pertaining shall be final.

311.01.03 – Traffic

If it is necessary to block off lanes of traffic to access the job site, the Contractor shall make the necessary arrangements with the Transportation Department before the commencement of the work.

311.01.04 – Access

The Contractor shall maintain adequate pedestrian and vehicular traffic access to all public and private property during the entire operation at no extra cost to The City.

311.01.05 – Markings

1) Contractor and Year of Construction

The Contractor shall mark the sidewalk, curb and gutter with a suitable marking tool approved by the Engineer, showing the name of the Contractor and the year of construction. The letters and numerals of the marking tool shall be 40 mm high.

Marks are placed at the end of the curve of each block corner, i.e. there shall be a minimum of eight marks per block. If the construction begins or terminates within the middle of the block, the Contractor shall also mark these locations or as directed by the Engineer. In addition, a similar mark shall be embossed on the corner on each apron and driveway crossing.

2) Reinforcing

All reinforcing rods sections shall be marked at their extreme limits with a marking tool showing the letter "R". This letter shall be 40 mm high.

311.01.06 – Cold Weather Requirements

1) Air Temperature

When the air temperature is at or below 5°C, or when there is a probability of the temperature falling below 5°C within 24 hours of placing as forecast by the nearest official meteorological office, cold weather requirements for concrete placement shall apply.

2) Off-Season Concrete

Between September 30 and the subsequent May 1, the following applies:

- The minimum allowable concrete compressive strength shall be attained in seven days.

- The Contractor shall adequately cover and protect the freshly placed concrete and cure for a minimum of 7 days; curing above 10°C is required as per CSA A23.1-09, Table 20 Additional Curing Requirements – Curing Type 2).

3) Job Preparation

When concrete is placed in cold weather, all equipment needed for adequate protection and curing shall be on hand and ready for use before concrete placement is started.

4) Placing

Snow and ice shall be removed using heat where necessary. In no case shall concrete be deposited on or against any surface at a temperature of less than 5°C.

5) Temperature Control

At their sole discretion, the Engineer may require the Contractor, at the Contractor's expense, to establish, by way of an independent third party, a record of the daily temperature of the concrete for its initial 72 hours in each pour of 150 linear metres or portion thereof.

6) Auxiliary Heating

If the Contractor uses forced air heating units, the concrete shall be kept continuously moist during the complete heating and curing period. Combustion-type heaters may be used, but they shall be so constructed and so placed that their combustion gases do not encounter concrete surfaces during placing and curing, causing carbonation of concrete. The protection period shall be seven days, and the Contractor shall bear the cost of all heating and protection.

311.01.07 – Hot Weather Requirements

Air Temperature

When the ambient air temperature is at or above 27°C, or when there is a probability of the temperature rising to 27°C during the placing period, as forecast by the nearest official meteorological office, facilities shall be provided for protection of the concrete in place from the effects of hot and drying weather.

The concrete temperature at the time of placing shall not exceed 30°C.

Fogging and evaporation protection shall be used subject to the approval of the Engineer.

311.01.08 – Temperature Non-Compliance

Any concrete failing to comply with the temperature requirements shall:

- If compliant to all other Specifications, be left in place with no payment, or if in a development area, the developer shall deposit with The City an amount of money equivalent to the value of the work.

- If non-compliant in any other aspect, be replaced.
- If freezing has occurred, be replaced.

Where non-compliance occurs, the test indicating non-compliance shall be held as representative of the test area.

311.01.09 – Extruded Sidewalk, Curb, and Gutter

The Contractor shall be given the option of constructing extruded sidewalk, curb, and gutter at the Unit Rate. Automatic grade and line control shall be required.

Extruded concrete shall be finished as shown in the applicable drawings, with the surface brush finished; a dense uniform surface shall be required on the curb and gutter.

311.01.10 – Monolithic Sidewalk

Monolithic sidewalks shall be constructed in one operation unless prior written approval has been granted by the duly authorized ROADS representative. If written approval is granted to construct in two separate operations, the Contractor shall install 150 mm long tie bars, made from 10M rebar, into the back of the curb at 750 mm centre-to-centre. The cost of installing tie bars shall be included in the Unit Rate for Monolithic Sidewalk.

In areas where a separate sidewalk is constructed at the back of an existing curb, tie bars shall be drilled into the back of the curb at 750 mm intervals. The cost of installing dowels shall be included in the Unit Rate for Separate Sidewalk.

311.01.11 – Termination

At the sole discretion of the Engineer, the placing of concrete may be suspended or terminated at any time after September 30.

311.02.00 – Site Preparation

311.02.01 – Break Out

The Contractor shall not break out any existing sidewalk and/or curb and gutter without first receiving approval from the Engineer. The designated amount of breakout shall be paid for at the Unit Rates. Any breakout exceeding the designated amount and the related replacement shall be at the Contractor's own expense.

All break out shall end at a contraction, expansion, or surface joint. The edge of a surface mark shall be sawn to a depth of 50 mm minimum, while contraction joints may be neatly hand chiselled. All work involved in saw cutting or hand chiselling shall be included in the Unit Rates.

The broken pieces of concrete shall be properly disposed of at Waste Management sites and conform to those conditions outlined in section 302.00.00 – Earthwork within 24 hours after the commencement of the break-out operation.

311.02.02 – Excavation and Fill

1) General

The excavation shall be to proper grade, line, and cross-section for placing of concrete sidewalk, curb and gutter, or combined sidewalk, curb and gutter, and construction of concrete catch basins and concrete invert crossings. If the Contractor excavates below grade, they shall backfill with approved base gravel, compacted to the Engineer's satisfaction at no extra cost to The City.

Excavation includes the removal and disposition of all material of whatever nature encountered, within the boundaries necessary for the preparation and construction of concrete sidewalk, curb and gutter, or combined sidewalk, curb and gutter, catch basins, and other structures to the required cross-section, alignment, and depth shown on the plans.

All unsuitable matter encountered at sub-grade level shall be removed and replaced with approved gravel fill, thoroughly compacted. See section 305.00.00 – Gravel Road and Lane Construction. The sub-grade shall provide a uniform bearing capacity over the area of the structure.

All approved loam or grass sods encountered during excavation shall be stockpiled at the site for use during backfilling and lawn rehabilitation.

Under no circumstances shall any excavated material be sold or otherwise disposed of by the Contractor, Sub-Contractors, or any of their employees. Excavated material from a natural gravel base area may be used as base gravel material for fills or embankments, providing the use of such material has first been approved in writing by the Engineer.

2) Gravelled Streets

Where concrete sidewalk, curb and gutter, or combined sidewalk, curb and gutter is constructed on a street or avenue that has been gravelled, the Contractor, at no cost to The City, shall blade the gravel to within the middle 3.6 m of the roadway. On completion, this material shall be replaced to the satisfaction of The City.

311.03.00 – Base Preparation

311.03.01 – Earth Sub-grade and Base Gravel Fill

The sub-grade shall be true to cross-section and grade. Irregularities in the sub-grade may be adjusted by use of compacted crushed gravel. Prior to the placing of concrete, the sub-grade shall be compacted to a uniform density of not less than 97.0 percent of design density.

When it is necessary to bring the base to proper elevation by using gravel, the Contractor shall supply approved gravel and provide all required material and labour to load, haul, and place it on the finished sub-grade. Placing and compaction of gravel shall be carried out in accordance with section 305.00.00 – Gravel Road and Lane Construction.

Where concrete sidewalks are placed on a fill, a shoulder of one metre width (measured from the sidewalk's edge) shall be constructed. The fill shall be constructed with 3:1 side slopes.

The Contractor shall place and compact a 50 mm lift of 25 mm crushed gravel before placing concrete for islands or medians. In areas where island and median concrete is placed above the asphalt, the entire volume between the asphalt and the concrete shall be filled with compacted 25 mm crushed gravel. The supply, placing, and compacting of this gravel shall be deemed incidental to the Unit Rates for Sidewalks or Median and Island Concrete.

If in the opinion of the Engineer, there is a danger of excessive absorption of concrete water by the earth or gravel base, the Contractor shall adequately sprinkle the base with water.

311.03.02 – Replacement of Unsuitable Material

Where unsuitable material is encountered during excavation, the Contractor shall notify the Engineer and, if directed, shall excavate the unsuitable material and backfill the area with an approved fill, in accordance with section 302.00.00 – Earthwork. The Contractor shall be responsible for the replacement, at their own expense, of any failure of the work which, in the opinion of the Engineer, was caused by an unstable base.

311.04.00 – Forms

311.04.01 – Formwork

Forms for sidewalk, curb and gutter, combined sidewalk curb and gutter, aprons, invert crossings, and catch basins shall be of metal or timber properly seasoned and free from warps or other defects. Metal forms shall be of approved type and section. The face of the curb form shall be removable without disturbing back and gutter forms. Forms shall be smooth and clean on the surface(s) next to the concrete and be oiled with an approved lubricant.

Forms shall be rigidly held true to the established lines and grades. No concrete shall be deposited against forms until the forms and their placing has been approved by the Engineer.

311.04.02 – Stripping of Forms

The face of curb forms is to be removed after the initial set. Adequate care shall be taken in removing forms to avoid spoiling or marring the concrete. Such patching as may be necessary shall be started immediately after removal of the forms.

Immediately after form removal and/or patching, the exposed surfaces shall be sprayed with a curing membrane.

311.05.00 – Reinforcing

1) General

Where required by the Engineer, structures shall be reinforced in accordance with the drawings provided.

Cold drawn steel wire shall meet the requirements of ASTM designation A 82.

Wire mesh shall meet the requirements of ASTM designation A 185. Overlapping of wire mesh reinforcing shall be a minimum of 300 mm and be wired together.

Bar reinforcing shall meet ASTM Designation A 184 and ASTM Designation A 304 intermediate grade new billet deformed steel. Overlapping of bar reinforcing shall be 30 bar diameters and be wired together.

The mesh and/or bar reinforcing shall be supported above the compacted gravel base to ensure a minimum 50 mm cover of concrete. The Engineer shall approve the manner of supporting the reinforcing. Concrete with wire mesh position at the bottom of the concrete element shall be deemed unacceptable.

2) Wire Mesh

A single layer of 150 mm by 150 mm No. 10 by 10 gauge wire mesh shall be installed in private residential driveway crossings and commercial sidewalks.

A double layer of 150 mm by 150 mm, No. 10 by 10 gauge wire mesh shall be installed in public lanes and commercial driveway crossings.

The mesh shall extend the entire width of the crossing. In aprons, the mesh shall extend to the full width, special attention being made that the mesh extends into the apron's corners. All acute angle apron corners shall be constructed and reinforced as shown in the Standard Drawing 454.1013.004.

Reinforcing mesh shall be rolled or otherwise straightened to make a perfectly flat surface before placing.

3) Reinforcing Bars

A 10M reinforcing bar shall be installed, as shown in the drawings, in separate curb and gutter at all crossings.

4) Synthetic Fibre Concrete

The Engineer may specify that synthetic fibre concrete is used instead of steel-reinforced concrete.

5) Bull Noses on Medians

Where bullnoses are to be constructed at the ends of medians, reinforcing bars may be left extending from the median to tie into the bullnose.

311.06.00 – Concrete Placing

311.06.01 – General

The Contractor shall notify the Pavements, Soil, and Asset Management (PSAM) dispatcher of ROADS of their intention to place concrete by 15:00 hours (3:00 p.m.) of the previous working day to permit arrangements to be made for the inspection and testing of the concrete. Contractor notification directly to a testing agency shall not relieve their obligation in this regard.

Advice as to work for later than the following working day, except in the case of weekends, shall be taken as advice only and shall not constitute notification as required under this section.

Note: Pavements, Soil, and Asset Management (PSAM) maintain a 24-hour answering service at 403-268-1602.

After mixing, the concrete shall be transported to the job site and delivered as close as possible to the point of deposit. Re-handling of concrete shall not be permitted.

Concrete operations shall be continuous until the section, panel, or scheduled pour is completed.

311.06.02 – Placing of Concrete

Concrete operations shall be continuous until the section, panel, or scheduled pour is completed.

Placing concrete during the rain or when there is imminent danger of rain is at the Contractor's risk.

Lateral movement of concrete can cause segregation and shall not be permitted. Concrete shall be compacted thoroughly and uniformly using hand-tamping tools, vibrators, or finishing machines to obtain a dense, homogenous structure, free of cold joints, fill planes, voids, and honeycombing. Special care shall be taken to place the concrete against the forms, particularly in corners, to prevent voids, rough areas, and honeycombing.

Freshly placed concrete shall be protected against adverse conditions such as high wind, precipitation, freezing high temperatures, temperature differentials, and moisture loss for the period of time necessary to develop the desired properties of the concrete.

311.06.03 – Addition of Water on the Job Site

The concrete supplier may add water to bring the concrete up to the designated slump provisional to the following requirements:

- The specified water-to-cementing materials ratio is not exceeded.
- No more than 60 minutes have elapsed from the time of batching.
- No more than the lesser of 16L/m³ or 10 % of the mixing water shall be added.

311.06.04 – Air Adjustment on the Job Site

One adjustment of air on-site may be allowed, provided that the adjustment is made under the supervision of the concrete supplier.

The use of de-air entraining admixtures shall not be allowed.

311.06.05 – Joints

1) Expansion Joints

Lateral expansion joints are required at the beginning and end of every corner. The joint shall consist of an approved mastic preformed material, 15 mm by 90 mm cross-section, laid plumb and straight, 6 mm below the finished sidewalk grade.



2) Contraction Joints

Contraction joints shall be cut at every 1.5 m using a marking tool or other approved method. Joints shall not be less than 30 mm in depth and 6 mm in width. The edges of the joint shall be rounded off with an edger having a radius of 6 mm.

Contraction joints in medians, traffic islands, and gores shall extend the entire width of the median, traffic island, curb and gutter, and gore. If the matching of joints is impossible because of irregular shapes, the Engineer may approve an alternate jointing pattern.

Contraction joints in monolithic sidewalk shall extend through the entire width of the sidewalk and curb and gutter.

Contraction joints in regional pathways shall be sawed. In lieu of sawing, the tool mark shall be broomed after cutting.

Contraction joints at catch basins shall be cut through the entire width of the sidewalk in line with both outside edges of the catch basin side inlet.

3) Sawed Joints

Saw cuts as specified are made with a concrete saw capable of producing a true straight joint of constant depth as specified.

4) Surface Joints

Surface joints shall be 15 mm in depth and 6 mm in width. The edge of the joint shall be rounded off with an edger having a radius of 6 mm.

5) Isolation Joints

Expansion joint material, 15 mm thick, and the full depth of the sidewalk shall be placed around all surface installations and between the sidewalk and existing buildings.

The Contractor shall be required to carefully fit, cut, and mark the sidewalk around all openings, iron covers, manholes, vaults, waterworks stop cock boxes, lamp standards, hydrants, poles, and other surface installations in accordance with Standard Drawing 454.1013.018. The surface joint shall be neatly tooled and marked to the satisfaction of the Engineer.

311.07.00 – Finishing

311.07.01 – Trowelling and Broom Finish

Application of water to the concrete surface to aid finishing is not permitted. Fogging and/or applying admixtures to control surface evaporation is acceptable.

A steel trowel finish shall not be applied to air entrained concrete. One or more passes of a magnesium float shall be made at suitable time intervals to obtain a level finish free of ridges.

Broom finish shall be applied when concrete has hardened sufficiently. The broom strokes should be square across the slab with adjacent strokes slightly overlapped to produce regular corrugations not over 3 mm in depth. The broom finish shall be carried out in accordance with applicable drawings and such a manner and at such a time as to minimize the depth and quantity of broom marks.

Broom finish shall be applied perpendicular to the pedestrian traffic except at crossings brushed perpendicular to the vehicle traffic.

311.07.02 – Tolerances

After trowelling, the surface grade along the lip of the gutter shall be true to an accuracy of plus or minus 6 mm in 3 m. The maximum allowable variation across the gutter shall be 3 mm.

All concrete work shall meet the following tolerances:

- The elevation of any given point shall not vary by more than 20 mm from the design grades.
- Deviations in alignment at any given point from that given on the survey stakes shall not exceed 15 mm, and the fluctuations in the alignment shall not be greater than 25 mm in 100 m.

311.08.00 – Curing

A curing compound shall protect the surface of the concrete. The material shall be applied uniformly; the application rate shall be as per the manufacturer's recommendations.

311.09.00 – Commercial Sidewalks

311.09.01 – General

All of the previous Sidewalk Specifications do apply to Commercial Sidewalks except as amended in this section.

311.09.02 – Concrete

Concrete is to meet the requirements of section 311.00.00 – Concrete Sidewalk, Curb and Gutter.

High early strength concrete shall be placed at lane crossings as required at no extra cost to The City.

311.09.03 – Breaking Out

The breaking out of the existing sidewalk and/or curb and gutter shall not commence until the Engineer, and the Contractor have measured the involved areas. The Transportation Department shall be notified where parking meters are removed so that the parking meter heads may be removed before breakout begins. The Contractor shall not remove the meter heads or remove the meter standards with the heads attached. All traffic signposts, parking meter standards, and like utilities shall be carefully removed and preserved by the Contractor at their expense. All hand chipping and repairs to building entrances, tiles, etc., shall be deemed incidental to the Unit Rates. No allowance shall be made for extras of this nature.

311.09.04 – Excavation for Deep Base

The excavation shall extend 600 mm out from the face of the curb and 300 mm out from the back of the walk where there are no adjacent buildings to a depth indicated by the Engineer and shall comply with all conditions as outlined in section 302.00.00 – Earthwork.

The Contractor shall at all times be responsible for the proper support of transit poles and electric light standards. The bottom of the excavation shall be to the proper grade and cross-section. If the Contractor excavates below grade, they shall backfill with approved base gravel, compacted to the Engineer's satisfaction at no extra cost to The City. The Engineer shall approve all excavation before proceeding with the construction of the base.

311.09.05 – Base Gravel Fill

The Contractor shall supply approved base gravel according to Specifications and provide all material and labour necessary to load, haul, place, and compact said gravel on the finished sub-grade as specified under section 304.00.00 – Utility Trench Backfill Regulations. The compacted base gravel shall be carried over the full extent of the excavation as indicated in the Standard Commercial Sidewalk Drawing and as noted above. The additional excavation, backfill, and compaction adjacent to the sidewalk and curb and gutter structure shall be deemed incidental to the Unit Rate for base gravel fill.

311.09.06 – Crushed Gravel Base

Sufficient crushed gravel to provide a levelling base shall be placed on top of the base gravel fill and extended to the gutter's edge only.

311.09.07 – Insulation

Rigid-foam insulation shall be used to construct all commercial sidewalk where the sidewalk is < 3 m from a structure, as shown on the Standard Drawing 454.1013.011.

311.09.08 – Special Finish

Where additional finishing techniques are required on commercial sidewalk, payment shall be made at the Unit Rate.

311.10.00 – Crossings, Bus Stop Aprons and Wheel Chair Ramps

311.10.01 – General

Concrete is to meet the requirements of section 311.00.00 – Concrete Sidewalk, Curb and Gutter.

Payment for high early strength concrete shall be allowed only on work orders given to the Contractor after September 30.

311.10.02 – Contractor's Responsibility

1) Public Lane Crossings

The Contractor shall be responsible for the correct placing of all public lane crossings. Where necessary, the location of public lane crossings shall be supplied by the Engineer. Unless the lane is hard-surfaced, a 250 mm concrete apron shall be required at all public lane crossings where no sidewalk is present or proposed.

Where the sidewalk and the curb are separate, a driveway crossing apron between the curb and sidewalk shall be placed at all public lane crossings unless directed otherwise by the Engineer.

2) Private Driveway Crossings

In the case of private driveway crossings, the Contractor shall be responsible only for those driveway crossings that are marked by signs or when one or more of the following conditions exist:

- A sidewalk or curb and gutter were previously cut down for crossings.
- A dirt, gravel, asphalt, or concrete driveway already exists on private property.
- A garage already exists on private property.
- A vehicle gate exists in a fence on private property.
- Loading doors are present on commercial buildings that are built to or near the property line.

A 250 mm concrete apron shall be required at all driveway crossings where no sidewalk is present or proposed unless the driveway is hard-surfaced.

3) Construction Scheduling

Weather permitting, the Contractor shall start construction within two weeks from the date the work order is issued and shall be completed within two weeks from the commencement of work.

Where the completion of other work, such as paving, is contingent upon crossing construction, the Contractor shall expedite the crossing construction.

311.10.03 – Regulations Governing Private Driveway Crossings

- Dimensions for driveways shall be in accordance with the Standard Drawing 454.1010.004 and 454.1010.005.
- Driveways shall not front on a freeway, expressway, or major road. City Bylaw 8500, Appendix A shall apply.
- A minimum of 6.7 m from the back of the walk to the front of the parking stall shall be required.
- A minimum of 2.75 m shall exist between the building and the property line.
- If a common driveway is requested in writing by both property owners concerned, the distance between buildings shall be a minimum of 2.75 m.

- Where a private driveway crossing and public lane crossing adjoin, no island shall be required unless a pole or utility is located within 1.5 of the walk. In this event, an island of sufficient width shall be constructed to protect the pole or utility.
- Except in the case of a common driveway, curb depressions shall not overlap the extension of a property line.
- A driveway shall not be constructed on a corner radius except with the approval of the Engineer.
- Driveways on corner properties shall be a minimum of 12 m apart, measured at the curb line.
- Driveways are not permitted within a crosswalk.
- Driveways are not permitted within a bus zone unless approved by the Engineer.

The City shall be responsible for compensating the Contractor for any changes made to any crossing covered by the above conditions unless the Engineer deems the necessary changes are due to negligence on the part of the Contractor in not placing or not placing correctly, the crossing. The decision of the Engineer shall be final in any matter pertaining to crossings.

311.10.04 – Reinforced Crossings

Where the boulevard width between separate sidewalk and curb and gutter is 1 m or less, the concrete apron shall be constructed monolithic with the separate sidewalk. A deep tool joint of 35 mm shall be installed along the face of the walk for the entire width of the crossing. The edge of the joint shall be rounded off with an edger having an arc of a circle of 6 mm radius.

Where the boulevard is greater than 1 m, the apron shall be constructed separately from the sidewalk, curb, and gutter. An approved 15 mm preformed expansion joint shall extend through the full depth and width of the crossing between the sidewalk and apron.

In each of the above cases, an approved 15 mm preformed expansion joint shall extend through the full depth and width of the crossing between the apron and curb and gutter.

The requirement for expansion joints in crossings may be waived at the discretion of the Engineer.

Where it may be necessary to depress either or both of the face of sidewalk and back of sidewalk to facilitate easier vehicular access at crossings, the Contractor shall obtain special permission from the Engineer.

Where driveway crossings exceed 6 m in length, 30 mm deep contraction joints may be constructed laterally across the driveway crossing.

311.10.05 – Curb and Gutter, Separate Sidewalk and Monolithic Sidewalk Crossings

1) Curb and Gutter

Crossings on the curb and gutter shall be constructed in accordance with the applicable drawings.

2) Separate Sidewalk

At private driveway crossings, the required sidewalk slab thickness shall be 100 mm.

At public lane and commercial crossings, the required sidewalk slab thickness shall be 150 mm.

3) Monolithic Sidewalk

Driveway crossings shall be constructed in accordance with curb and gutter and sidewalk Specifications. Reinforcing shall extend into the curb and gutter.

311.10.06 – Bus Stop Aprons

At bus stop aprons, the required sidewalk slab shall be 100 mm and be constructed in accordance with either Standard Drawing No. 454.1012.001 or 454.1012.002. An expansion joint shall be required where the apron abuts on the existing sidewalk or curb and gutter. The contact edge of such structures shall be faced to provide a straight and plumb surface for the joint. The requirement for expansion joints may be waived at the discretion of the Engineer.

Curb placed adjacent to bus stop aprons shall be standard rather than rolled.

311.10.07 – Wheelchair Ramps

Wheelchair ramps shall be constructed at all intersection locations where sidewalks abut curbs and gutters and at Community Mailbox locations. Wheelchair ramps are not required where sidewalks are not provided or planned.

Where the design of intersections includes medians, traffic islands, etc., ramps shall be formed where the normal passage of wheelchairs occurs. Where the median or traffic island is less than 3 m in width, the ramps shall be cut straight through on a continuous grade providing the positive drainage is maintained. Payment for wheelchair ramps shall be under the Unit Rate for the sidewalk and curb, and gutter. No separate payment shall be made for wheelchair ramps.

311.10.08 – Temporary Crossings

1) Temporary Gravel Driveway Crossing

The Contractor shall supply and place 100 mm of approved crushed gravel on top of the finished sub-base. Upon the above-mentioned layer, the Contractor shall supply and place 50 mm of approved gravel crushed to a maximum size of 25 mm. The gravel shall be levelled off at a slope of 6 mm per 300 mm towards the street and be properly tamped or rolled to the Engineer's satisfaction.

2) Temporary Asphalt Driveway Crossing

The Contractor shall construct temporary asphalt driveway crossings as required on a compacted 100 mm crushed gravel base. A 50 mm mat of hot asphalt mixture Type B shall be placed on the prepared base for residential driveway crossings. A 100 mm mat shall be required for commercial crossings. Construction procedure shall conform to section 308.00.00 – Pavement Design.

311.11.00 – Concrete Walkways and Bicycle Paths

Construction of concrete walkways and bicycle paths shall conform to the requirements of section 309.02.00 – Asphalt Walkways and Bicycle Paths, except that the surfacing material shall conform to the requirements of section 311.01.00 – General. A longitudinal centreline tool joint or saw cut shall be made in all concrete walkways and bicycle paths wider than 2,440 mm. Contraction joints shall be made in accordance with section 311.06.05 – Joints.

311.12.00 – Rehabilitation

311.12.01 – General

When the Contractor shall be required to replace existing City sidewalk and/or curb and gutter on which private walks and/or driveways abut, it shall be their responsibility to replace the said walks and driveways to meet the new City sidewalk and/or curb and gutter to the satisfaction of the Engineer. Payment for the above work shall be deemed incidental to the Unit Rate of the specific sidewalk.

Should this work not be completed within two weeks of the construction commencement date, The City may complete the work and any expenses incurred are charged to the Contractor.

311.12.02 – Backfilling and Backsloping

Where excavation has been made wider than the finished concrete width, this area between the excavation and the finished concrete surface, when both are level, shall be filled with a well-compacted soil substantially free from any granular material and shaped as specified herein. In locations susceptible to washout, the fill material shall be 50 mm gravel or as directed by the Engineer.

All backfilling and backsloping for sidewalk, curb and gutter, combined sidewalk, curb and gutter, aprons, and catch basins shall be at a slope of 3:1 or a slope approved by the Engineer both to start at the finished concrete surface.

All of the costs involved in backfilling and backsloping are borne by the Contractor. Backfilling and backsloping for lane crossings and private driveway crossings shall be at a slope of 1:10 or a slope approved by the Engineer, both to start at the finished concrete surface. The backfill for all crossings shall be well compacted 50 mm crushed gravel. In no case does the Contractor backfill or backslope beyond the property line without permission of the Engineer.

All costs involved in backsloping and gravelling these lane crossings and private driveway crossings shall be borne by the Contractor.

Where a backfill or any other fill is made by the Contractor such fill shall be maintained unless otherwise directed by the Engineer at its original slope, at no cost to The City, until the work is measured and checked.

Where excavation is carried out past the end of any sidewalk, curb, and gutter or combined sidewalk, curb, and gutter, the Contractor shall adequately compact fill in the excavated area to present a smooth walking surface when completed.

311.12.03 – Levelling Boulevards

In addition to all excavation and backsloping covered under these Specifications, the Contractor, at their own expense, shall grade at a slope of two percent towards the road, the unimproved boulevard strips between the sidewalk and curb and gutter, or roadway where no curb and gutter exists.

Improved boulevards between the sidewalk and curb and gutter may be graded where the owner agrees and is aware that he shall loam at their own expense. Otherwise, an improved boulevard shall be backsloped at a 3:1 slope from the new structure.

311.12.04 – Miscellaneous Loaming

Where established lawns are disrupted by construction, they shall be restored to equal or better condition using approved loam.

The Contractor shall backfill and compact any part or the whole of any excavation deemed necessary for the satisfactory completion of the work involved in this Contract with a suitable backfill material before using approved loam.

All loam delivered shall be free of quack grass, perennial weeds, and/or any other plants or organic or inorganic matter that renders the loam unsatisfactory in the Engineer's opinion.

311.12.05 – Asphalt Rehabilitation

The Contractor shall be responsible for the Asphalt Rehabilitation to Specifications of paved streets damaged during the construction of the work under this Contract.

Unless otherwise specified, the hot asphalt concrete mixture shall be Mix "B".

All asphalt rehabilitation shall conform to Specifications subject to the following modifications:

- Asphalt shall be required for the entire fill operation or lean concrete fill topped with 50 mm of hot asphalt concrete.

Asphalt rehabilitation shall be carried out to the Engineer's satisfaction within five days of the concrete work completion. Work not completed within this period may be done by The City, with all expenses for the rehabilitation charged to the Contractor.

311.12.06 – Mortar and/or Tar Cleanup

Mortar and/or tar on the sidewalk and/or curb and gutter, which is considered detrimental to pedestrian safety or appearance of the sidewalk and/or curb and gutter shall be removed or the sidewalk and/or curb and gutter replaced, at the discretion of the Engineer.

311.13.00 – Maintenance Standards

Maintenance Standards in Table 62: Replacement or Liquidated Damages Based on the Percent Affected Area of the Surface Condition shall apply at the final acceptance inspection to all sidewalks, curb and gutter, guard rail and related on grade concrete work.

311.13.01 – Surface Condition

- Loss of surface mortar and/or aggregate between 2 mm and 5 mm deep. Cracking shall not be included if there is no evidence of loose or lifting mortar.
- Loss of surface mortar and/or aggregate greater than 5 mm deep.

Replacement or liquidated damages are based on the surface area as in Table 62: Replacement or Liquidated Damages Based on the Percent Affected Area of the Surface Condition and Table 63: Replacement of Concrete Based on Type.

TABLE 62: REPLACEMENT OR LIQUIDATED DAMAGES BASED ON THE PERCENT AFFECTED AREA OF THE SURFACE CONDITION

Surface Condition	Affected Surface Area (%)	
	1. Loss of surface mortar and/or aggregate between 2 mm and 5 mm deep	5 to 15
>15		Replace
2. Loss of surface mortar and/or aggregate greater than 5 mm deep	0 to 5	Liquidated damages as per 310.06.04
	> 5	Replace

TABLE 63: REPLACEMENT OF CONCRETE BASED ON TYPE

% of Surface Area, Based on	Replacement
Separate Sidewalk Flag	Separate Sidewalk Flag
Monolithic Sidewalk Flag	Monolithic Sidewalk Section
3m Curb Section	3m Curb and Gutter Section
3m Gutter Section	3m Curb and Gutter Section

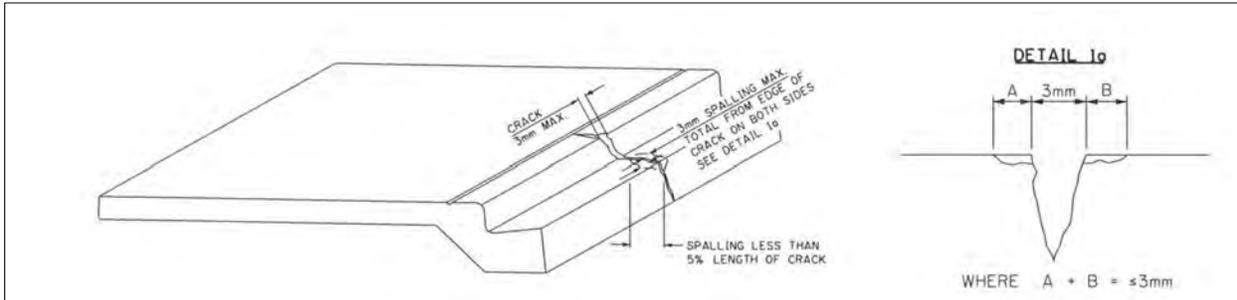
311.13.02 – Sidewalk, Curb and Gutter Failures

Replacement of affected sections shall be required when one or more of the following exist:

1a) Crack greater than 3 mm in width in curb & gutter

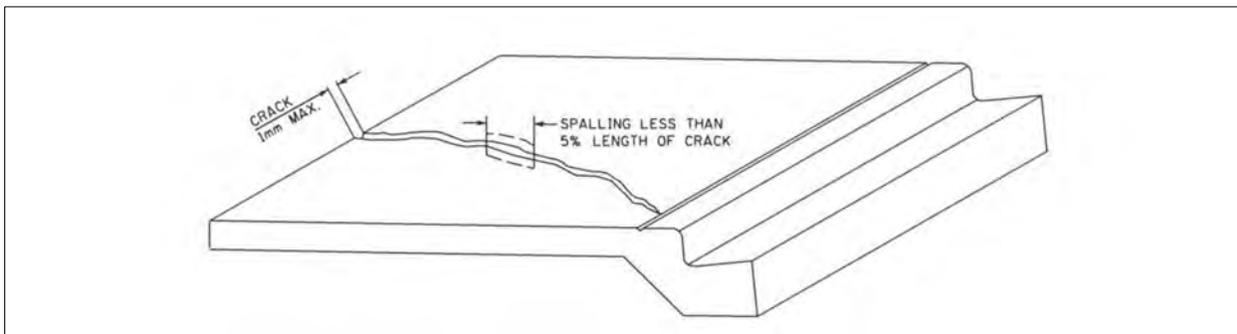
- Excluding expansion joint.
- No vertical displacement.
- No chipping greater than 3 mm.
- Less than 5 % in length of crack with spalling edges.

- Spalling edges maximum total width for both sides is less than 3 mm from the outer edge of the crack (see detail).
- Special consideration if the crack is located at invert of curb and gutter.



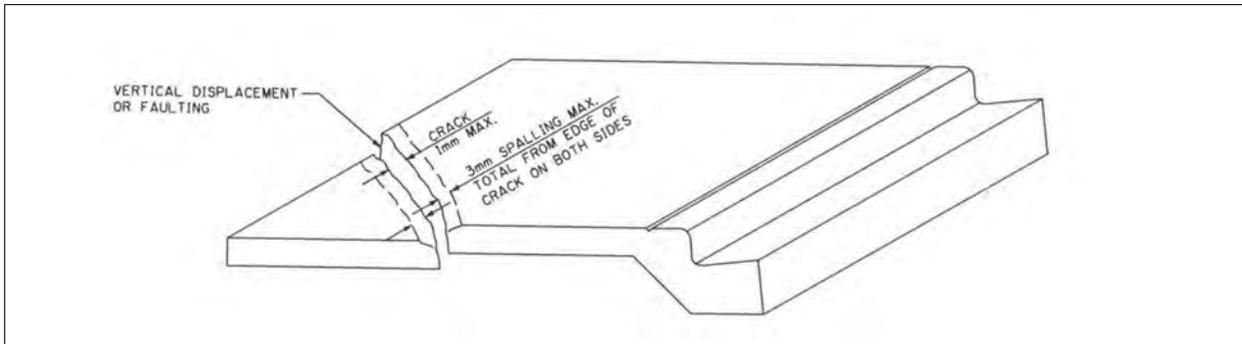
1b) Crack greater than 1 mm in width on flag of sidewalk

- Excluding expansion joint.
- No vertical displacement.
- No chipping greater than 3 mm.
- Less than 5 % in length of crack with spalling edges.
- Spalling edges maximum total width for both sides is less than 3 mm from outer edge of the crack (see detail 1a).



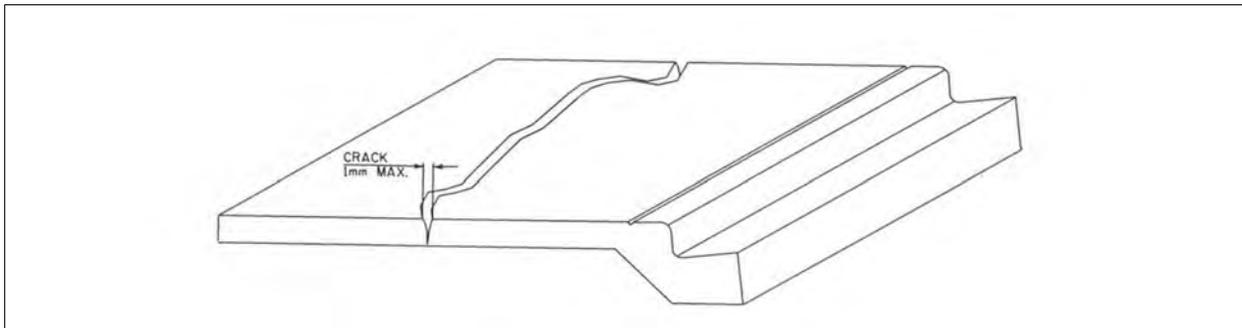
2) Cracks with

- Any vertical displacement or faulting greater than 1mm.



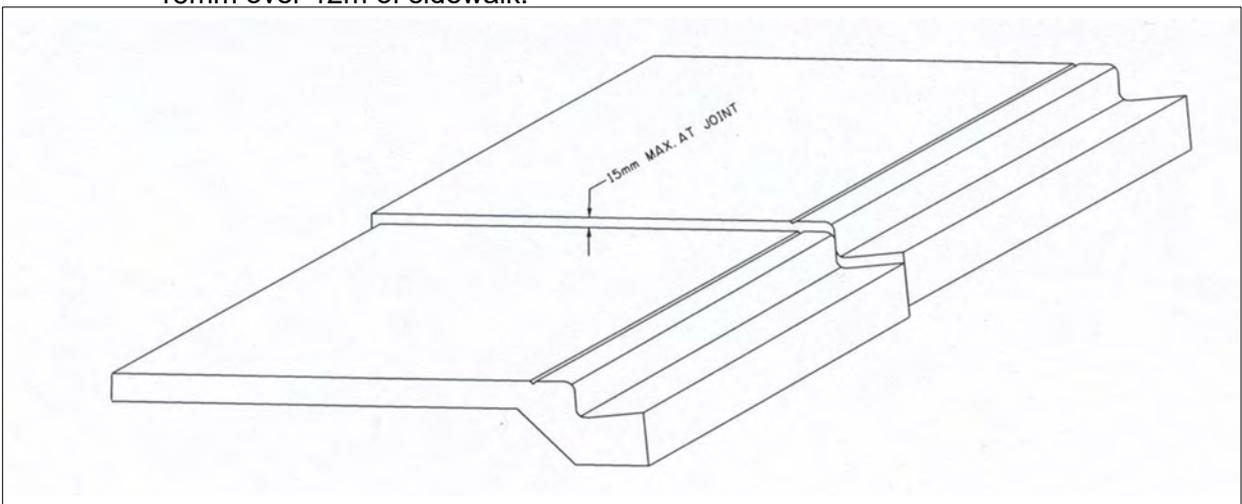
3) Longitudinal Crack

- Greater than 1mm in width.



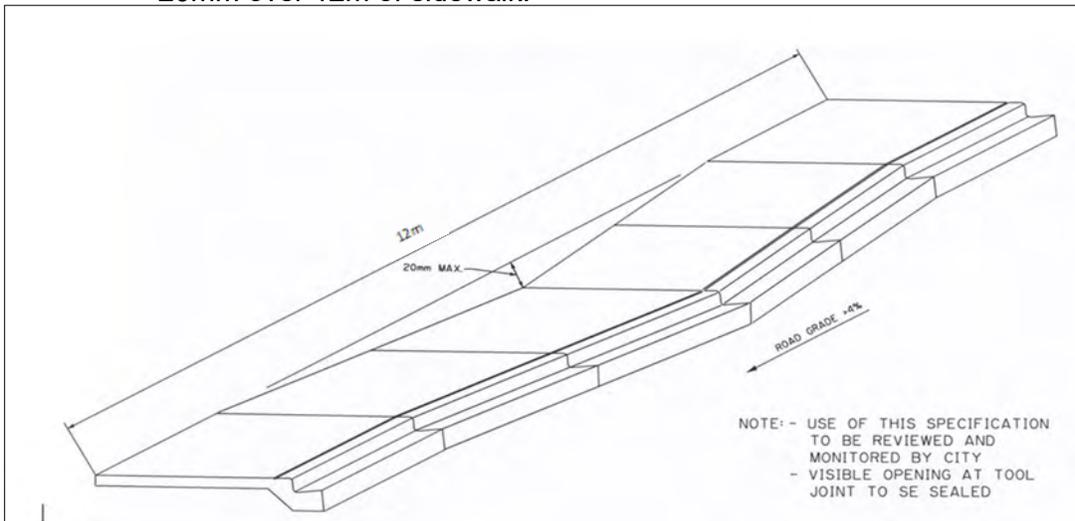
4a) Joint displacement or settlement on a road grade less than or equal to 4 %

- At a joint of greater than 15 mm.
- Settlements of sidewalks and curb and gutter at a rate greater than 15mm over 12m of sidewalk.

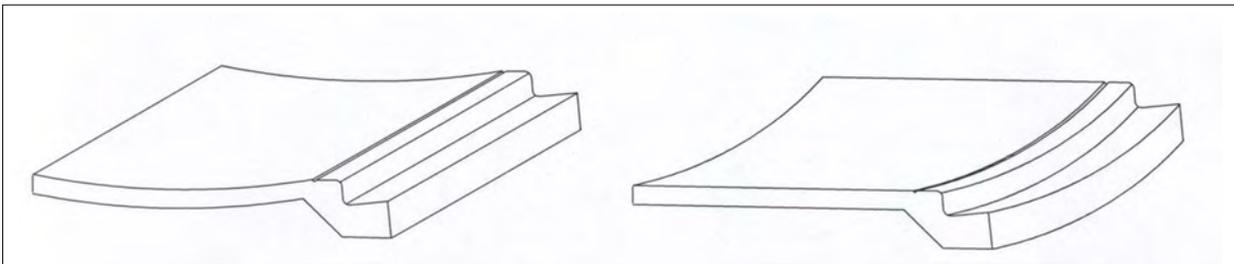


4b) Settlement on a road grade greater than 4 %

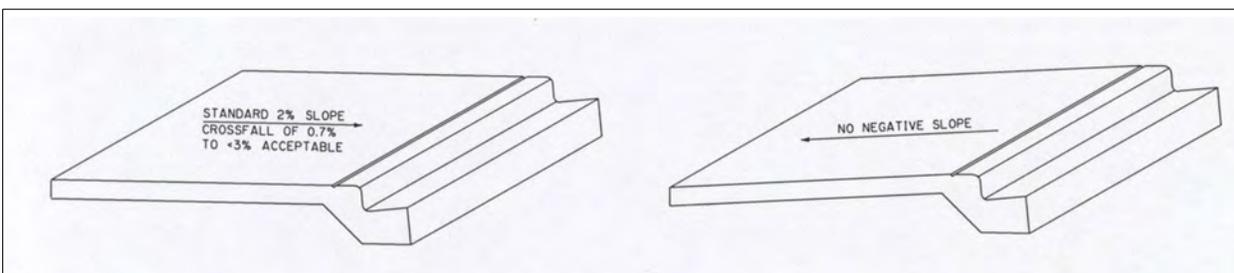
- Any part of the sidewalk or curb and gutter at a rate greater than 20mm over 12m of sidewalk.



5) Dished sidewalk or curb & gutter

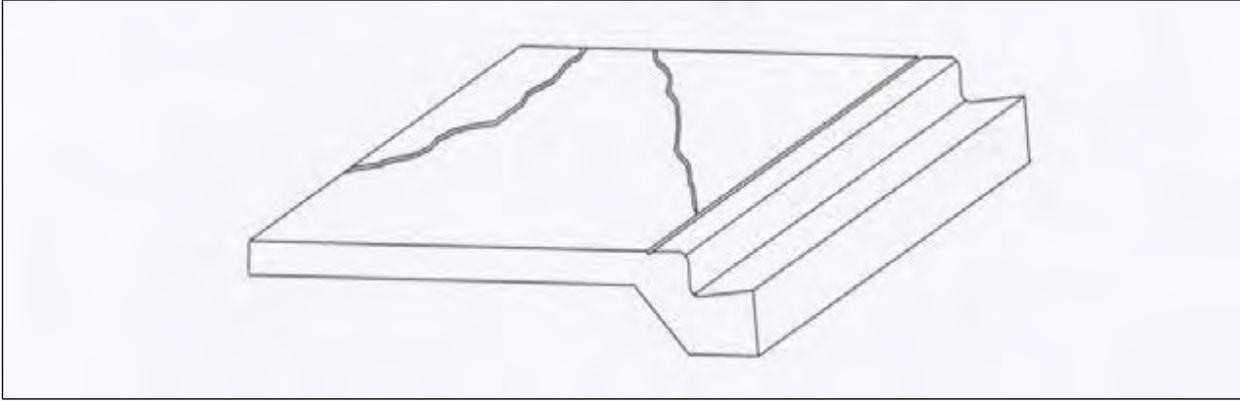


6) Reverse cross fall or cross fall greater than 3 % or less than 0.7 %

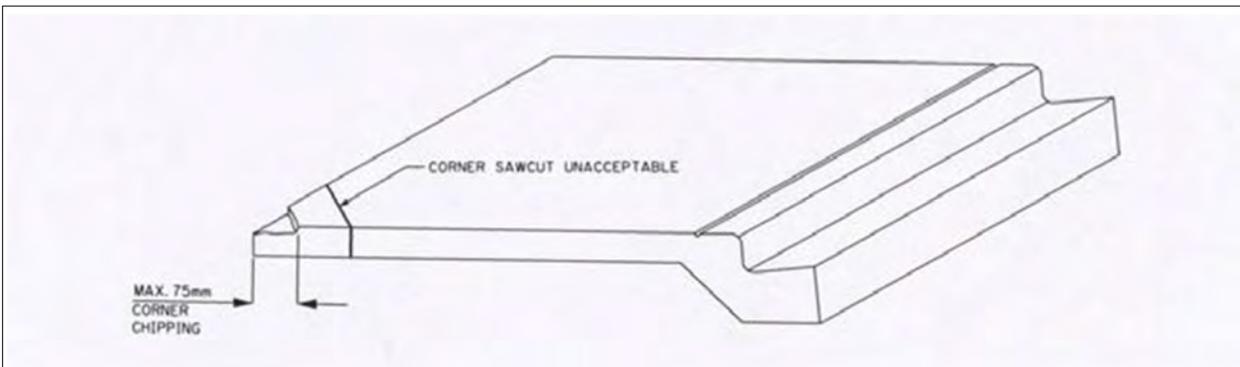


7) Random crackling

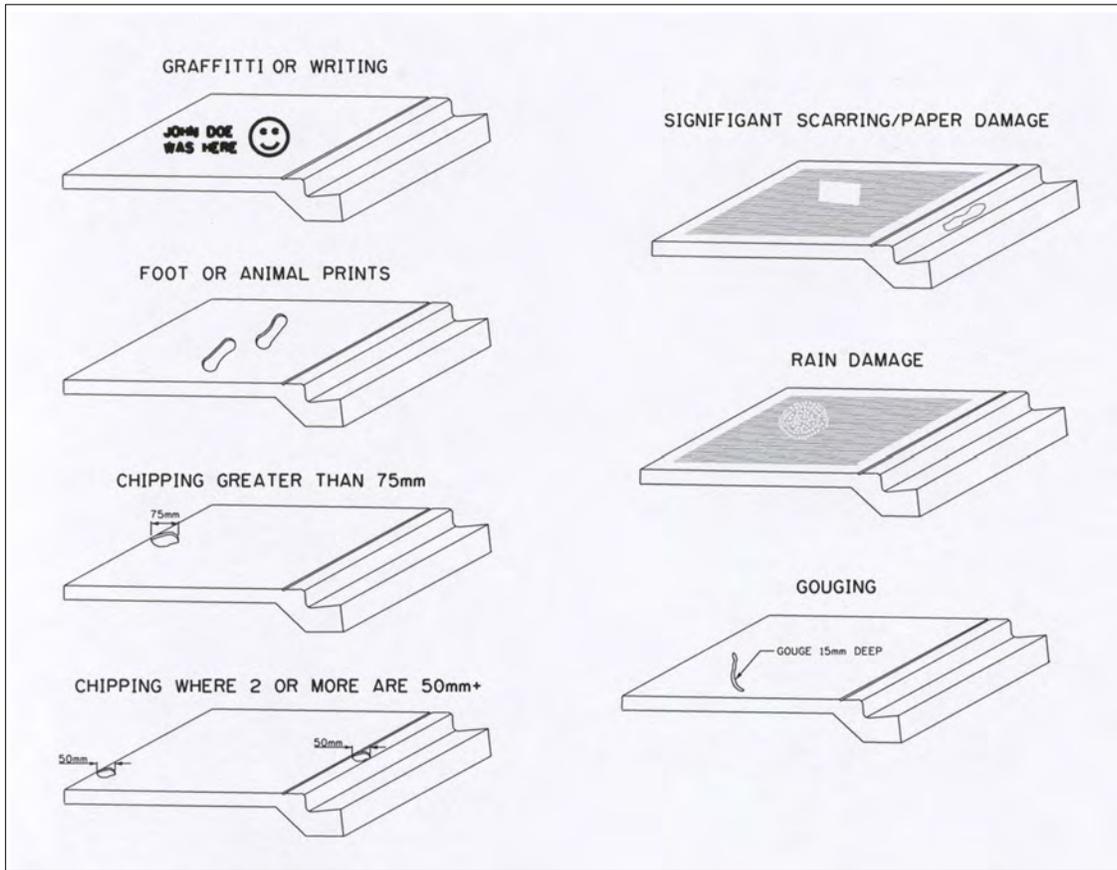
- Two or more cracks between any two edges.
- Cracks of any size in one section of sidewalk or curb & gutter, including hairline or pencil cracks.



8) Corner chip greater than 75 mm



9) Deficiencies considered detrimental to pedestrian safety or appearance of the sidewalk and/or curb & gutter, including but not limited to the following:



311.13.03 – Sectional Replacement

All breakouts shall end at a contraction, expansion or surface joint. The edge of a surface mark shall be sawn to a depth of 50 mm minimum, while contraction joints may be neatly hand chiselled to produce a true straight joint. The contact edge shall be exposed to produce a good bond.

311.13.04 – Specifications

All replacement work shall be placed in accordance with the Detailed Sidewalk Specifications.

311.13.05 – Grouting

No grouting of cracks shall be allowed.

311.13.06 – Sealants

Joints that have expanded up to a maximum of 13 mm without vertical displacement shall be sealed using an approved flexible sealant.

311.14.00 – Quantity Measurements

311.14.01 – Excavation

1) General

The Unit Rates for sidewalk, curb and gutter, combined sidewalk, curb and gutter and concrete invert crossing shall include all excavation where the subgrade is 600 mm or less below the existing grade. When the design grade is more than 600 mm below the existing grade, payment shall be made on the computed in place volume between the 600 mm grade and the design subgrade. In place volume shall be computed prior to excavation.

2) Driveway Crossings, Bus Stop Aprons and Wheelchair Ramps

For all "Driveway, Bus Stop Apron and Wheelchair Ramp" Contracts, the Unit Rate for concrete work includes ordinary excavation costs as noted above, except overhaul costs.

3) Special Project Contracts

For all Special Project Contracts, where excavation costs are covered by payment for earthwork, the Unit Rate for concrete work shall not cover any excavation costs other than base preparation.

311.14.02 – Concrete

1) Sidewalk, Combined Sidewalk, Curb and Gutter

- Measurement shall be taken on the centre line of the structure.
- Measurement for the sidewalk width shall be between the face and the back of walk.
- Measurement for the combined sidewalk, curb and gutter width shall be between the back of curb and the back of walk.
- Additional sidewalk width, i.e., other than specified in the standard drawings, shall be paid at the unit rate.

2) Curb and Gutter

- Measurement shall be taken along the face of curb.

3) Aprons

- Measurement for apron lengths shall be the mean length.
- Measurement for apron widths shall be the distance between the back of curb and face of walk.

4) Irregular Shapes (triangles, etc.)

- Measurements are made and the areas computed.

Note: No measurement shall be made on any block where the backfill and/or clean-up have not been carried out in accordance with these Specifications or where the walk is not complete.

312.00.00 – Portland Cement Pavement

312.01.00 – General

This specification covers the requirements for the construction of Portland cement concrete pavement (PCC) for roadway applications to dimensions, lines grades, and typical cross-sections as shown on the Drawings.

312.01.01 – Reference Standards

- CSA A3000-08, Cementitious Materials Compendium.
- CSA A23.1-09, Concrete Materials and Methods of Concrete Construction.
- CSA A23.2-09, Test Methods and Standard Practices for Concrete.
- CSA A283-06 Qualification Code for Concrete Testing Laboratories.
- Related Sections: The City of Calgary Roads - Standard specifications Roads Construction, Section 310.00.00 Portland Cement Concrete.

312.01.02 – Submittals

- Submit the proposed mix design for PCC mix to the Engineer for approval four weeks prior to the commencement of the Contract. Mix design documentation shall include all components of the mix and quantities of the materials used.
- Submit copies of mill certificate test reports of cement and fly ash.
- Submit the test results for each aggregate source to be used for compliance with 310.02.03 – Aggregate.
- Submit data on all proposed concrete admixtures.
- Submit data on proposed fibres.
- Submit the results of trial batch testing for each type of concrete for compliance with concrete properties specified in relevant sections of this Specification. Any change in the materials and/or quantities shall require a new trial batch testing.

312.02.00 – Materials

312.02.01 – Cementing Materials

Cementing materials shall meet the requirements of section 310.02.01 – Cementing Materials.

312.02.02 – Supplementary Cementing Materials

Supplementary cementing materials shall meet the requirements of section 310.02.02 – Supplementary Cementing Materials.

312.02.03 – Aggregate

Aggregates shall meet the requirements of section 310.02.03 – Aggregate.

312.02.04 – Water

Water shall meet the requirements of 310.02.04 – Water.

312.02.05 – Admixtures

Admixtures shall meet the requirements of section 310.02.05 – Admixtures. Admixtures containing calcium chloride shall not be used.

Calcium chloride shall not be used in concrete pavement applications.

312.02.06 – Fibres

Fibres shall meet the requirements of section 310.02.06 – Fibres.

312.02.07 – Curing Membrane

Curing membrane shall meet the requirements of section 310.02.07 – Curing Membrane.

The application and dosage of the curing membrane shall follow the manufacturer's recommendation for the product.

312.02.08 – Joint Materials

1) Preformed Sealant

Preformed sealant shall conform to requirements of ASTM Designation D-1751.

2) Hot Pour Sealant

Hot poured sealants are asphalt-latex compounds conforming to the requirements of ASTM D1190.

312.02.09 – Reinforcing

- Dowels and tie-bars shall conform to CSA G40.21.
- Epoxy-coated bars shall conform to ASTM A 775.
- Smooth dowels shall be corrosion resistant, clean, straight, and epoxy coated steel bars, grade 300.
- Deformed dowels shall be corrosion resistant, clean, straight, and epoxy coated steel bars, grade 400.
- Tie-bars shall be epoxy coated deformed steel bars, grade 400.

312.03.00 – Concrete Mixes: Design and Trial Batch Testing

The Contractor shall undertake the concrete mix design and pay for all costs associated with the development, testing, and submissions of the mix designs and results of performance testing. In lieu of the trial batch testing, the Contractor may submit for review and consideration by the Engineer, mix design,



laboratory and field test results. All performance criteria of this Specification shall apply. Trial mixes shall be used to develop the relationship between compressive strength and flexural strength at ages seven days and 28 days and to demonstrate that the air entrainment provides the spacing factor not greater than 230 µm.

312.03.01 – Mix Properties

The mix properties of the concrete pavement shall conform to the following requirements.

TABLE 64: CONCRETE PAVEMENT MIX PROPERTIES

Cement	Supplementary Cementing Materials	Maximum Aggregate Size (mm)	Synthetic Fibre	w/cm	Plastic Air Content (%)	Slump (mm)
Type GU, cement content per mix design	Fly Ash, Type F ¹ Up to 20 % ²	20	Macrofibre, monofilament, per mix design	Max. 0.45	5 - 8	80 ± 20 (hand placing) ³

¹Maximum CaO content for Type F fly ash – 12%.

²Fly ash content by total mass of cementing materials.

³For slip form paving concrete slump – 20 ±10 mm, for fixed form paving with mechanical paver slump 45±15.

312.03.02 – Mix Performance

The mix performance of the concrete overlay shall conform to the following requirements.

TABLE 65: CONCRETE OVERLAY MIX PERFORMANCE

Flexural Strength at 28 Days (MPa)	Compressive Strength at 28 Days	Maximum Spacing Factor (ASTM C 457)
4.2	32 ¹	0.023 mm

¹The design 28-day compressive strength to be established on the trial batch testing to develop the relationship between compressive strength and specified flexural strength. Higher compressive strength than that for Class.

Higher compressive strength than that for Class C-2 exposure may be required to meet the flexural strength requirements.

312.04.00 – Equipment

312.04.01 – Concrete Production and Delivery

Concrete proportioning, mixing, and delivery shall be in accordance with CSA A23.1, Section 5, production and delivery.

Concrete suppliers shall submit certification of concrete production facilities in accordance with the Alberta Ready Mixed Concrete Association (ARMCA) audit checklist and instructions for each plant supplying concrete under the Contract.

312.04.02 – Slip-Form Paver

Portland cement concrete, placed by slip form pavers and related equipment, shall be to the depth, width, crown, and grade shown on the plans.

The slip-form paver shall be self-propelled and mounted on two sets of crawler treads, each not less than 250 mm wide and 6.5 m long, except where a widening strip is constructed adjacent to the previously constructed pavement. The propelling unit may be mounted on rubber-tired wheels and operated on the adjacent pavement. The machine shall be of ample strength to withstand severe use and fully and accurately adjustable for crown loss or other derangements due to wear.

Slip form pavers used in the pavement placement are subject to the Engineer's approval before their use. A test strip may be required to demonstrate that the pavement can be placed and consolidated properly to provide durable long lasting concrete pavement.

When slip-form and related equipment is used for placing of Portland Cement Concrete, Specifications relating to the use of fixed side forms or the use of equipment designated to ride on fixed forms shall not apply.

312.04.03 – Forms

Forms shall be of such cross-section and strength and so secured to resist the concrete pressure when placed and the impact and vibration of any equipment they support, without springing or settlement. The method of connection between sections shall be such that the joints shall not move in any direction.

All side forms for this work shall be of metal. These shall be shaped steel sections and shall have a depth of at least equal to the edge thickness of the work prescribed and shall have a base equalling 80 percent of the height of the form with a minimum base width of 150 mm.

The forms shall be free from warps, bends or kinks. Approved flexible forms shall be used for construction where the radius is 60 m or less.

312.04.04 – Additional Equipment

The Contractor shall furnish all other tools and supplies necessary for the proper execution of the work.

312.05.00 – Paving Operations

312.05.01 – General

Adjustments to equipment and working techniques are made as required to produce pavement of the specified standards of dimensions, strength, finish, and riding quality.

If a construction area fails to meet the Specifications requirements, it shall be removed at the direction of the Engineer and replaced at no expense to The City.

Weather Requirements

All-weather requirements outlined in 311.00.00 – Concrete Sidewalk, Curb and Gutter shall apply.

312.05.02 – Protection of Sub-grade

The finished sub-grade shall be maintained in a smooth and compacted condition until the concrete has been placed. No storage piles of fine or coarse aggregate are placed directly upon the finished sub-grade. The mixer, ready-mix trucks, or other equipment shall not operate between the forms in the paving lane unless conditions of the job do not permit operation from the shoulder or outside the lane. If it is necessary to operate trucks between the forms, and the trucks cause rutting or displacement of the sub-grade material, lighter trucks shall be used, or suitable runways shall be provided. The Contractor shall re-roll or hand-tamp the sub-grade to correct any rut or other objectionable irregularities that may have been caused by trucking.

312.05.03 – Setting Forms

The forms, when set, are uniformly supported for the entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are staggered and free from play or movement in any direction.

After the forms are set, they are checked with a three metres straightedge. The maximum deviation from the design elevation and alignment shall be:

- 3 mm for the top surface of any form or line of forms.
- 6 mm for the inside face of forms.

The Contractor shall check the alignment and grade elevations of the forms and the necessary corrections made immediately before placing the concrete. Forms remain in place at least 12 hours after the concrete has been placed against them. All forms shall be thoroughly cleaned and oiled each time they are used. Forms shall be removed during daylight hours only and in such a manner as to avoid damage to the pavement.

312.05.04 – Placing Concrete

Spreading shall be accomplished using a mechanical concrete spreader of a type and design approved by the Engineer unless the Engineer approves an alternative method.

The base shall be true to cross-section when placing the concrete, thoroughly consolidated and free of any soft areas. At all times during the operation, at least 150 m of foundation shall be prepared ahead of the paver.

Prior to placing concrete, the base surface shall be thoroughly wetted, so it will not absorb moisture from the concrete to be placed. The method of sprinkling shall be such that no pools of water form on the base.

No concrete shall be placed around manholes or other structures until they have been brought up to the

required grade or alignment or until expansion joint material is placed around them for the full depth of the pavement.

The concrete shall be deposited on the base in a manner requiring minimal re-handling. It shall be distributed to sufficient depth above the base that, when consolidated and finished, the slab thickness as shown on the plans shall be obtained at all points, and the surface shall not be below the grade specified at any point.

Concrete shall be deposited as near expansion and contraction joints as possible without disturbing them but shall not be dumped onto a joint assembly.

Concrete shall be thoroughly consolidated against and along the faces of all forms and the entire length and on both sides of all joint assemblies. Vibrators shall not be permitted to contact a joint assembly, the grade, or a side form. The vibrator shall never be operated longer than 15 seconds in any one location.

Longitudinal joints between lanes or sections are constructed in accordance with the details shown on the plans.

When concrete placement is interrupted for any reason longer than 30 minutes, an emergency construction joint shall be constructed as shown in the Standard Drawings. The amount of time a problem may occur depends on environmental conditions and the type of cementing materials used in the concrete mix. Except as provided above, no joint of any kind shall be placed across the pavement at any other location than that directed or shown on the plans. Sections less than 3 m in length are not permitted and, if constructed, are removed at the Contractor's own expense.

312.06.00 – Strike-Off, Consolidation and Finishing

312.06.01 – General

The sequence of operations shall be the strike-off and consolidation, floating if necessary, straight-edging, and final surface finish. When approved by the Engineer, the pavement shall be struck off and consolidated with a mechanical finishing machine, vibrating screed, or hand-finishing methods. A slip-form paver with provision for integral curb may be used. Adding water to the surface of the concrete to assist in finishing operations shall not be permitted.

312.06.02 – Placing and Finishing

1) Machine Placing and Finishing

The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing methods may be used only with the written permission of the Engineer, except in areas where the width of the slab changes.

During the operation of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. Except when making a construction joint, the finishing machine shall not

be operated beyond that point where the just-noted ridge, or surplus, of concrete, can be maintained ahead of the front screed.

Through the use of this machine, the concrete shall be left with a true and even surface, free from rock pockets. The pavement's surface shall be properly consolidated and finished to the exact grade elevation, crown, and cross-section shown on the plans.

After the concrete has been struck off and consolidated, it shall be further smoothed using a mechanical float of a design approved by the Engineer. The machine shall be of such a design that the float is operated transversely across the pavement, with its longitudinal axis approximately parallel to the centre line. Successive passes shall be lapped by at least half the length of the float.

After floating, the pavement shall be scraped with a straightedge. The straightedge shall be from two to three metres long and equipped with a handle of sufficient length to permit it to be operated from the edge of the pavement. The straightedge shall be operated so that any excess water, laitance, and inert material are removed from the surface of the pavement.

Prolonged operation over any given area shall be avoided.

Hand finishing tools shall be kept available for use in the event of a breakdown of the finishing machine.

2) Hand Placing and Finishing

When hand finishing is permitted, the concrete shall be struck off and consolidated by a vibrating screed to the exact elevation as shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off.

After the concrete has been struck off and consolidated, smooth it by using a float. The float shall not be less than 3.5 m long and 150 mm wide and shall be adequately stiffened and provide handles at each end. Hand finishing and the use of edging tools are kept to an absolute minimum. No tool marks of any kind should be present on the finished surface.

Prolonged operation over any given area shall be avoided.

3) Straight-Edge Finishing

After the floating is completed, but while the concrete is still plastic, minor irregularities and score marks remaining in the pavement surface are eliminated by means of long-handled magnesium bow floats and straightedges. When necessary, excess water and laitance are removed from the surface transversely by means of a finishing straightedge. The long-handled floats may be used to smooth and fill in open-textured areas in the pavement surface, but the final finish shall be made with the straightedge.

The use of long-handled floats shall be held to the minimum necessary to correct local surface unevenness not taken care of by the float. It shall not be used to float the entire pavement surface.

Straightedges shall not be less than 3 m in length and shall be operated from bridges and the side of the pavement. A straightedge operated from the side of the pavement shall be equipped with a handle 1 m

longer than half the width of the pavement. The surface shall be tested in trueness with a straightedge, which shall be held in successive positions parallel and at right angles to the centre line of the pavement in contact with the surface and the whole area covered as necessary to detect variations.

The straightedge shall be advanced along the pavement in successive stages not more than half its length. Depressions are immediately filled with freshly mixed concrete, struck-off, consolidated and refinished. Projections above the required elevations also shall be struck-off and refinished. The straightedge testing and finishing continue until the entire surface is free from observable departure from the straightedge and conforms to the required grade and contour. When the concrete is hardened, it shall conform with the surface requirements specified.

4) Surface Texturing

The surface shall be finished with a stiff-bristled broom to produce a non-slip concrete surface finish. Commence texturing immediately after float finishing.

Texturing shall be straight, precise, perpendicular to the paving lane, and not damage pavement edges. After the final finish, but before the concrete has taken its initial set, the pavement edges along each side of each slab and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints are worked with an approved tool. A well-defined and continuous radius shall be produced, and a smooth-dense mortar finish obtained when fixed form paving is used. Slipform pavement does not require edging.

312.06.03 – Pavement Protection

The Contractor shall have available materials to protect the surface of the plastic concrete against rain. When slip-form construction is being used, materials to protect the edges of the pavement are also required.

312.07.00 – Integral Curbs

Integral curbs may be used along the edges of all pavement where shown on the plans and are formed to the cross-section in accordance with the plans. They are constructed simultaneously with the pavement with extrusion equipment or hand-formed immediately after the finishing operation.

312.08.00 – Joints

312.08.01 – General

Joints shall be of the type shown on the plans and are constructed where designated on the plans or directed by the Engineer. The Engineer shall approve the base at joint locations before any joint materials are set in place.

All transverse joints are perpendicular to the direction of traffic, and longitudinal joints are parallel to the centre line of the pavement.

312.08.02 – Joint Construction

Joints shall be constructed as follows:

1) Sawed Weakened Plane Joint

Sawed contraction joints are created by sawing grooves in the surface of the pavement with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.

The grooves are cut to depths equal to one quarter the thickness of the concrete slab, and the width of the cut shall not exceed 6 mm.

Sawing of the joints begins as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually four to 24 hours. All joints are sawed before uncontrolled shrinkage cracking occurs. If necessary, the sawing operations are carried on both day and night, regardless of weather conditions. A stand-by saw shall be available in the event of a breakdown.

The sawing of any joint shall be omitted if a crack occurs at or near the joint location before the time of sawing. In general, all joints are sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes are sawed before uncontrolled cracking occurs. If extreme conditions make it impracticable to prevent erratic cracking by early sawing, the contraction joint grooves shall be formed before an initial set of concrete.

2) Isolation Joint

Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer. The thickness of the filler shall be 15 mm.

The expansion joint filler shall be held in a vertical position. An approved installing bar or other device shall be used if necessary to ensure proper grade and alignment during the placing and finishing of the concrete. Finished joints shall not deviate in horizontal alignment more than 6mm from a straight line. If joint fillers are assembled in sections, there are no offsets between adjacent units. No plugs of concrete are permitted anywhere within the expansion space.

See Standard Drawings 454.1015.007 regarding isolation joints.

3) Transverse Joint

Transverse joints consist of planes of weakness created by forming or cutting grooves on the pavement's surface. They shall be equal to at least one-quarter the depth of the slab. Transverse joints shall extend continuously through the pavement and curb. (Spacing as shown in the plans).

For high-speed routes, the skewed joints shall be spaced at consecutive intervals of 3.5 m 4.0 m 5.5 m 6.0 m on a counter-clockwise skew of 300 mm for every 2 m of lane width.

4) Contraction Joint

Contraction joints shall be of the 'sawed weakened plane" type and are constructed in accordance with the provisions specified herein at locations as shown in the plans or as directed by the Engineer.

5) Construction Joint

Construction joints shall be placed at the end of each day's work and at places where paving operations are interrupted for a period of more than 30 minutes and are formed by placing a bulkhead complete with a keyway for the entire width of the lane.

6) Expansion Joint

Expansion joints shall be constructed where the pavement slab abuts some permanent structure such as railway crossings, bridge approaches, or other intermediate points as shown on the plans or specified by the Engineer.

7) Longitudinal Joint

For full-width paving, longitudinal joints are to be formed by sawing unless otherwise approved by the Engineer. These joints shall comply with provisions for Sawed Weakened Plane Joints as specified. Where the pavement is constructed in separate abutting lanes, the longitudinal joint shall be keyed together as shown on the plans. Unconfined outside lanes are joined by tie bars placed through the joint at 750 mm spacing. The tie bars are held securely in position to ensure proper alignment during the placing and finishing of the concrete.

Before placing an adjacent lane, the perpendicular face of the first lane constructed shall be thoroughly coated with an asphalt-latex to prevent a bond between adjacent lanes. When placing the second slab, concrete shall not be left overhanging the lip formed in the first slab by the edging tool.

312.09.00 – Curing

Concrete shall be adequately cured by protecting it against moisture loss, rapid temperature change, and mechanical injury at least seven days after placement.

After finishing operations have been completed, the entire surface of the newly placed concrete shall be covered by a curing medium approved by the Engineer. The edges of concrete slabs exposed by removing forms shall be protected immediately to provide these surfaces with continuous curing treatment equal to the method selected for curing the slab.

Membrane curing shall comply with the section 310.02.07 – Curing Membrane.

312.10.00 – Joint Sealing

Joints shall be filled within a period from 7 to 14 days after the concrete has been placed. Immediately before sealing, the joints shall be thoroughly cleaned in such a manner that all loose and foreign material, including membrane curing compound, is removed. Joints shall be inspected and approved by the Engineer prior to sealing.

All joints shall be filled to not less than 3 mm from the surface of the pavement and in no case are they overflowed.

Any material spilled on adjacent pavement areas shall be removed immediately and the pavement surface cleaned.

The use of sand or similar material to cover the seal shall not be permitted. Joint sealing material shall not be placed when the air temperature in the shade is less than 10°C unless approved by the Engineer.

312.11.00 – Surface Tolerance

Areas of pavement showing high spots exceeding 3 mm in 3 m but not exceeding 13 mm when tested shall be ground down by approved methods until the deviation does not exceed 3 mm.

In the case of pavement constructed using the slip-form method, an additional 3 mm deviation shall be allowed on the outer 150 mm of each pavement edge, adjacent to the slip-form.

Where the deviation exceeds 15 mm, the Contractor shall remove and replace the pavement at their own expense. The area removed shall not be less than 1.5 m in length nor less than the entire width of the lane involved. If the pavement area to be removed extends to within 1.5 m of a transverse joint, the pavement shall be removed to that joint.

Areas corrected by grinding to acceptable tolerances shall be coated with an approved surface sealer.

312.12.00 – Opening Pavement to Traffic

The entire pavement area shall be cleaned of all debris and construction equipment as soon as curing and joint sealing have been completed. Neither construction nor any other traffic shall be permitted to use the pavement until seven days after concrete placement.

The pavement may be opened to traffic only upon the written authority of the Engineer and only after the flexural beam tests indicate a minimum flexural strength of 4.0 MPa when tested by the third point loading method.

312.13.00 – Thickness Verification

312.13.01 – General

Prior to final acceptance of the work, the pavement shall be cored by The City or its appointed Testing Firm, and thickness determined by measuring the cores.

Pavement, which is deficient in thickness by more than 8 mm, shall be subject to reductions in Unit Rate as provided herein. Areas of pavement deficient in thickness by more than 25 mm shall be removed and replaced when directed by the Engineer.

312.13.02 – Determination of Pavement Thickness

The pavement shall be divided into units which are considered separately when adjustments in Unit Rate are required due to deficient pavement thickness.

Major pavement lanes of each specified thickness and each separate pour width are divided into basic units of 2 500 m² each. The remaining fractional area at the end of each mainline pour width shall be considered a separate unit if the fractional area exceeds 1 000 m² or is included in the adjacent basic unit if the area does not exceed 1 000 m².

An individual ramp, cross-over, intersection, or other irregular areas of pavement not included in the mainline shall be considered a separate unit when cored for pavement thickness determination. The Engineer may include small irregular unit areas as part of another unit.

Five cores shall be taken at random from each pavement unit. If the average of the lengths of five cores is deficient by more than 8 mm, five additional random cores shall be taken from the unit. The average of the lengths of the 10 cores shall determine the thickness of the pavement unit. In calculating the average thickness, any core having a length above the specified thickness by more than 5 mm shall be considered as having the specified length plus 5 mm. Any core having a length deficiency greater than 25 mm shall not be included in the calculation to determine average thickness.

When the length of any random core is less than the specified thickness of the pavement by more than 25 mm, exploratory cores are taken at not less than 3 m intervals parallel to the centre line in each direction from the random core until, in each direction, an exploratory core shall be obtained which is not deficient in length by more than 25 mm.

The pavement area found deficient in thickness by more than 25 mm includes the monolithic pour width of the lane or lanes and a length equal to the distance between points located midway between the last two cores at each end of the deficient section.

The average thickness of the remainder of the unit shall be determined from the random cores obtained outside the deficient area by more than 25 mm.

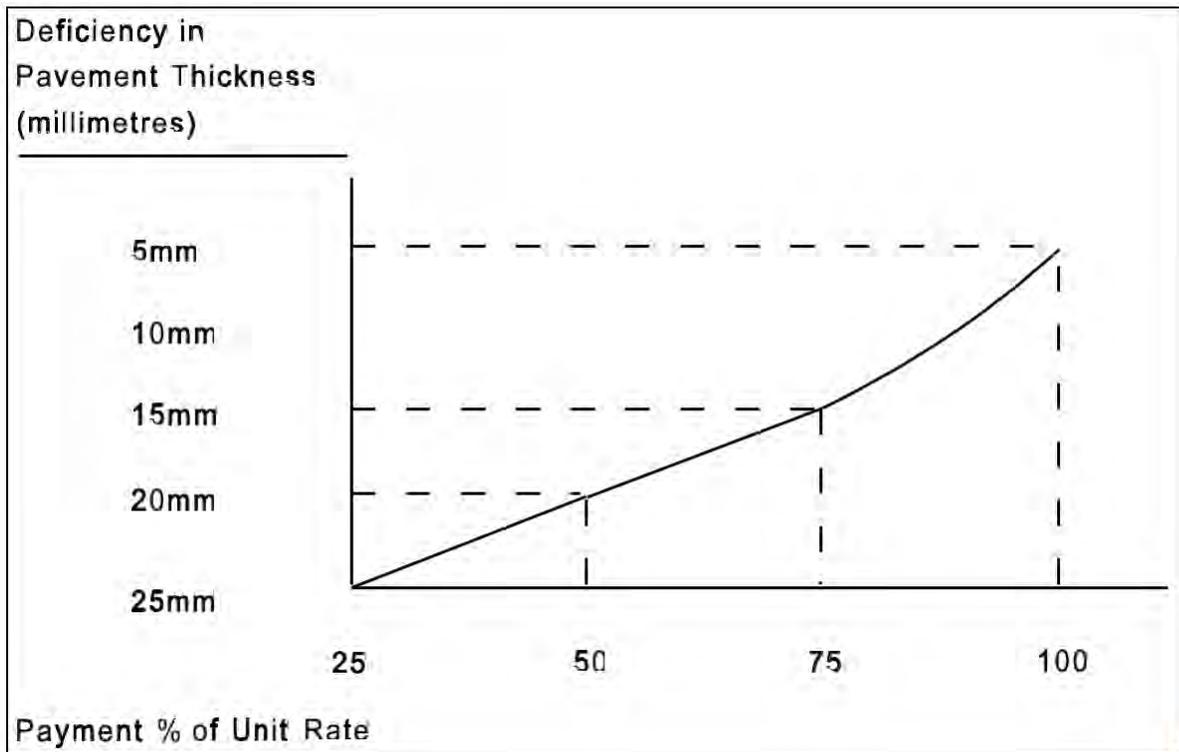
Exploratory cores are not used in the computation of average thickness in determining the adjusted Unit Rate.

312.14.00 – Unit Rate Adjustment

1) Thickness Adjustment

Pavement found deficient in thickness by more than 7.5 mm but not more than 25 mm shall be paid by the reduced price as shown below.

When the thickness of the pavement is deficient by more than 25 mm and the Engineer judges that the area of such deficiency should not be removed and replaced, there shall be no payment for the area retained. No additional payment over the Unit Rate shall be made for any pavement with an average thickness above that specified on the plans.



2) Strength Adjustment

In the case where the compressive strength of the test cylinders for any portion of the work falls below the requirements outlined in section 310.00.00 – Portland Cement Concrete, the concrete shall be paid for on the following basis.

TABLE 66: PAYMENT ADJUSTMENTS BASED ON MINIMUM ALLOWABLE STRENGTH

% Minimum Allowable Strength	% Payment
100 % - or greater	100 %
80 % - 99.9 %	$\frac{\text{Unit Rate} \times \text{Average Test Strength}}{\text{Minimum Allowable Strength}}$
70 % - 79.9 %	No Payment
Less than 70 %	Replacement

3) Spacing Factor Adjustment

In the case where the spacing factor of the test cylinders for any portion of the work falls below the requirements outlined in section 310.00.00 – Portland Cement Concrete, the concrete shall be paid for on the following basis.

TABLE 67: PAYMENT ADJUSTMENTS BASED ON THE SPACING FACTOR

Spacing Factor	% Payment
Less than 230 µm	100 %
230 µm to 260 µm	50 % reduction
Greater than 260 µm	No payment, replacement

312.15.00 – Concrete Overlay for Pavement Rehabilitation

312.15.01 – General

This specification covers the requirements for the construction of bonded concrete overlay of existing asphalt pavement.

312.15.02 – Reference Standards

- CSA A3000-08, Cementitious Materials Compendium
- CSA A23.1-09, Concrete Materials and Methods of Concrete Construction
- CSA A23.2-09, Test Methods and Standard Practices for Concrete
- CSA A283-06 Qualification Code for Concrete Testing Laboratories

312.15.03 – Submittals

Submittals in accordance with section 310.03.00 – Submittals.

312.15.04 – Materials

Materials in accordance with section 310.03.00 – Submittals.



312.15.05 – Concrete Mixes – Design and Trial Batch Testing

1) General

The Contractor shall undertake the concrete mix design and pay for all costs associated with the development, testing and submissions of the mix designs and performance testing results. In lieu of the trial batch testing, the Contractor may submit for review and consideration by the Engineer, mix design, laboratory, and field test results. All performance criteria of this Specification shall apply.

312.15.06 – Mix Properties

The mix properties of the concrete overlay shall conform to the following requirements.

TABLE 68: CONCRETE OVERLAY MIX PROPERTIES

Cement	Supplementary Cementing Materials	Max. Aggregate size (mm)	Synthetic Fibre	w/cm	Plastic Air Content (%)	Slump (mm)
Type GU, cement content per mix design	Fly Ash, Type F ¹ Up to 20 % ²	20	Macrofibre, monofilament, 1 kg/m ³	Max. 0.37	5 - 8	80 ³

¹ Maximum CaO content for Type F fly ash – 12 %
² Fly ash content by total mass of cementing materials.
³ For slip formed (machine placed) concrete slump – 30 mm

312.15.07 – Mix Performance

The mix performance of the concrete overlay shall conform to the following requirements.

TABLE 69: CONCRETE OVERLAY MIX PERFORMANCE

Flexural Strength at 28 Days (MPa)	Compressive Strength at 2 Days (MPa) ¹	Compressive Strength at 28 Days ¹	Maximum Spacing Factor (ASTM C 457)
4.2	20	35 ²	230 µm

¹ Compressive strength based on an average of three cylinders.
² Experience indicates that a 28-day strength in the order of 40 MPa is required to provide two-day compressive strength of 20 MPa. The design 28-day compressive strength to be established on the trial batch testing to develop the relationship between compressive strength and specified flexural strength.

312.15.08 – Execution

1) Asphalt Surface Preparation

- Mill existing asphalt surface to the depth indicated on the project drawing.
- Saw cut the longitudinal and transverse edges of the cold-milled asphalt pavement to provide a vertical face.
- Mechanically sweep the pavement clean of all loose or foreign material, followed by pressure washing and blow-drying the surface.

- Apply the sand/cement slurry to enhance the bond between milled asphalt pavement and concrete overlay. A 1:1 cement-sand slurry with a maximum w/cm ratio of 0.45 shall be applied ahead of the overlay concrete. The slurry shall not be allowed to dry out before the concrete is placed.

2) Placement and Finishing

- Placement procedures have an impact on the durability performance of the concrete, especially on concrete cracking.
- Placement of concrete overlay shall not commence if:
 - The asphalt surface temperature is less than 5°C.
 - The anticipated air temperature during the concrete placement is expected to drop below 5°C on the day of concrete placement and during the subsequent seven days unless enclosure and heating are used, or insulated forms capable of maintaining a minimum of 10°C are used.
 - Windy conditions are present or expected during the pour, and the combined effects of air temperature, relative humidity, concrete temperature and wind velocity could result in a surface moisture evaporation rate in excess of 1 kg/ m²•h as determined by CSA A23.1-09, Annex D, guidelines for curing and protection.
 - Rain is predicted for the time of concrete pour.
- Concrete placement and curing requirements shall comply with hot/cold requirements as per CSA A23.1, Sections 7.4.1.4 and 7.4.1.5.
- Fixed form or slip-form placing of concrete is acceptable. The Contractor shall ensure proper consolidation of concrete.
- Concrete shall have floated surface finish and surface textured. Tined texture shall have transverse grooving. The grooved depth shall be between 3 mm and 5 mm, spaced from 10 mm to 20 mm.

312.15.09 – Protection and Curing Requirements

- Freshly placed and finished concrete shall be protected against adverse conditions, such as high wind, precipitation, freezing, abnormally high temperatures, premature drying, and moisture loss for the time necessary to develop the desired performance of concrete.
- All materials and equipment needed for adequate protection and curing shall be on hand and ready for use prior to concrete placement.
- Curing shall begin immediately following the placing and finishing operations and provide the temperature and moisture conditions necessary for concrete to develop its strength and durability properties.



- Fog spray shall be applied immediately after placement and before finishing under severe drying conditions (surface moisture evaporation rate greater than 0.5 kg/ m²•h).
- White pigmented Type 2 liquid membrane-forming curing membrane shall be applied during summer construction of the concrete overlays.
- Clear or translucent Type 1 liquid membrane forming curing membrane shall be applied during fall construction of the concrete overlays. Finished surface shall be treated with silanes prior to road salt applications.

312.15.10 – Joints

- Transverse and longitudinal control joints shall be constructed using a maximum of 1.8 m spacing.
- The longitudinal joints shall be a centre of lane or between lanes based on the designed lane width.
- The length to width ratio for each panel shall not exceed 1.25 to 1.0.
- Joints shall be saw-cut as soon as the concrete surface hardened sufficiently to resist ravelling, but before shrinkage cracks are formed. Lightweight early entry saws (3 mm thick) may be used. Transverse joint saw-cut depths for early-entry sawing should be not less than 30 mm. Longitudinal joints should be sawed to a depth of one-third of the concrete overlay thickness. The Contractor is responsible for the proper timing of cutting operations.

312.15.11 – Quality Control

- The Contractor is responsible for the quality of materials and products used for the concrete overlay construction.
- The Contractor shall perform inspections and testing necessary to ensure that the works conform to the Specification requirements and the Contract Documents.
- Where no previous history has been established, pre-construction laboratory or field trials shall be performed to demonstrate that the performance requirements are met.

312.15.12 – Quality Assurance

- The City will undertake, through an independent CSA certified firm, sampling, inspection and testing to determine the compliance with the Specifications and other Contract Documents.
- Compressive strength and flexural strength tests shall be taken to represent each 10 m³ portion of the concrete pour. An additional cylinder shall be cast to represent each
- 20 m³ of concrete for the determination of air-void system in hardened concrete.
- Only one re-dose of water reducer is allowed after batching to adjust the slump of the concrete.

- Adding water to the batch is not permitted.
- One adjustment of air on site may be allowed provided that the adjustment is done under the supervision of the qualified personnel. The supplier shall use the same air entraining admixture approved for use in the mix design.
- The use of de-air entraining admixtures shall not be permitted.
- If the air content of the plastic concrete exceeds the maximum limit after the air adjustment on-site, that load of concrete shall be rejected.
- The air-void system shall be determined in accordance with ASTM C457 on hardened concrete to represent each 20 m³ of concrete. If the requirements of the section 310.06.03 – Compliance Verification of this Specification and the provisions of CSA A23.1-09, Section 4.3.3 are not met, the concrete shall be rejected. The air-void system shall be verified by the cores extracted from the concrete overlay. Rejected concrete shall be removed, and the Contractor shall bear the cost of removal and replacement.

312.16.00 – Bus Lay-Bys

Portland Cement Concrete Pavement shall be used for Bus Lay-bys. The properties of concrete shall meet the requirements of sections 312.03.01 – Mix Properties and 312.03.02 – Mix Performance. Minimum pavement thickness shall be 225 mm and in accordance with Standard Drawing 454.1012.008.

313.00.00 – Fencing

313.01.00 – General

Fencing shall be supplied and erected in accordance with the following Specifications and to line and grade established by the Engineer. The Contractor shall be responsible for determining the location of all underground utilities prior to digging post holes.

Fencing shall be paid for at the Unit Rate measured in its erect position.

313.02.00 – Barbed Wire Fencing

313.02.01 – Materials

Fencing wire shall be "Four Point" 122 gauge galvanized strands. Diagonal bracing shall be 6 gauge soft galvanized wire. This bracing wire shall be doubled for all installations. Staples are 30 mm long galvanized steel.

Posts and braces shall be made of pressure-treated wood, with a minimum diameter of 100 mm. Posts and braces shall be two metres long. Gate droppers shall be 1.4 m long and shall be a minimum of 50 mm in diameter. Dressed lumber with nominal dimensions of 50 mm by 100 mm may also be used for gate droppers.

313.02.02 – Installation

Posts shall be installed a maximum of four metres apart, with the bottoms of the posts 750 mm below the finished grade line. The posts shall be set and tamped in a plumb and firm position.

Adjacent to each end of a gate, in each direction from a change in direction or an intersection of fences, a bracing panel two metres long shall be installed. If a tangent length of fencing exceeds 300m or a curved length exceeds 150 m, a bracing panel shall be installed.

Bracing panels shall have one brace post installed horizontally 150 mm from the top of the two fence posts. Bracing wire shall be run diagonally in both diagonals from the top of one post to the bottom of the other. Bracing shall be stretched.

Four strands of barbed wire are strung, with the wires located 150 mm, 450 mm, 750 mm and 1 m below the top of each post. Each wire shall be stretched and stapled to each post; and on the opposite side of the post to the roadway right-of-way.

Gates shall have barbed wire spacing the same as the rest of the fence. Droppers are spaced at a maximum of 2.5 m apart. At the hinge post, no dropper is required, as the wire may be connected directly to the gate post. At the fastening end of the gate, the end dropper shall be connected to the gate post using two wire loops, one at the bottom of the gate and one at the top.

313.02.03 – Maintenance

The City shall not hold the Contractor responsible for damages resulting from traffic or malice following the issuance of the Construction Completion Certificate.

313.02.04 – Ends, Gates, Corners and Braces

Unless otherwise specified, end, gate, corner and other bracing panels or gates shall be included in the Unit Rate for fencing, and no additional compensation shall be paid.

313.03.00 – Chain Link Fencing

313.03.01 – Materials

Fence fabric shall conform to CGSB Standard CAN/CGSB-138.1-M unless otherwise specified in the Contract Documents. If green, olive green, brown or black coloured vinyl-coated wire is specified, colours shall conform to ASTM Standard F 934.

Gates and gate hardware shall be as specified in CGSB Standard CAN/CGSB-138.4-M. In addition to meeting the minimum requirements of CGSB Standard, gate frames shall be designed so the outer member will not sag more than one percent of the gate leaf width or 50 mm, whichever is less. Gates shall be assembled with fabric mounted on the outside. Gate heights shall match fence heights unless otherwise specified. Gate sections three metres or more in width shall have three hinges per section.

All posts and rails shall be of Type "A" or Type "B" at the Contractor's discretion.

Type "A" posts and rails shall be steel butt weld pipe, Schedule 40, as specified by ASTM Standard A53, except that the hydrostatic testing requirement is waived, and the minimum weight shall be no less than 95 percent of the nominal weight. The pipe shall be zinc-coated in accordance with ASTM Standard A53-88a, Section 19. This ASTM Standard requires, among other things, an average zinc coating of 550 g/ m² and a minimum zinc coating of 490 g/ m².

Type "B" posts and rails shall be made from steel pipes. The pipe shall be formed from a steel strip conforming to ASTM Standard A-569. The steel in the formed pipe shall have a minimum yield strength of 350 MPa. The product of the pipe's yield strength and section modulus shall be not less than that of the pipe meeting the requirements for Type "A" posts and rails.

The outer surface of Type "B" posts and rails shall have all the following protective coatings applied in the following order:

- (1) Hot-dip zinc coating, conforming to ASTM standard B-6, high grade or special high grade, applied at an average weight of 305 g/ m² and a minimum weight of 275 g/m², as determined by the test method in ASTM A-90.

- (2) Chromate conversion coating, with a weight of $46.5 \text{ mg/m}^2 \pm 23 \text{ mg/m}^2$, as determined by a strip and weight method for the zinc and chromate and by determining the percentage of each by atomic absorption spectrophotometer.
- (3) Clear acrylic polyurethane coating with a thickness of $0.1 \text{ mm} \pm 0.025 \text{ mm}$.
- (4) The combined outer coating shall have an ability to resist:
- (5) 1,000 hours of exposure to salt fog with a maximum of 5 % red rust when tested in accordance with ASTM B117.
- (6) 500 hours of exposure to 100 % relative humidity without blistering and peeling when tested in accordance with ASTM D2247, and
- (7) 500 hours of exposure in a weatherometer without film cracking of the clear coat when tested in accordance with ASTM G23, type e or eh carbon arc, or ASTM G26, type B or BH xenon arc.

The inner surface of Type "B" posts and rails shall have either a zinc coating as per ASTM F1234, Type B, applied at an average rate of 305 g/m^2 and a minimum rate of 275 g/m^2 ; or an ASTM F1234, Type D coating with a minimum zinc powder loading of 91 percent by weight and a minimum thickness of 0.075 mm. The inner coating shall have the ability to resist 650 hours of exposure to salt fog with a maximum of 5 percent red rust when tested in accordance with ASTM B117.

Fittings shall be constructed of aluminium or steel, as specified by ASTM Standard F 626. Fittings shall be of adequate strength for the intended purpose. Steel fittings shall be hot-dipped galvanized to achieve the same zinc coating required for Type "A" posts and rails.

313.03.02 – End, Gate, Corner and Strain Posts

Unless otherwise specified, end, gate, corner and strain posts are paid for at the Unit Rate for the respective class of post, which shall include excavation and pouring of footings, supply and installation of posts, post tops and braces.

Gates are paid for at the Unit Rate, which includes the supply and installation of the gate, complete with hinges, latch, fabric and miscellaneous material necessary for its completion. Gate terminal posts are paid for as gate posts.

313.04.00 – Fence Removal

Fencing shall be removed with care, avoiding damage to fence components. As designated by the Engineer, all salvageable material shall be transported to a City storage area designated by the Engineer.

313.05.00 – Fence Removal and Relocation

All fences designated for relocation shall be disassembled in a careful, skillful manner. If required, the Contractor shall provide safe storage of the fence components. Any damaged or otherwise defective materials shall be replaced by the Contractor.

The fence shall be reassembled at the lines and grades established by the Engineer to a standard similar to the fence removed. Any excess salvageable materials shall be transported to a City storage area designated by the Engineer.

314.00.00 – Guardrails

314.01.00 – General

Guardrails shall be installed at locations as shown on the drawings or as directed by the Engineer.

All terminal sections and approach end treatments are formed from the same material as rail elements.

Installation at each location shall conform to the Standard Drawings and approval of The City’s Structural Engineer.

Guardrails shall be paid for at the Unit Rate measured in its erect position.

Unless otherwise specified, each "Approach/End Treatment" or "Attachment to Structures" shall be paid for as a separate item of specified length.

314.02.00 – Steel W-Beam on Wooden Posts

314.02.01 – Materials

1) General

Guardrail parts are standardized and are interchangeable with components produced by guardrail manufacturers. Dimensions and details are shown on Standard Drawings.

2) Rail

Rail elements are formed from an open hearth or electric furnace steel and shall meet the following requirements:

TABLE 70: MINIMUM REQUIREMENTS FOR RAIL ELEMENTS

Gauge	12 minimum
Tensile Strength	550 MPa minimum
Elongation (ASTM)	12 % minimum
Des: (E-8)	50 mm gauge length

The load shall be applied through a 75 mm flat surface at the centre of a freely supported 3.65 m clear span, and when the joint is tested, it shall be at the centre of the span.

TABLE 71: MAXIMUM DEFLECTION LIMITS

Max Deflection	Load Traffic Face Up	Load Traffic Face Down
70 mm	680 kg	550 kg
140 mm	900 kg	1,180 kg

Rail elements shall be galvanized to conform to the requirements for the Coating Class 2.50 of the current ASTM Designation A-525.

3) Bolts

Bolts, nuts and washers shall be galvanized to meet the requirements of ASTM Designation A-153. The post connection shall withstand a 2,250 kg side pull in either direction.

4) Posts and Blocks

The wood posts and blocks shall be constructed with pine; and conform to No. 1 Structural Grade for posts and timbers as classified and defined by NLGA 1970, Standard Grading Rules for Canadian Lumber. All posts and blocks shall be incised and pressure treated with Chromate Copper Arsenate (CCA) to a minimum net retention of 6.4 kg/m³ of wood (3.5 kg/ m³ for blocks), in accordance with CSA Standard 080.14: Pressure Preserved Wood for Highway Construction.

5) Recycled Plastic

The use of recycled plastic posts and blocks shall be subject to the prior written approval of the Engineer.

314.02.02 – Installation

Posts shall be spaced on 1.9 m centres measured along the centerline of the rail. The rail elements shall be erected to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown on the plans. The rail elements shall be lapped in the direction of traffic. Terminal sections are attached to the ends of each installation.

314.02.03 – Attachment to Concrete Structures

The rail elements are bolted to concrete structures as shown on the Standard Drawings for Steel W-Beams. In the vicinity of the structures, the guardrail shall be strengthened by adding a 150 mm X 3.7 kg channel bolted to the wooden posts below the W-Beam for a distance of 7.6m. This 150 mm X 3.7 kg channel shall be galvanized or metalized as specified below the steel box beam guardrail.

314.03.00 – Steel Box Beam on Steel Posts

Details of this guardrail are shown on the Standard Drawings for steel box beams.

314.03.01 – Materials

There are three types of material as follows:

1) Corten Grade “A” Steel

Corten Grade “A” Steel shall be in accordance with CSA. G 40.11 Grade A. Bolts for the connection of the steel to structures shall be painted to match the matured Corten A colour, the colour of “Stelcoloy Weathering Steel - Halifax Rural” or approved equal.

2) Metallized Steel

Metallized Steel shall be in accordance with Stelco 50 or approved equal and with a minimum yield strength of 350 MPa.

Steel shall be field or shop metallized to provide deposition of not less than 0.15 mm thickness of zinc on all surfaces 0.92 kg/ m².

Work shall be in accordance with the requirements of American Welding Society C2.2 "Recommended Practices for Metallizing, Part 1B - Application of Aluminium and Zinc for Protection of Iron and Steel", New York, 1952.

A dry blast cleaning process shall clean surfaces to be metallized in accordance with the latest edition of CGSB Schedule 31-P-404, Classification 2.1.2 "Commercial Blast Cleaning".

Blast cleaning shall be carried out at such a rate that blast-cleaned metal is not exposed for more than one hour before applying the spray metal coating.

The zinc coating shall be applied by wire or powder process and shall be of first-class commercial quality, free from surface blemishes, breaks, etc., and uniform thickness.

A thickness gauge shall always be kept on hand, and coating thickness shall be checked as often as necessary to ensure uniformity. Immediately after completing a section of the railing, the entire area shall be spot-checked with a magnetic thickness gauge. If thin spots are found, additional metal shall be applied immediately.

3) Galvanized Steel

Galvanized Steel shall be in accordance with Stelco 50 or approved equal and with a minimum yield strength of 350 MPa. Galvanizing of the box beam and posts shall conform to the requirements for the coating Class 0.6 litres per square metre of the current ASTM Designation A-525. Galvanizing of the bolts, nuts and washers shall conform to the requirements of ASTM Designation A-153.

314.03.02 – Installation

Posts shall be spaced on 1.8m centres measured along the centerline of the beam. Near the structures, spacing can be closer, as shown on the Standard Drawings for post-installation. The beams are erected to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown on the plans.

314.04.00 – Pre-cast Concrete Guardrail

Details of this guardrail are shown on the Standard Drawings for a standard concrete barrier.

314.04.01 – Materials

1) Concrete

- Concrete shall be a minimum of 35 MPa compressive strength at 28 days.

- Cement shall be Type 30 Portland Cement meeting the requirements of CAN3-A5- M77.
- Aggregate gradation shall conform to the requirements of ASTM Designation C33. Fine aggregate Clause 3.
- Coarse aggregate Table 2, Size 67.
- Maximum water-cement ratio shall be 0.43.
- Slump shall be 75 mm maximum.
- Air entrainment shall be 6 % minimum.
- Concrete shall also comply with section 310.00.00 – Portland Cement Concrete of the Specifications regarding entrained air spacing factor.
- No calcium chloride shall be used.

2) Reinforcing Steel

Reinforcing steel shall be intermediate grade deformed bars meeting the requirements of ASTM Designation A615, Grade 40.

3) Miscellaneous Metals

Miscellaneous metals shall conform to the requirements of ASTM Designation A36 or better.

4) Air Entraining Agents

Air entraining agents shall conform to the requirements of ASTM Designation C260.

314.04.02 – Mix Design

Prior to casting a guardrail, the proposed mix design, including the source of proposed aggregates, shall be submitted to the Engineer for approval.

314.04.03 – Testing

The manufacturer shall notify the Engineer of casting times in order to arrange concrete testing and/or inspection at the expense of The City. For this purpose, the supplier shall allow the Engineer free access to those portions of their plant where the guardrails are being produced and stored.

Concrete cylinders are tested in accordance with the following current ASTM standards:

Moulding: ASTM Designation C192.

Curing: ASTM Designation C31.

Test for compressive strength: ASTM Designation C39.

314.04.04 – Forms

Forms shall be true to shape, lines and dimension as called for on the drawings. They shall be substantial and tight to prevent leakage of moisture. Maximum tolerance for final dimensions shall be ± 5 mm.

314.04.05 – Inserts

All inserts shall be placed accurately and securely in position by templates prior to concrete placement.

314.04.06 – Concrete Compaction

Mechanical vibrators shall thoroughly compact concrete during casting. It shall be worked around reinforcement, embedded fixtures and into the corners of the forms.

Vibrators are internal and/or form vibrators at the manufacturer's option.

314.04.07 – Curing**1) Moist Curing**

New concrete surfaces shall be kept continuously moist for at least seven days and are protected against the harmful effects of sunshine, drying winds, cold running water, surface water, and mechanical shock.

The temperature of the concrete shall be kept at 20°C for not less than seven days.

2) Steam Curing

If steam curing is used to maintain a daily cycle of casting, the following criteria for curing shall be adhered to:

- There shall be a minimum of four hours delay after the final placement of the concrete prior to applying steam.
- The maximum rate of temperature rise of the concrete shall be 20°C per hour.
- The maximum temperature to which the concrete shall be raised is 70°C.
- The maximum rate of cooling shall be 20°C per hour.

Immediately after stripping of forms, the members shall be moist or steam cured for an additional five days at a temperature of not less than 65°C.

After completion of moist curing or steam curing, the members are stored and allowed to dry out for a further period of 30 days prior to being put into service.

314.04.08 – Protective Coatings for Metal

Connector-lifting coupling inserts and threaded caps shall be completely galvanized.

314.04.09 – Handling, Storage and Delivery

Care shall be taken in the handling, storage and delivery of completed pre-cast units to avoid damage.

Damage to units prior to acceptance by The City at the point of delivery shall be rectified by the supplier at no extra cost to The City.

The units are delivered to the worksite as directed by the Engineer and are unloaded and stacked at a specified location.

314.04.10 – Installation

Backfill behind the guardrail shall be placed and compacted prior to placing pavement against the face of the guardrail.

Concrete slabs between the curb and the guardrail on guardrail taper sections shall be constructed as shown on the plans and shall conform to the Specifications for concrete sidewalk, concrete curb and gutter.

314.05.00 – Concrete Guardrail

The concrete guardrail shall have a cross-section as shown on Standard Drawings.

Unless otherwise specified, the concrete levelling slab between the asphalt and the concrete guardrail (if required) shall not be considered incidental to the Unit Rate of the concrete guardrail.

314.05.01 – Materials**1) Concrete**

Concrete shall be Class "A" conforming to all Specifications for Portland Cement Concrete, found in section 310.00.00 – Portland Cement Concrete.

2) Reinforcing Steel

Reinforcing steel shall conform to ASTM Designation A-432, with deformations conforming to ASTM Designation A-305.

3) Crushed Gravel

25 mm crushed gravel (see section 303.00.00 – Granular Material) shall be used to trim the sub-grade to the design line and grade.

314.05.02 – Cast-In-Place Concrete Guardrail**1) Length**

Guardrail sections shall not exceed six metres in length.

2) Joints

Joints between sections shall have joint filler and dowels installed as shown on the plans.

3) Curves

Guardrail sections shall be curved on curved roadways and are not a series of chords unless the degree of curvature of the roadway is greater than 8 degrees (218 m radius).

314.05.03 – Extruded Concrete Guardrail

Extruded concrete shall comply with the Specifications for cast-in-place concrete guardrails except as herein provided.

The concrete shall be continuously extruded. Sawing or deep tool marking of contraction joints is required. The contraction joints shall have a minimum depth of 25 percent of the section thickness and be placed at 3 metres spacing unless otherwise specified by the Engineer. Any contraction cracks that occur between contraction joints shall be grouted, with material approved by the Engineer, within 30 days of construction completion.

Reinforcing steel shall not be used.

1) Tolerance

- The surface grade along the top of the guardrail shall be true to an accuracy of 6 mm in 3 lineal metres.
- The maximum allowable variation across the top of the guardrail shall be 3 mm.
- The elevation of any given point along the top of the guardrail shall not vary by more than 20 mm from the design grades.
- Deviation in alignment at any given point shall not exceed 15 mm and shall not be greater than 25 mm in 100 lineal metres.
- Maximum tolerance for cross-section dimensions shall be 5 mm.



315.00.00 – Architectural Pavements

Concrete which will be permanently exposed to view and which requires special care in selection of the concrete materials, forming, placing and finishing, to obtain the desired architectural appearance. Concrete which will be permanently exposed to view and which requires special care in selection of the concrete materials, forming, placing and finishing, to obtain the desired architectural appearance.

315.01.00 – Reference Standards

Perform cast-in-place concrete work in accordance with the following standards, except where specified otherwise.

- CSA A3000-08, Cementitious Materials Compendium.
- CSA A23.1-09, Concrete Materials and Methods of Concrete Construction.
- CSA A23.2-09, Test Methods and Standard Practices for Concrete.
- CSA A283-06 Qualification Code for Concrete Testing Laboratories.

315.02.00 – Exposed Aggregate Surfaces

315.02.01 – General

An exposed aggregate concrete surface is a decorative finish constructed in one of three ways; seeding a select aggregate into the surface, mixing a chosen aggregate (usually gap graded) into the concrete, or applying a special topping course.

The required mix properties shall be as per section 310.04.00 – Concrete Properties and shown in Table 72: Mix Properties of Concrete Pavement below.

All concrete shall comply with the CSA A23.1, Table 1, Table 2, and Table 4 requirements for class of exposure C-2, non-structurally reinforced concrete exposed to chlorides with or without freezing and thawing conditions.

TABLE 72: MIX PROPERTIES OF CONCRETE PAVEMENT

Type of cement ¹	Supplementary cementing materials	Maximum water-to-cementing materials ratio	Nominal maximum coarse aggregate size	Air content	Slump
GU, GUb, or HSb	Type F ² Up to 20 % ³	0.45	20 mm	5 % to 8 %	As required by the method of placement

¹Minimum cement content shall be 310 kg/m³.

² CaO content of Type F fly ash shall not exceed 12 %.

³ By the mass of total cementing materials. The required performance characteristics shall be as shown below.

TABLE 73: PERFORMANCE CHARACTERISTICS OF CONCRETE PAVEMENT

Compressive strength at 28 days ¹	Maximum air void spacing factor
32 MPa	230 µm

¹For concrete placed between September 30 and May 1, minimum specified compressive strength shall be achieved in seven days.

315.02.02 – Aggregate

Aggregate properties shall meet the requirements of section 310.02.03 – Aggregate with the additional requirements provided below.

1) Colour

Colour shall be selected from locally available aggregate.

2) Size

Gap-graded aggregate shall meet grading requirements of CSA A23.1-09, Table 11, Group II, 10-5 mm.

TABLE 74: GRADATION REQUIREMENTS FOR GAP GRADED AGGREGATE

Nominal Size of Aggregate (mm)	Percent Passing
14	100
10	85 - 100
5	0 - 20
2.5	0 - 5

315.02.03 – Exposing Aggregate

1) Seeding Method

The base concrete shall be placed, vibrated, and screeded. Screed operation shall produce a level surface 20 mm below the desired finish to allow the volume of select aggregate to be seeded.

Apply only one layer of stone, removing stacked stone or silver particles. Embed the aggregate into the concrete by tapping with a wood float or a rolling device. Use a magnesium float for final embedding: mortar completely surrounds and slightly covers all particles. A surface retarder may be desirable.

2) Washing and Brushing Method

Exposure of the aggregate shall be accomplished by removing the matrix by washing and brushing. Concrete shall be sufficiently set to prevent aggregate from being dislodged. The Contractor shall prevent wastewater from entering the storm sewer system.

3) Other Exposure Methods

Other methods to achieve an exposed aggregate surface, i.e. sandblasting and/or the use of acid, shall be at the Engineer's discretion.

315.02.04 – Curing

To receive an exposed aggregate finish, cast-in-place concrete shall be cured by established standard procedures as outlined in section 311.00.00 – Concrete Sidewalk, Curb and Gutter. Curing shall begin as soon as the exposure operation ceases.

315.03.00 – Concrete Paving Stones

315.03.01 – General

Manufacturing, delivering, and placing concrete paving stones shall be in accordance with the Specifications and Standard Drawings, ASTM C936 – Standard Specification for Solid Concrete Interlocking Paving Units and further modifications mentioned in this section.

315.03.02 – Materials

Materials shall meet the requirements of section 310.03.00 – Submittals.

1) Concrete Strength

At the time of delivery to the site, the average concrete compressive strength shall be not less than 55 MPa with no individual unit less than 50 MPa.

2) Absorption

The average absorption of the test samples sample shall not exceed 5 % when tested in accordance with CSA A23.2-11C with no individual unit greater than 7%.

3) Freezing and Thawing Resistance

The manufacturer shall satisfy the purchaser with a supported field performance or laboratory freezing-and-thawing test to prove the paving stones have adequate resistance to freezing and thawing. If a laboratory test is used, when tested in accordance with Section 8 of ASTM Method C67 – Standard Test Methods for Sampling Brick and Structural Clay Tile, specimens shall have no breakage and not greater than 1.0 % loss in dry weight of any individual paving stone when subjected to 50 cycles of freezing and thawing. This test shall be conducted not more than 12 months before delivery.

4) Abrasion Resistance

When tested in accordance with ASTM Method C418 – Standard Test Method for Abrasion Resistance of Concrete by Sandblasting, specimens shall not have a greater volume loss than 15 cm³ per 50 cm². The average thickness loss shall not exceed 3 mm.

5) Mix Design

Immediately after the award of Tender and before any casting of interlocking stone, the supplier shall submit to the Engineer for approval of the proposed mix design, including the source of proposed aggregates.

6) Testing

The supplier shall notify the Engineer of casting items so that arrangements for concrete testing and/or inspection can be made as desired, at the expense of The City. The supplier shall allow the Engineer free access to those portions of their plant where the paving stones are being produced and stored for this purpose.

315.03.03 – Workmanship and Procedures

1) Forms

Forms shall be true to shape, lines, and dimensions called for on the drawings. They shall be substantial and tight to prevent leakage of moisture. Maximum tolerance for final dimensions shall be ± 2 mm.

2) Compaction

During casting, sufficient vibratory or other mechanical efforts shall be applied to compact the concrete thoroughly.

315.03.04 – Curing

1) Moist Curing

The surfaces of fresh concrete shall be kept continuously moist for at least seven days and shall be protected against the harmful effects of sunshine, drying winds, cold running water, surface water, and mechanical shock. The temperature of the concrete shall be kept at 20°C for not less than seven days.

2) Steam Curing

If steam curing is used to maintain a daily cycle of casting, the following criteria for curing shall be adhered to:

- There shall be a minimum of four hours delay after the final placing of the concrete prior to applying steam.
- The maximum rate of temperature rise of the concrete shall be 20°C per hour.
- The maximum temperature to which the concrete shall be raised shall be 60°C.
- The maximum rate of cooling shall be 20°C per hour.

Immediately after stripping of forms, the members shall be moist or steam cured for an additional five days at a temperature of not less than 65°C.

315.03.05 – Handling, Storage, and Delivery

Care shall be taken in the handling, storage, and delivery of completed interlocking stone to avoid damage. Damage to units prior to acceptance by The City at the point of delivery shall be rectified by the supplier at no extra cost to The City.

315.03.06 – Inspection and Testing

1) Visual Inspection

All units shall be sound and free of defects that would interfere with the unit's proper placing or impair the construction's strength or permanence. Minor cracks incidental to the usual methods of manufacture or minor chipping resulting from customary handling methods in shipment and delivery shall not be deemed grounds for rejection.

2) Sampling and Testing

The purchaser or their authorized representative shall be accorded the proper facilities to inspect and sample the units at the place of manufacture from lots ready for delivery.

Sampling and Testing of Units shall be in accordance with Method C140.

315.03.07 – Rejection

In case the shipment fails to conform to the specified requirements, the manufacturer may sort it, and new specimens shall be selected by the purchaser from the retained lot and tested at the manufacturer's expense. , in case the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.

315.03.08 – Base Preparation

1) General

The base shall be as shown on the Standard Drawing 454.1013.013 for sidewalks.

2) Sand Bedding Course

The Sand Bedding Course shall meet the following gradation:

TABLE 75: GRADATION REQUIREMENTS FOR SAND BEDDING COURSE

Sand	Percent Passing
10 mm	100
5.0 mm	95 - 100
2.5 mm	80 - 100
1.25 mm	50 - 90
630 µm	25 - 65
315 µm	10 - 35
160 µm	2 - 10

The sand bedding course shall be spread evenly over the area to be paved and screeded to a level that will produce the required 15 mm thickness when the paving stones have been placed and vibrated. Once screeded and levelled, this sand bedding course shall not be disturbed.

315.03.09 – Construction

1) Edge Restraint

All edges of the paving stones installation shall be restrained. There shall be positive edge restraint, and the type of restraint used shall be subject to the Engineer's approval.

2) Laying of Paving Stones

The concrete paving stones shall be laid in a pattern approved by the Engineer.

The concrete paving stones shall be laid so the desired pattern can be maintained and the joints between the stones do not exceed 3 mm.

The gaps at the edge of the paved surface shall be filled with standard edge pieces or with stones cut to fit. The stones shall be cut to an even straight surface without cracks or chips.

The concrete paving stones shall be vibrated to their final level.

After vibration, sand shall be brushed over the surface and vibrated to fill the joints. Sands worked between the paving stones shall be thoroughly mixed with six (6) percent by weight of bentonite clay.

Surplus material shall then be swept from the surface, and the entire site left clean.

After final vibrating, the surface shall be true to line and grade and shall not vary by more than 8 mm when tested with a 3 m board at any location on the surface.

3) Areas with Vehicle Traffic

Paving stones used in areas subject to vehicle traffic shall be set on a concrete base. Paving stones shall be seated on latex or polymer modified mortar. All joints shall be mortar-filled. Prior to use, the design section and material shall be submitted to the Engineer for written approval.



315.04.00 – Paving Brick

315.04.01 – General

This Specification covers fired units made from clay, shale, fire clay, or mixtures thereof. The units are intended for use as paving material to support pedestrian and light vehicular traffic.

315.04.02 – Material

1) Requirements

The brick shall conform to the requirements of ASTM standards:

- C7 Specifications for Paving Brick.
- C67 Sampling and Testing Brick and Structural Clay Tile.
- C88 Test for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
- C410 Specifications for Industrial Floor Brick.

No breakage and not greater than 0.5 percent loss in dry weight on any individual unit.

Sulphate Soundness Test - the brick shall survive 15 cycles of the sulphate soundness test in accordance with Sections 3, 4, and 7 of Method C88 with no visible damage.

Warpage - the concave or convex warpage of that face of the brick that is to become the surface shall not exceed 1.6mm for each 150 mm of brick length when measured in accordance with Section 12 of Methods C67.

Efflorescence - when brick is tested in accordance with Section 10 of Methods C67, the rating for efflorescence shall not be more than 'slightly effloresced.'

2) Classifications

Light traffic paving bricks are classified according to the severity of their use-environment. Two types of environments are considered: (1) weather and (2) traffic:

- (1) **Weather:** Class SX - brick intended for use where the brick may be frozen while saturated with water.

TABLE 76: PHYSICAL REQUIREMENTS FOR CLASS SX PAVING BRICKS

Physical Requirements ¹			
Designation	Compressive Strength, flatways, gross area, Min. MPa	Cold Water Absorption Max.% Max	Saturation ² Coefficient
	Individual	Individual	Individual
Class SX	55.2	5	0.78

¹The purchaser should consider minimum modulus of rupture values for uses of brick where support or loading may be severe.

²The saturation coefficient shall be the ratio of absorption by 24-hours submersion in room temperature water to that after five hours of submersion in boiling water.

(2) Traffic**Abrasion Requirements**

The abrasion index shall be calculated from the cold absorption in percent and the compressive strength in pounds per square inch (MPa) as follows:

$$\text{Abrasion index} = \frac{100 \times \text{absorption}}{\text{compressive strength}}$$

The volume abrasion loss should be determined in accordance with Method C418, with the following changes in procedure:

- The sand shall be natural silica sand from Ottawa, ILL., graded to pass a 314 µm sieve and retained on a 160 µm sieve.
- The test shall be run on dry brick.
- The duration of the test shall be 2 minutes.
- The rate of sand flow shall be 400g/min.
- The volume loss shall be determined by filling the abraded depression with modelling clay, striking off level with the original surface of the brick, and removing and weighing the modelling clay. The volume loss shall be calculated from the bulk density of the modelling clay. The bulk density should be determined on each lot of modelling clay.

An alternative method of determining the weight of clay used in filling the sand-blast cavity is to determine the weight of the modelling clay sample before and after filling the cavity.

TABLE 77: MAXIMUM ABRASION INDEX, MAXIMUM VOLUME ABRASION LOSS AND THE TOLERANCE

(1) Abrasion Index max.	(2) Volume Abrasion Loss max, cm³/cm²
0.11	1.7
Tolerances on Dimensions	
Dimensions, mm	Permissible Variation, max, plus or minus mm.
Application PS	
76 and under	3.2
Over 76 to 102 incl.	4.7
Over 127 to 203 incl.	6.4



TABLE 78: MAXIMUM PERMISSIBLE EXTEND OF CHIPPING FROM EDGES AND CORNERS

Maximum Permissible Extend of Chipping from Edges and Corners		
Application	Chipping in Millimetres from	
	Edge	Corner
	6.4	9.5

315.04.03 – Visual Inspection

The brick shall be free of cracks or other imperfections detracting from the appearance of a designated sample when viewed from a distance of 4.6 m for Type PX and a distance of 6m for Type PS.

The parts of the brick that will be exposed in place shall be free of chips that exceed the limits given in Table 4.

Unless otherwise agreed upon by the purchaser and the seller, a brick delivery shall contain no more than 5 percent brick that does not meet the combined requirements of Tables 2, 3 and 4, including broken brick.

315.05.00 – Brick Pavement

315.05.01 – General

Rigid brick paving shall consist of units laid in a mortar bed with subsequent mortar joints between the units. Construction shall be on a concrete or asphalt concrete base as specified.

315.05.02 – Latex - Portland Cement Mortars

Materials and installation are contained in ANSI A118.4 'specifications for Latex - Portland Cement Mortar". Manufacturers" directions shall be carefully followed.

315.05.03 – Levelling Bed

The mortar levelling bed shall be 10 mm to 14 mm thick. Brick paving stones are buttered with mortar and shoved into the levelling bed of mortar.

315.05.04 – Joints

1) General

Joint width shall be specified within the range of 10 mm to 14 mm.

2) Expansion Joints

Expansion Joints shall be provided:

- Parallel to curbs and edging.
- At 90 degree or right-angle turns.
- Around interruptions.

315.05.05 – Protection of Work

No pedestrian or vehicle traffic shall be permitted within 48 hours after the paving stones have been placed.

315.06.00 – Silane Surface Treatment

315.06.01 – General

This work consists of treating concrete surfaces with a silane protective solution, including surface preparation and application, in accordance with the manufacturer's specifications.

315.06.02 – Material

Silane treatment shall be a 40 percent solution. Proposed silane product shall be submitted to the Engineer for approval.

315.06.03 – Application

Application of silanes shall follow manufacturers' recommendations.

Traffic shall be kept off treated surfaces until the solution has penetrated completely and is surface dry (usually 30 to 45 minutes).

316.00.00 – Noise Barriers

316.01.00 – General

Manufacturers shall prove, prior to tendering, to the Engineer that they are capable of fulfilling these specifications.

1) Design

The noise barrier shall be designed in accordance with the National Bridge Code as a slender structure not usually sensitive to wind action. Design wind loads and ice accretion on panels shall be as prescribed for sign panels. Reference wind pressure for a 25 year return period shall be used. The reference wind pressure shall be determined on a site-specific basis as described in the National Bridge Code.

The site-specific depth and size of post foundations shall be determined in accordance with the National Bridge Code based on the determined soil design parameters along the alignment of the noise barrier.

Where post foundations are to be installed on or within one meter from a downward slope of 3:1 or steeper, the embedment depth of the foundations shall be a minimum of 500 mm greater than the requirements of the National Bridge Code, which assumes level ground surrounding the post location.

The top of the barrier profile shall be installed level. To accommodate sloping ground, the barrier shall be evenly stepped with all panels installed level. Steps shall not exceed 300 mm in height. If stepping is required the minimum height of the noise barrier, as specified, shall be maintained.

Termination of barriers higher than 2 m shall be by stepping the height of the noise barrier down to a minimum height of 2 m.

2) Sound Transmission Class (STC)

The Sound Transmission Class (STC) of the specimen shall be 20 or greater and shall be determined from the measured sound transmission loss in accordance with ASTM-E413.

3) Post Foundation Concrete

Concrete used for post foundations shall be sulphate resistant and shall achieve a minimum of 25 MPa compressive strength at 28 days. The maximum slump shall be 100 mm. The concrete in the footings shall be cured for a minimum period of five days before the noise barrier panels are installed.

4) Materials

All materials shall have a minimum predicted maintenance-free lifespan of 20 years.

Noise barriers made from materials other than wood and/or concrete shall be subject to the same specifications regarding durability. They shall meet or exceed the accelerated weathering test and the test for colour fastness. Materials typically subject to damage from Ultra Violet (UV) rays shall be treated to make them UV resistant.

Materials used to fill cavities in double-walled noise barrier systems to increase sound absorption shall be manufactured to meet CGSB Standard 51-GP-10-M, rigid type. The noise reduction coefficient (NRC) shall not be less than 0.70 using 25 mm of insulation thickness on an F400 mount in accordance with ASTM Standard E795.

All materials shall be protected from weather and damage while in transit or at the construction site.

5) Samples

Prior to production of materials, the Contractor shall supply members for two complete panels erected on temporary supports suitable for visual inspection.

Full production of materials shall not commence until approval of the sample panels regarding finishes, colour, dimensions, tolerances, workmanship, etc., has been given.

The sample fence approved by the project Engineer shall be used as a standard for consistency of colour and texture from plank to plank.

6) Finish

The surface texture shall be subject to approval by the Engineer.

7) Drawings

Minimum specifications are shown in the Contract Drawings. The successful tenderer shall be required to submit Shop Drawings to scale showing the proposed method of panel erection, post details, and attachment method. The Shop Drawings and attached notes shall stipulate the construction of both posts and panels and the respective finishes and bear the seal of a professional engineer registered in the Province of Alberta.

8) Construction

The fence shall be constructed at the location and grade established by the Engineer and shall conform to all applicable Standard Drawings.

316.02.00 – Wood Noise Barrier

316.02.01 – Material

All materials shall conform to the requirements as outlined in section 300.00.00 – General.

316.02.02 – Height Restriction

The maximum height of a Wood Noise Barrier shall be 2 400 mm, measured at the midpoint of the panel.

316.03.00 – Pre-cast Concrete Noise Barrier - Zero Slump

316.03.01 – General

1) Mix Design

Submittals shall follow section 310.04.00 – Concrete Properties.

316.03.02 – Materials

All materials shall meet the requirements of section 310.03.00 – Submittals.

Reinforcing steel shall be accurately and firmly anchored in place as designated in the drawings.

316.03.03 – Production

1) Tolerances

Tolerances shall be in accordance with CSA A23., Section 10.

2) Curing

Curing shall conform to requirements of CSA A23.4-M78, Section 21. Planks shall be steam cured for a minimum of eight hours.

316.03.04 – Erection

1) Delivery, Handling and Storage

Delivery, handling, and storage shall be in accordance with CSA A23.4-09, Section 27.

2) Erection

Erection shall be in accordance with CSA A23.4-09, Section 30.

Pre-cast members shall not be handled for shipment until 75 percent of design strength is achieved. Proof of strength shall be a compressive strength of a cube (core) on a field cured plank at the Contractor's expense.

3) Rejection

The Engineer reserves the right to reject any product not meeting the requirements of these Specifications including, but not limited to, the occurrence of one or more of the following:

- Defects that indicate any imperfect concrete mixing or moulding.
- Surface defects indicated by honeycombed or open textures and damaged areas where such defects would affect the structural adequacy.

Minor surface cavities or irregularities which are satisfactorily repaired shall not constitute a cause of rejection. Repairs shall not be made until the Engineer has inspected the extent of the irregularity and has determined whether or not the product shall be accepted.

4) Cleaning, Patching and Repairs

Cleaning, patching, and repairing pre-cast concrete shall be in accordance with CSA A23.4- 09, Clause 32. Approval by the Engineer shall be required for all cleaning, patching, and repairing methods. Clean soiled pre-cast concrete surfaces by approved means.

316.03.05 – Testing

1) General

The supplier shall notify the Engineer of casting times. Concrete testing and/or inspection shall be done at the expense of The City. The supplier shall allow the Engineer free access to those plant portions where the planks are being produced and stored.

Strength testing of concrete shall be carried out by a testing laboratory designated by The City. The City shall pay costs for testing. The Contractor shall bear the cost of supplying materials for test samples.

At the Engineer's option, cube samples shall be taken on-site from the pre-cast concrete members and tested to confirm the specified compressive strength has been attained.

Planks shall be tested at the discretion of The City. These planks shall be cubed (cored) and tested for compressive strength and absorption.

2) Plastic Concrete Testing

Plastic concrete testing shall be conducted in accordance with CSA A23.2-12C, Making, curing, and testing compression test specimens of no-slump concrete.

3) Hardened Concrete Testing

To evaluate the in-place hardened concrete produced by these special mixes, cube specimens shall be cut from the middle third of a sound barrier plank chosen at random from each day's production.

4) Absorption

Six cubes shall be tested for 24-hour water absorption at room temperature in accordance with the procedures of ASTM C140.

5) Compression

Zero slump concrete shall achieve a minimum of 25 MPa compressive strength at 28 days for a saturated cube sample.

Three cubes shall be tested in compression in accordance with the procedures of ASTM C140.

316.04.00 – Pre-cast Concrete Noise Barrier - Wet Cast

316.04.01 – Mix Design

1) General

Submittals shall follow section 310.04.00 – Concrete Properties.

2) Compressive Strength

Unless otherwise noted, wet cast concrete shall achieve a minimum of 30 MPa compressive strength at 28 days for laboratory samples and 25 MPa for saturated core samples.

3) Water - Cement Ratio

Maximum water-cement ratio shall be 0.45.

4) Air Entrainment

Air entrainment minimum 5 - 8%.

5) Absorption

Absorption to be 5 % maximum ASTM Designation C140.

6) Calcium Chloride

No calcium chloride shall be used.

316.04.02 – Materials

All materials shall meet the requirements of section 310.03.00 – Submittals.

1) Reinforcing Steel

Reinforcing steel shall be deformed bars meeting the requirements of ASTM Designation A615, Grade 400 or CSA G30.12.

Reinforcing steel shall be accurately and firmly anchored in place as designated in the drawings.

316.04.03 – Testing

1) General

Strength testing of concrete shall be carried out by a testing laboratory designated by The City. The City shall pay costs for testing. The Contractor shall bear the cost of supplying materials for test samples.

The supplier shall notify the Engineer of casting times so that arrangements for concrete testing and/or inspection can be made at the expense of The City. The supplier shall allow the Engineer free access to those portions of their plant, where the planks are being produced and stored, for this purpose.

2) Linear Transverse

A 100 mm diameter core shall be taken and subjected to laboratory testing by the linear transverse method in accordance with ASTM C-457, Modified Point-Count Method using a magnification of a minimum of 100 times.

The acceptance of the air void system shall be in accordance with CSA A23.1, 4.3.3.3. The spacing factor of a single core exceeding 230 μm and air content in the hardened concrete less than 3 % shall result in a rejection of the concrete represented by the core, and complete replacement of the work shall be required. The results of one full traverse shall be held as representative of all concrete cast on the same day.

3) Compressive Strength

- Concrete sampling shall be conducted in accordance with CSA A23.2-1C, sampling plastic concrete.
- Making and curing concrete compression test specimens shall be conducted in accordance with CSA A23.1-3C. Concrete with a specified slump greater than 40 mm may be consolidated by rodding in accordance with Table 2 of CSA A231-3C. Concrete with a specified slump equal to or less than 40 mm shall be consolidated by vibration.
- Air content and slump of plastic concrete shall be determined in accordance with CSA A23.-4C and CSA A23.2-5C.
- Concrete cylinders shall be made and cured in accordance with CSA A23.2-3C, Making and curing concrete compression and flexural test specimens.
- Concrete compressive strength shall be determined in accordance with CSA A23.2-9C. Plastic and hardened concrete test results shall include the information listed in Section 8 of A23.2-9C.
- Additional air and slump tests on-site shall be undertaken as required by the Engineer.
- Each test consists of three cylinders, broken at 28 days. The average breaking strength of the two cylinders with the most closely related breaking strengths determines the compressive strength of the test sample.
- Air and slump tests shall be taken in every case when cylinders are cast.

At the Engineer's option, core samples shall be taken on-site from the pre-cast concrete members and tested to confirm that the specified compressive strength has been attained. The concrete's compressive strength in the area of the structure represented by the core test shall be considered adequate if the average of each set of three cores is equal to at least 85 percent of the specified strength and no single core is less than 75 percent of the specified strength.

Any concrete found non-compliant as to the above Sections shall be rejected, and removal and replacement may be required at the Engineer's discretion.



317.00.00 – Railway Crossing Planks

317.01.00 – General

All railway crossing planks within the Streets Right-of-Way shall be constructed in accordance with Canadian Pacific Railway and/or Canadian National design specifications. General arrangement to be as shown on Standard Drawing 454.1007.014.

The rate of transition, from railway longitudinal grade to pavement road crown, shall be as per railway guideline or federal crossing guidelines.

Note: To maintain constant pavement depth, the sub-grade shall also conform to the rate of transition.

318.00.00 – Mud-jacking and Soil Stabilization

318.01.00 – General

318.01.01 – Definitions

1) Mud-jacking

Restoration of surface grade of concrete flatwork or pavement by pressure injection of grout.

2) Soil Stabilization

The use of cementitious grout to enhance the bearing properties of soil.

318.01.02 – Mud-jacking

The work shall include the following:

- Coring or drilling holes through the existing concrete/pavement structure of a diameter not to exceed 63mm.
- Supply equipment, labour and grouting materials for pressure grouting to fill all voids between the underside of the concrete/pavement and the existing subgrade to restore concrete/pavement elements to control elevations.
- Repairing all grouting holes.
- Removal of all temporary repairs and construction debris.
- The Contractor shall prevent wastewater or mud-jacking slurry from entering the storm sewer system.

318.01.03 – Soil Stabilization

A fine particle grout shall be used to fill soil pore space without significant fissuring of the soil mass. The scope of the work shall be backfill stabilization and moisture reduction in areas of frost susceptible soils.

The work shall include the following:

- Coring or drilling holes through the existing concrete pavement structure of a diameter not to exceed 63mm and at horizontal spacings to produce an ultimate grid of two metres centre-to-centre within the area to be densified/stabilized, as shown on the Drawings.
- Supply equipment, labour and grouting materials for pressure grouting to fill all voids and soil pore spaces and otherwise densify all soil strata where deficient soil density may exist. Provide for partial completion of grouting at any individual grouting location and progressive grouting from depth to the underside of the existing concrete pavement.
- Repairing all grouting holes.
- Removal of all temporary repairs and construction debris.

318.01.04 – Sequential Work

Procedures and materials to execute the work described in 318.01.02 and 318.01.03 may be performed sequentially using the same grouting hole when the occasion permits and approved by the Engineer.

318.01.05 – Temperature

Operations are to be suspended when the air temperature is less than 5° Celsius.

318.02.00 – Grout Mixes

318.02.01 – Type “A” Grout

Type “A” grout shall be an approved fine particle grout with the solids component consisting of Type 30 Portland cement and silica fume.

Type “A” grout shall be used to stabilize reasonably dense fine-grained soils which contain no significant fissuring in the soil mass and to fill soil pore spaces within the soil mass. This type of grout may also be used to modify the natural moisture content of frost susceptible soils.

318.02.02 – Type “B” Grout

Type “B” grout shall be approved with the solids component consisting of Type 10 Portland cement and bentonite.

Type “B” grout shall be used to densify and stabilize medium to loose fine-grained soils whose mass does not typically contain significant void spaces and to stabilize well-graded granular soils by filling voids between particles that generally have particle-to-particle contact. This type of grout may also be used for mud-jacking concrete pavement slabs where no void space initially exists between the slab and the supporting sub-grade.

318.02.03 – Type “C” Grout

Type “C” grout shall be approved with the solids component consisting of Type 10 Portland cement, fine sand, and bentonite with or without an approved pozzolan.

Type “C” grout shall typically be used to fill substantial-sized void spaces within the targeted zone of sub-grade stabilization and for typical mud-jacking purposes.

318.02.04 – Mix Designs

Mix designs for each type of grout shall be submitted to the Engineer for approval. Submission requirements shall include:

- Batch proportions to produce a unit volume of injectable grout and intended dosage rates of permitted admixtures.



- Verification of compliance with the following physical property requirements, as submitted by an independent testing firm acceptable to the Engineer and shall be retained and reimbursed by the Contractor.

318.02.05 – Mix Properties

TABLE 79: MIX PROPERTIES OF GROUT

Property	Grout Type		
	A	B	C
CAN3-A23.2-1B:			
Flow, seconds	10 - 16	15 - 30	N/A
Compressive Strength @ 28 days, Mpa	3 - 5	3 - 5	3 - 5
Bleeding @ one hr. after casting	Nil to trace		
Slump, mm	N/A	N/A	150 - 250
Spread, max, in diameter, mm	N/A	N/A	400
Density, kg/ m ³	1350 - 1450	1400 - 1600	1700 min
Cement content kg/m ³ 1 minimum	400	450	300
Aggregate: Cement Ratio, by volume	N/A	N/A	2.25 – 3.00
Shrinkage, max, %	1.0	1.0	1.0

318.03.00 – Grout Material

318.03.01 – General

All materials shall be obtained from the same source of supply or manufacturer for the project duration.

318.03.02 – Cement

- Normal, type 10 Portland conforming to CSA A5.
- High early strength, type 30 Portland cement.

318.03.03 – Fine Aggregates

Fine Aggregate shall conform to Clause 5.3, CAN-A23.1-M77 (mortar sand free of excess rubble or stone material).

318.03.04 – Pozzolanic Material

Pozzolanic materials shall conform to CAN3-A 266.1-M78 (as required)

318.03.05 – Water

Water shall be clean and free from oil, alkali, organic matter, or deleterious matter.

318.03.06 – Admixtures

- Flake calcium chloride conforming to ASTM C494-71 as required.
- 4 % to 6 % air entrainment as required.
- Plasticizer as required.
- Derex pumping aid as required.
- Water reducer as required.
- Lime and or fly ash as required.
- The use of powdered bentonite shall be subject to the prior approval of the Engineer.

318.04.00 – Equipment

318.04.01 – General

All equipment required for mixing and injecting each type of grout mix shall be located at the worksite. All grouts shall be mixed on-site.

318.04.02 – Grout Mixers and Grout Pumps

Grout mixers shall be capable of thorough, homogeneous mixing.

For mixing, pumping and injecting fine particle grout (Type "A"), the following equipment shall be provided, as a minimum:

- High-speed colloid mixer, or equivalent.
- Non-pulsing progressive cavity pump system, or an equivalent with constant flow pressure up to 150 psi and controllable flow rate from 1 to 25 GPM.
- Packer system to seal the zone between the injection probe and surrounding pavement, when applicable.
- Pumping Types B and C grout shall be undertaken with a pump capable of applying up to 1,750 kPa (250 psi) pressure at the outlet end of the discharge pipe.
- The pump shall be a positive displacement type. It shall be equipped with a return line to the pump hopper so that the grout mixture can be continuously circulated during periods when no grout is being placed.

318.05.00 – Construction

318.05.01 – General

The Contractor shall be responsible for selecting the appropriate type of grout to commence stabilization/densification operations within the installation zone, using evidence acquired by him during the

development of the grouting holes by auguring or other hole-making techniques. They shall be prepared to change grout type immediately upon identifying the rate at which the initial grout injection rate, or "take", occurs.

318.05.02 – Mud-jacking

1) General

Mud-jacking shall be done in small increments so as not to damage the pavement.

2) Grouting Holes

Grouting holes are to be carefully planned in strategic locations, and an attempt should be made to use mud-jacking grouting holes for subsequent soil stabilization/densification operations.

3) Water Injection

Water injection may be used to create voids beneath concrete slabs if necessary. The Contractor shall make the arrangements required for the water supply.

4) Faulted Joints

Mud-jacking at a faulted or misaligned joint shall continue until the vertical dimension across the joint, measured by a straightedge placed across the joint, is 6mm or less. If the Contractor causes a slab to uplift so that its edge is higher than the edge of the adjacent slab(s), they shall, at their own expense, undertake corrective measures using approved grinding means to restore a maximum 6mm vertical dimension across the joint. Other joints may be repaired by use of approved grinding techniques at applicable Unit Rate.

5) Excessive Grout

If an excessive amount of grout is being used at a location, as determined by the Engineer, the Contractor shall suspend operations to allow the injected grout to set up before resuming grouting.

6) Cracks

Cracks caused by the mud-jacking operation greater than or equal to 3mm in width shall be repaired by the Contractor, at their expense, using materials and methods satisfactory to the Engineer.

318.05.03 – Stabilization/Densification

1) Grouting Holes

Grouting holes for grout injection shall be established on a two-metre horizontal grid within the area of work set out by the Engineer. Initial grouting shall be undertaken at each alternate hole location (i.e. 4 metres spacing) on the longitudinal axis of the work area and the transverse axis if necessary.

2) Initial Grouting

Initial grouting shall consist of the injection of sufficient grout to create a "plug" of stabilized soil, after which grouting at a location shall be suspended until that initial grout sets up.

3) Infill Grouting

Infill grouting at the alternate core hole locations shall be permitted after the grout has been set up at the initial injection locations and shall continue only until a "plug" has been created to abut the "plugs" created at the initial grout locations.

4) Completion Grouting

Completion grouting shall be permitted throughout the vertical dimension of each core hole to the underside of the concrete/pavement in a sequence that shall be consistent with the soil conditions determined to exist by the Contractor at that location.

5) Grouting Pressure

Grout injection pressures shall be the Contractor's responsibility but should only be sufficient to ensure reasonable grout "take".

318.06.00 – Inspection and Testing

318.06.01 – General

Grout sampling, inspection and testing shall be performed by an inspection and testing firm appointed and paid for by The City. Slump and spread testing may be performed regularly on-site by the Engineer or their representative.

The Contractor shall provide the appointed testing firm with free access to all portions of the worksite at all times.

318.06.02 – Tests

Strength, shrinkage, density, slump and spread tests of the grout and/or materials in the grout shall be performed to ensure conformance with requirements stated herein.

To conform to the strength requirements of the Specifications, the results of tests performed on laboratory cured cylinders or cubes for each type of grout shall meet the following:

- The average of all tests shall exceed the specified strength.
- When five or more tests of the same type of grout are available, the average of any five consecutive tests shall be equal to or greater than the specified strength.
- No three consecutive tests shall fall below the specified strength.
- No individual strength test shall fall in excess of 0.5 MPa below the specified strength.

318.06.03 – Additional Testing

If any of the foregoing criteria are not met, the Engineer or their representative shall have the right to require one or more of the following, the costs of which shall be borne by the Contractor:

- Changes in the mix proportions for the remainder of the work.
- After completion of the testing procedure, if the Engineer or their representative is not satisfied with the indicated quality or consistency of the grout, the Contractor may be required to strengthen or replace those portions which are deemed to be unsatisfactory, or an adjustment of grout used shall be made and deducted from submitted invoices, or a particular batch of grout may be rejected on site.

318.07.00 – Measurement

The Contractor shall provide to the Engineer, at the end of each working day, a summary of all payment quantities claimed in accordance with the terms of this Contract.

319.00.00 – Geotextiles and Geomembranes

319.01.00 – Filter Fabrics

319.01.01 – General

Filter fabrics are divided into separation membranes and drainage membranes.

1) Separation Membranes

Separation membranes shall be used to separate native soils from construction materials. The fabric shall be woven polymer fibre having the following minimum properties:

TABLE 80 SEPARATION MEMBRANES

Grab Tensile Strength	890 N
Puncture Strength	420 N
Mullen Burst Strength	2 900 kPa
Trapezoidal Tear Strength	400 N

2) Drainage Membranes

Drainage membranes shall filter excess water entering the drainage gravel and/or sub-drain from the sub-grade.

The fabric shall be a non-woven polymer having the following properties:

TABLE 81: DRAINAGE MEMBRANES

Grab Tensile Strength	890 N
Mullen Burst Strength	2 000 kPa
Trapezoidal Tear Strength	270 N
Permeability K.	0.1 cm/sec

319.01.02 – Joints

All fabric joints shall be sewn using a thread having equal or greater tensile strength than the fabric. Seams (joints) shall be double stitched using the "J" seam with interlocking stitches. The strength of the finished joint shall meet the same specifications required for the fabric.

319.01.03 – Packaging and Storage

Each roll shall be packaged and stored in such a manner as always to be protected until used. The fabric shall not be stored in direct sunlight.

319.01.04 – Certification

Two copies of the Mill or Manufacturer's Certificate listing the mill number of each roll and verifying compliance with the Specifications shall be supplied with each shipment of geotextile materials. The Mill or Manufacturer's Certificate shall be signed by a duly authorized official of the manufacturing firm.

Prior to shipment, one copy of the Mill or Manufacturer's Certificate shall be provided to the Engineer. The Mill or Manufacturer's Certificate specifications shall be provided in the same units as specified in these Specifications.

Each roll shall be clearly marked indicating the manufacturer, product type, mill number, and roll number.

320.00.00 – Agricultural Crossings

320.01.00 – General

1) Definition

"Agricultural Crossing" means the driveway crossing to a property from a City roadway having drainage ditches.

2) Agricultural Crossing Agreement

An "Agricultural Crossing Agreement" between The City and the property owner shall be executed prior to any work being performed.

320.02.00 – Design

320.02.01 – General

All agricultural crossings shall be designed and constructed to conform to the following minimum Specifications and Standard Drawing unless prior, written approval is obtained from the Engineer for construction to alternate standards.

320.02.02 – Alignment

The agricultural crossing shall be aligned at right angles to the tangent of The City road.

320.02.03 – Grade

A minimum grade of minus 10 percent and a maximum of plus 10 percent shall be maintained along the agricultural crossing from the shoulder edge of the intersecting City street to the property line.

320.02.04 – Culverts

The minimum requirements for culverts, where they are required to be installed, shall be:

- a. 450 mm diameter;
- b. Galvanized corrugated metal pipe with 4:1 tapered ends for local streets and 5:1 tapered ends for a collector and/or major roads;
- c. 1.6mm wall thickness;

Note: A corrugated polyethylene pipe of equivalent strength may be used.

Culverts shall be installed along the ditch bottom, so the existing drainage along the ditch is maintained. A larger diameter culvert may be required when drainage conditions dictate, as determined by Wastewater.

320.02.05 – Minimum Cover

There shall be a minimum cover equal to the diameter of the culvert over the culvert.

320.02.06 – Side Slopes

The agricultural crossing side slopes shall be 4:1 on local streets and 5:1 on collector and/or Major roads.

320.02.07 – Crossing Surface

The finished travelling surface of the agricultural crossing shall be crowned and shall be a minimum of 6.1m in width.

320.03.00 – Construction

320.03.01 – Utility Locates

The Applicant shall be responsible for all utility locations and any costs for repair and/or relocation of utilities arising out of the construction of the agricultural crossing.

320.03.02 – Embankment Material

All organic or otherwise deleterious materials shall be removed before any fill material is placed for the new agricultural crossing. The fill used for construction of the agricultural crossing shall not contain any organic, frozen or otherwise deleterious materials. It shall be compacted to a minimum of 97.0 percent of Standard Proctor Density.

320.03.03 – Construction Standard

The entire width of the agricultural crossing, from the shoulder of The City street to the property line, shall be constructed to be equivalent to or better than the standard of the abutting City road.

320.03.04 – Damage to City Property

Any damage to City property, including utilities and road surface, shall be repaired at the applicant's expense.

320.03.05 – Ditch Rehabilitation

Any disturbed areas in the ditch shall be reclaimed, including seeding and removing rocks larger than 75 mm.

320.04.00 – Inspection

ROADS shall be notified within 72 hours of the completion of the agricultural crossing. An inspection will then be conducted to ensure compliance with these specifications.

320.05.00 – Maintenance

The construction of an agricultural crossing is for the sole benefit of the applicant. Therefore, the applicant is responsible for the maintenance of the agricultural crossing, including the maintenance and cleaning of the culvert.



321.00.00 – Landscaping

Refer to the current issue of the Standard Specifications City of Calgary Development Guidelines and Standard Specifications for Landscape Construction.

322.00.00 – Standard Drawings

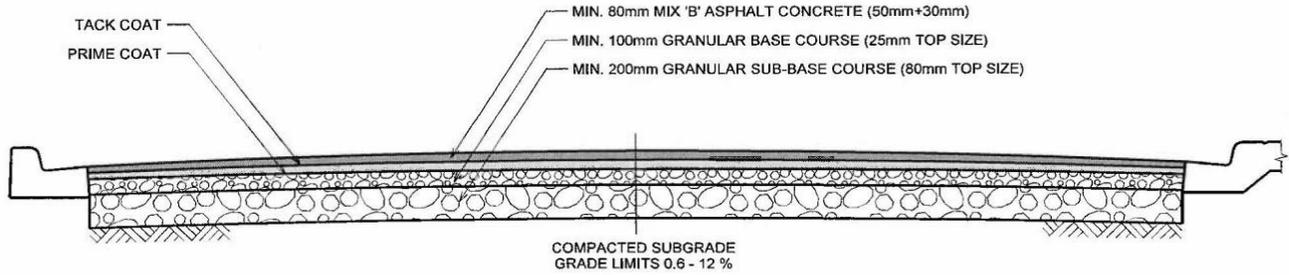
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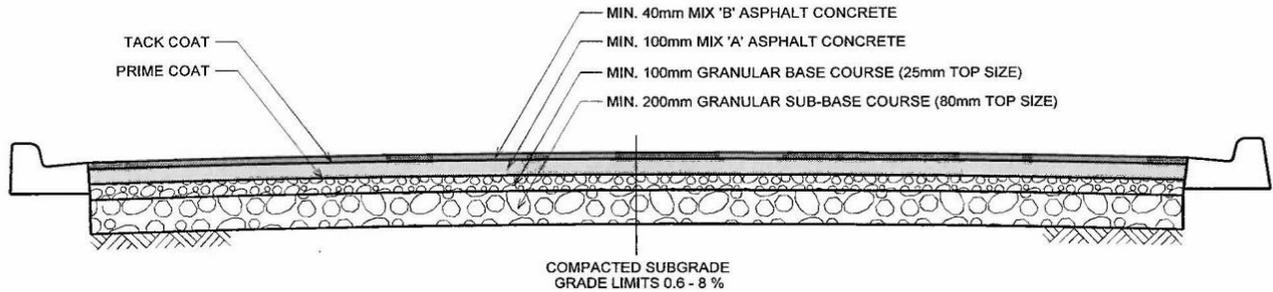


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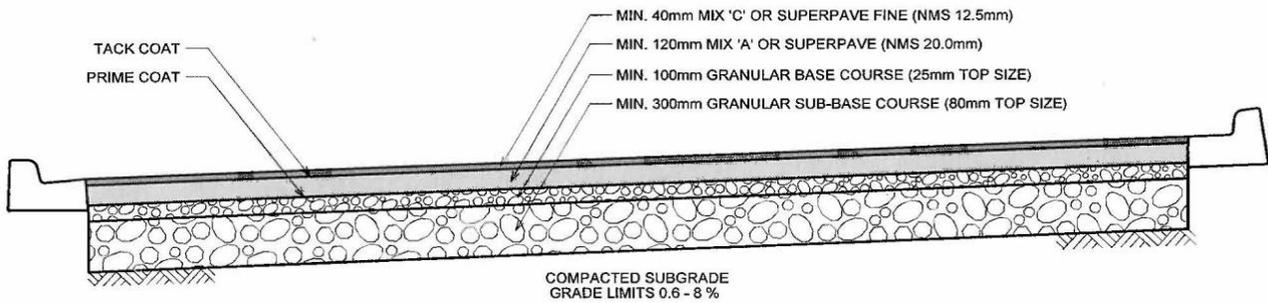


RESIDENTIAL ROADS

(RESIDENTIAL ENTRANCE STREETS, RESIDENTIAL STREETS)



NON-TRANSIT COLLECTOR ROADS



TRANSIT COLLECTOR ROADS

(PRIMARY COLLECTOR STREETS, COLLECTOR STREETS, ACTIVITY CENTRE STREETS)



TOLERANCE 0-5mm

STANDARD

REVERSE

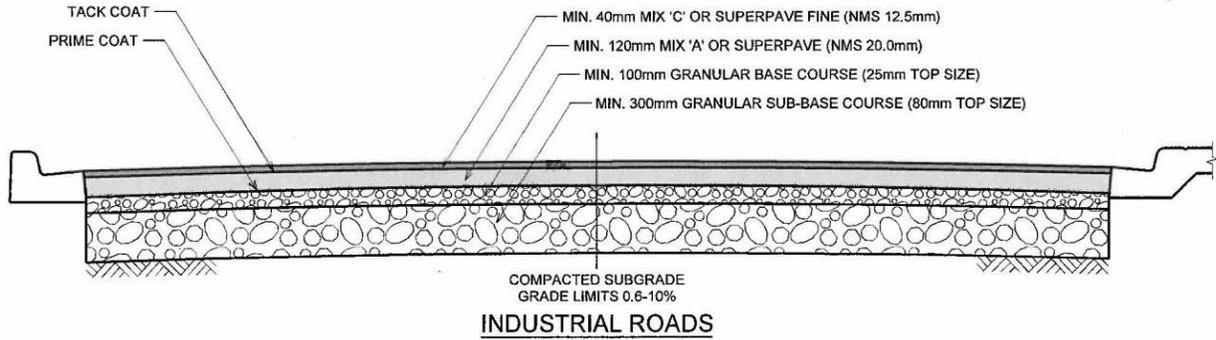
THICKNESS OF ASPHALT CONCRETE TO CURB

NOTES:

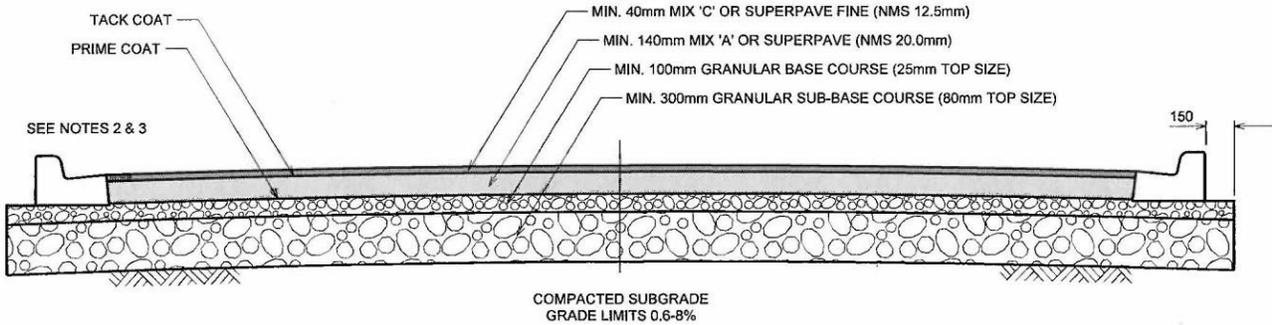
- FOR PAVEMENT ROAD CROWNS, SEE DRAWING, FILE No. 454.1005.001.
- SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
- GRANULAR BASE AND SUB BASE COURSE MATERIAL SHALL MEET REQUIREMENT AS IN 303.00.00.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-10 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC		Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS		Figure 1 File Number 454.1005.002	

Figure 2: TYPICAL ASPHALT PAVEMENT STRUCTURE - INDUSTRIAL AND MAJOR ROADS (454.1005.009)

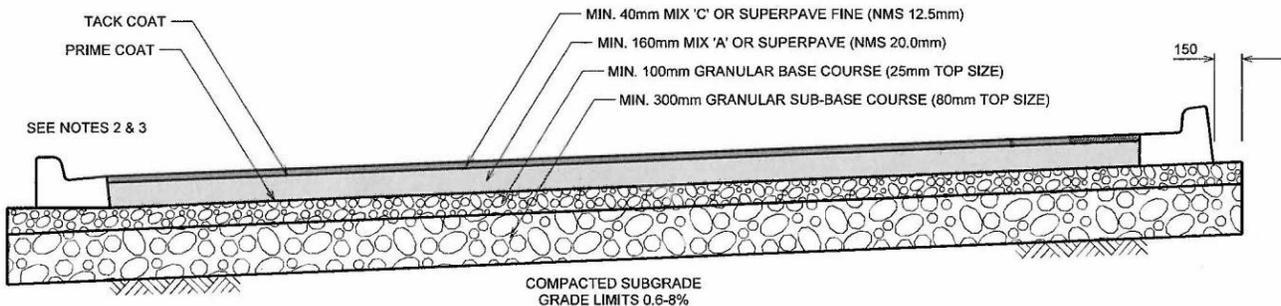


INDUSTRIAL ROADS



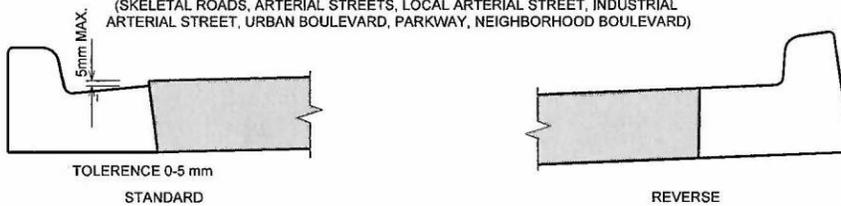
MAJOR ROADS

(<5 MILLIONS ESALS)
(SKELETAL ROADS, ARTERIAL STREETS, LOCAL ARTERIAL STREET,
INDUSTRIAL ARTERIAL STREET, URBAN BOULEVARD, PARKWAY, NEIGHBORHOOD BOULEVARD)



MAJOR ROADS

(>5 MILLIONS ESALS)
(SKELETAL ROADS, ARTERIAL STREETS, LOCAL ARTERIAL STREET, INDUSTRIAL
ARTERIAL STREET, URBAN BOULEVARD, PARKWAY, NEIGHBORHOOD BOULEVARD)

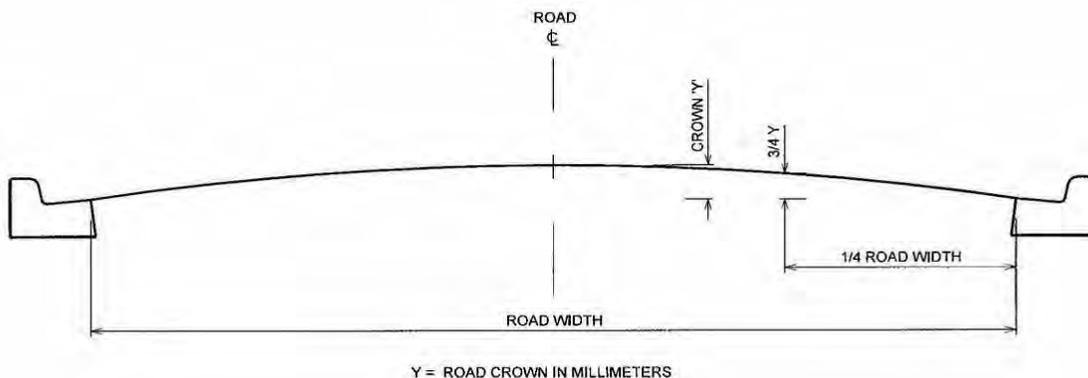


THICKNESS OF ASPHALT CONCRETE TO CURB

NOTES:

1. FOR PAVEMENT ROAD CROWNS, SEE DRAWING FILE No. 454.1005.001.
2. IF CURB IS PLACED ON ASPHALT MIN. THICKNESS OF ASPHALT (MIX "A" AND MIX "C") IS 225 mm SEE DRAWING FILE No. 454.1003.010 & 454.1003.006.
3. IF CURB IS PLACED ON GRAVEL SEE DRAWING FILE No. 454.1003.017 & 454.1003.015.
4. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
5. GRANULAR BASE AND SUB - BASE COURSE MATERIAL SHALL MEET REQUIREMENT AS IN 303.00.00.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																									
<table border="0"> <tr> <td rowspan="4"> PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015 MAR 11</i> PERMIT NUMBER: P. 01426 The Association of Professional Engineers and Geoscientists of Alberta </td> <td rowspan="4"> </td> <td rowspan="4"> THE CITY OF CALGARY ROADS </td> <td rowspan="4"> DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541005\USTN4541005009_V8.dgn 13-MAY-2015 14:11 ISC : UNRESTRICTED </td> <td>Drawn</td> <td>Date</td> <td rowspan="4"> TYPICAL ASPHALT PAVEMENT STRUCTURE INDUSTRIAL AND MAJOR ROADS </td> <td>Figure</td> </tr> <tr> <td>JL</td> <td>2014-10</td> <td>2</td> </tr> <tr> <td>Designed</td> <td>EW</td> <td>File Number</td> </tr> <tr> <td>Checked</td> <td>EW</td> <td>454.1005.009</td> </tr> <tr> <td>Scale:</td> <td colspan="2">NTS</td> <td colspan="2"></td> <td colspan="2"></td> <td></td> </tr> </table>												PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015 MAR 11</i> PERMIT NUMBER: P. 01426 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541005\USTN4541005009_V8.dgn 13-MAY-2015 14:11 ISC : UNRESTRICTED	Drawn	Date	TYPICAL ASPHALT PAVEMENT STRUCTURE INDUSTRIAL AND MAJOR ROADS	Figure	JL	2014-10	2	Designed	EW	File Number	Checked	EW	454.1005.009	Scale:	NTS						
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015 MAR 11</i> PERMIT NUMBER: P. 01426 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541005\USTN4541005009_V8.dgn 13-MAY-2015 14:11 ISC : UNRESTRICTED	Drawn	Date	TYPICAL ASPHALT PAVEMENT STRUCTURE INDUSTRIAL AND MAJOR ROADS	Figure																													
				JL	2014-10		2																													
				Designed	EW		File Number																													
				Checked	EW		454.1005.009																													
Scale:	NTS																																			



UNDIVIDED ROADWAYS

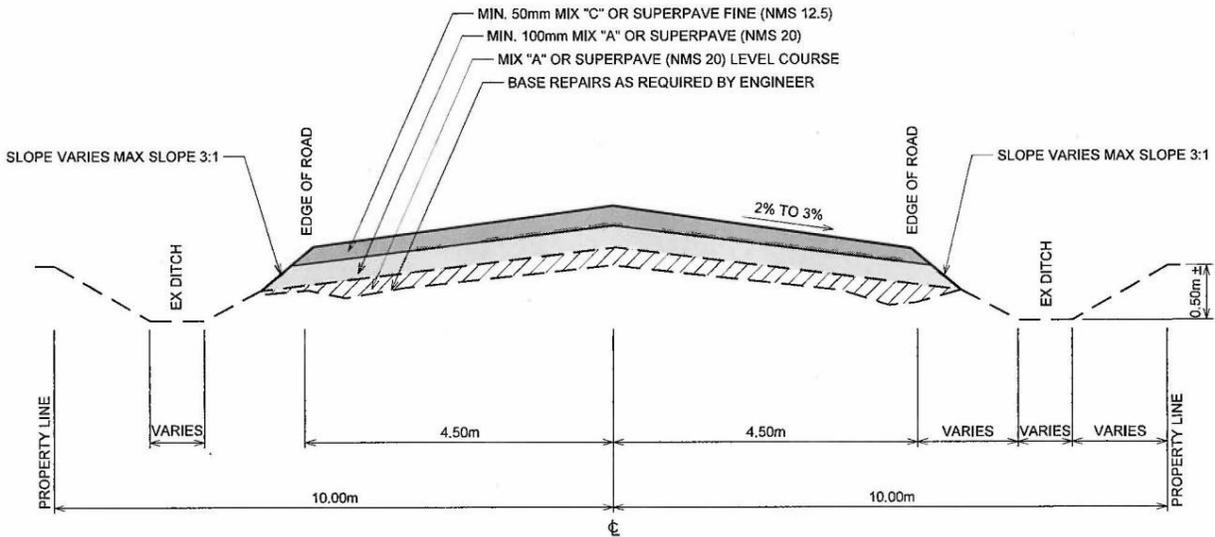
ROAD GRADE	0.6 - 3%	3 - 4%	4 - 6%	6 - 9%	9 - 12%
ROAD WIDTH IN METERS	ROAD CROWN IN MILLIMETERS				
8.50	135	105	85	65	50
9.00	145	115	90	70	50
9.50	150	120	95	70	55
10.00	160	125	100	75	55
10.50	170	130	105	80	60
11.00	175	140	110	85	65
11.50	185	145	115	85	65
12.00	190	150	120	90	70
12.50	200	160	125	95	70
13.00	210	165	130	100	75
13.50	215	170	135	100	75
14.00	225	175	140	105	80
14.50	230	180	145	110	85
15.00	240	190	150	110	90

DIVIDED ROADWAYS

1. THE PAVEMENT SHALL BE 2% SLOPE.
2. NO CROWN PERMITTED ON SUPERELEVATED OR DIVIDED ROADWAY.

No.	Date	Revision	App'd No.	Date	Revision	App'd No.	Date	Revision	App'd	
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2014-10-10</i> PERMIT NUMBER: P 04388 The Association of Professional Engineers and Geoscientists of Alberta		SEAL PROFESSIONAL ENGINEER CIVIL 2015-78221		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED 2:\permanentStdRoadSpecs_2014\Drawing Files\4541005\USTN4541005001_V6.dgn 28-OCT-2014 08:28 ISC - UNRESTRICTED		Drawn: JL Date: 2014-10-10 Designed: EW Checked: EW Scale: NTS		PAVEMENT ROAD CROWNS		Figure 3 File Number 454.1005.001

Figure 4: TYPICAL RURAL ROADS ASPHALT PAVING (454.1005.012)

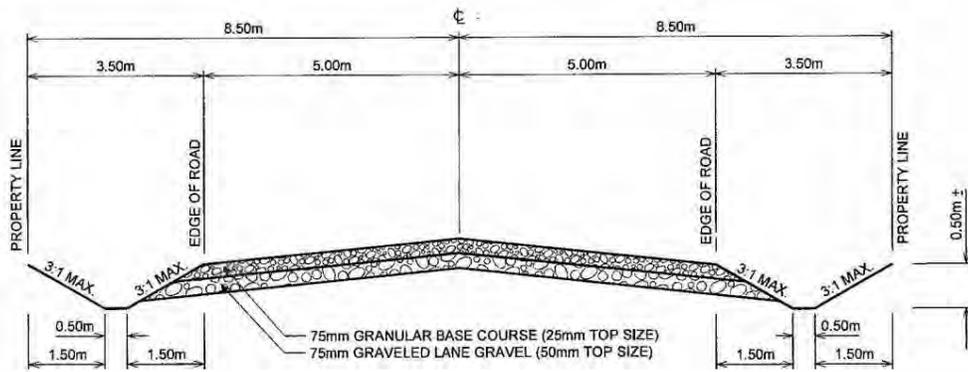


**9.00m ROAD / 20.00m RIGHT OF WAY
RURAL ROAD ASPHALT PAVING**

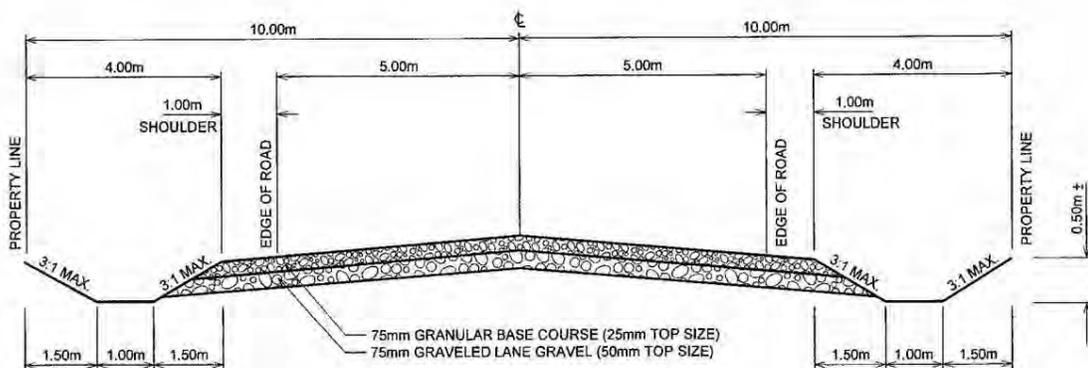
NOTES:

1. FOR ROAD CROWNS SEE DRAWING 454.1005.001.
2. CROSS-SLOPE TO BE DETERMINED IN FIELD.
3. IN LOCATIONS WHERE THE 3:1 MAXIMUM SIDESLOPE CANNOT BE ACHIEVED, ADDITIONAL GRADING AND/OR GUARDRAILS MAY BE REQUIRED.
4. WHEN R.O.W. GREATER THAN 20.00m, SHOULDER ROUNDING IS DESIRABLE.

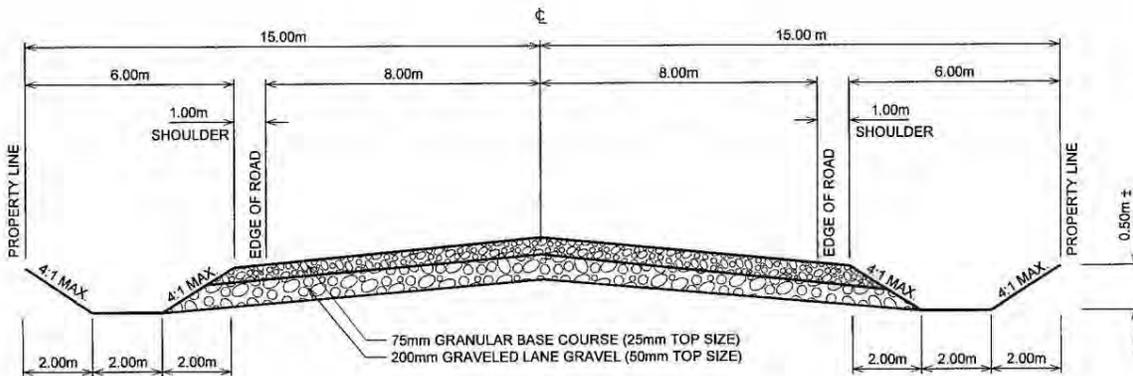
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2014-10-10 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta						 THE CITY OF CALGARY ROADS			Drawn: JL, Date: 2014-10 Designed: EW Checked: EW Scale: NTS			TYPICAL RURAL ROAD ASPHALT PAVING			Figure 4		
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED						METRIC			Z:\permanent-StrRoadSpecs_2014\Drawing Files\4541005\USTN\4541005012_VB.dgn 29-OCT-2014 11:51 ISC: UNRESTRICTED			File Number 454.1005.012					



10.00m ROAD / 17.00m RIGHT OF WAY



10.00m ROAD / 20.00m RIGHT OF WAY

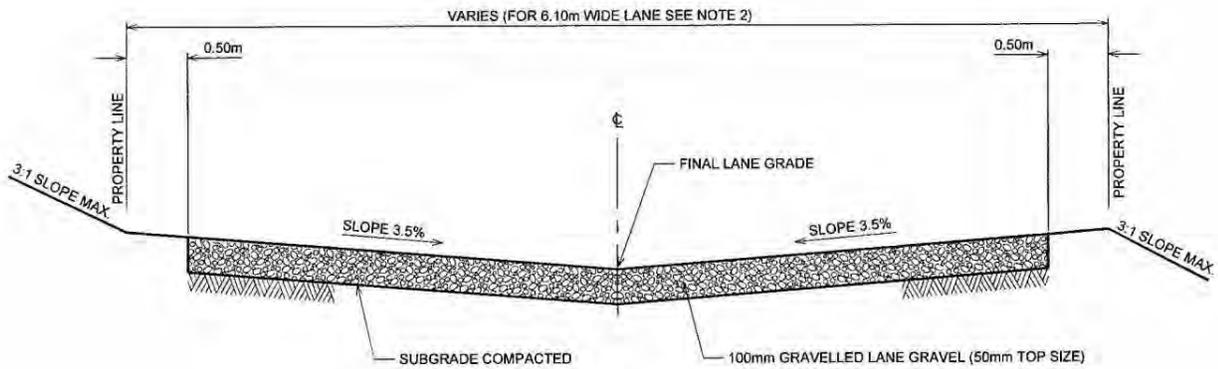


16.00m ROAD / 30.00m RIGHT OF WAY

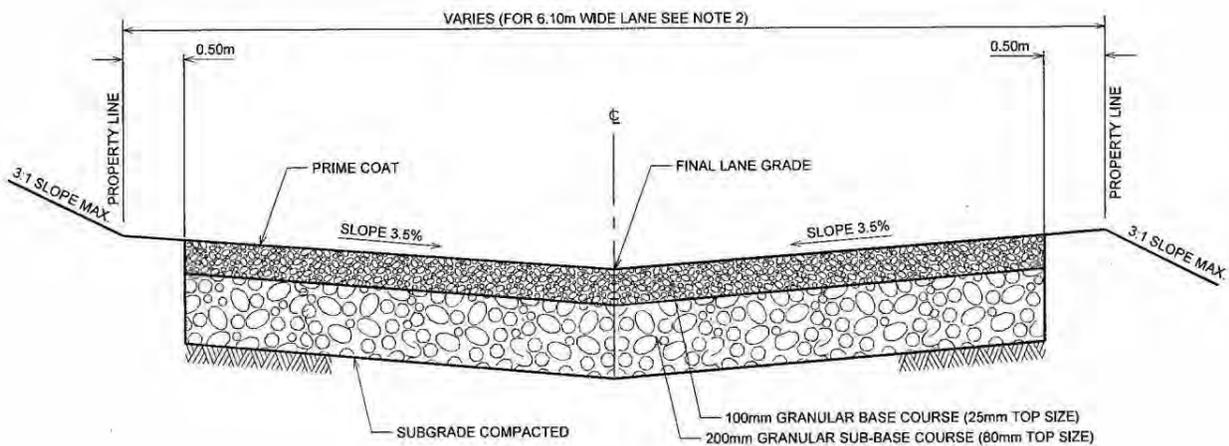
NOTE:
FOR ROAD CROWNS SEE DRAWING #454.1005.001.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd							
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>[Date]</i> PERMIT NUMBER: P/04428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\p\m\h\StdRoadSpecs_2014\Drawing Files\4541005\USTM4541005004_V6.dgn 13-MAY-2015 14:15	METRIC	Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS	TYPICAL GRAVELLED ROADS	Figure 5 File Number 454.1005.004												

Figure 6: TYPICAL GRAVELLED LANES (454.1011.003)



STANDARD SECTION

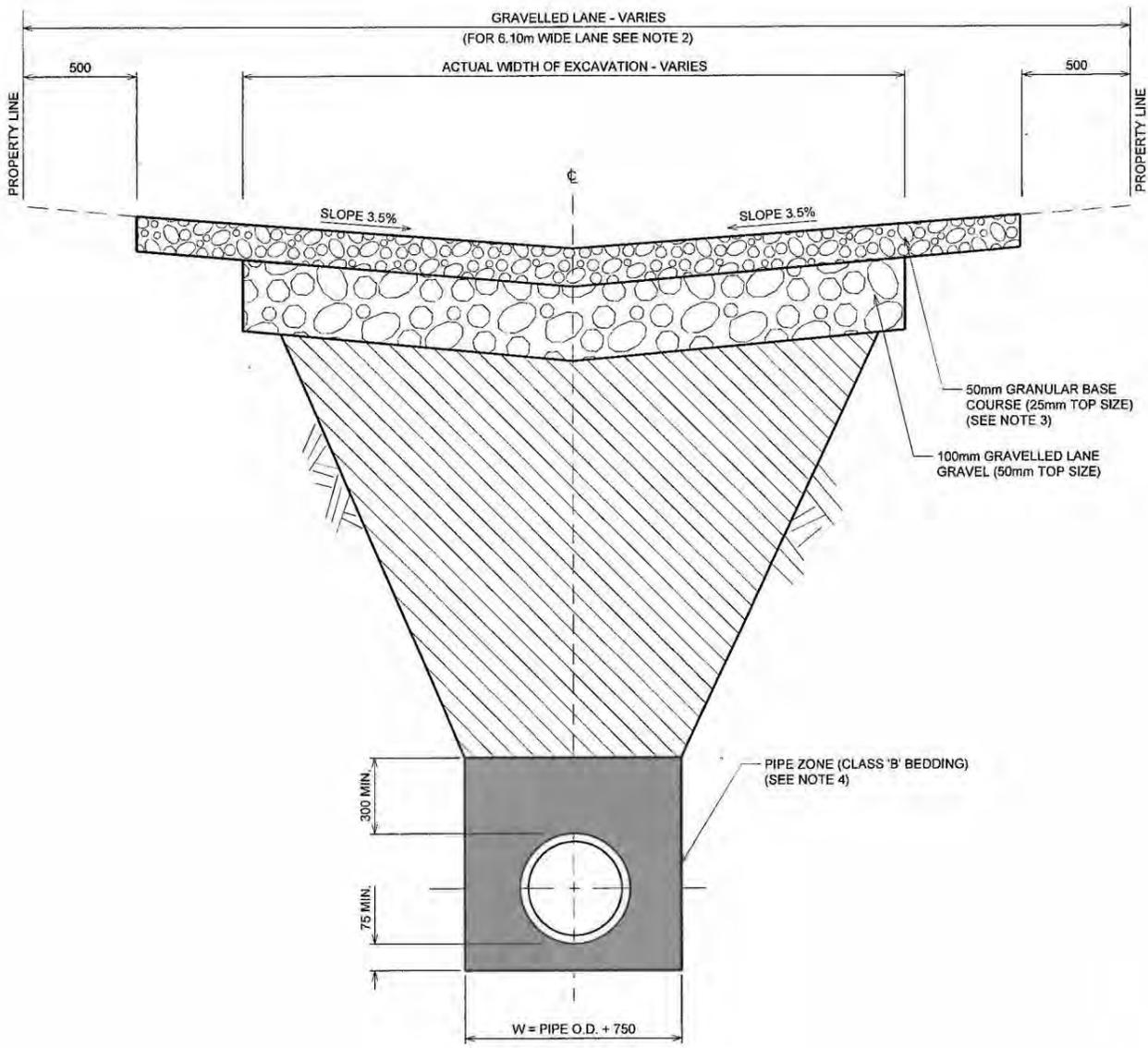


BASED SECTION

NOTES:

1. FOR GRANULAR MATERIAL SPECIFICATIONS SEE CHAPTER 303.00.00.
2. FOR 6.10m WIDE LANE, GRANULAR MATERIAL SHALL EXTEND FOR THE FULL WIDTH (PROPERTY LINE TO PROPERTY LINE).
3. LANES SHALL BE GRAVEL BASED WHEN THE FOLLOWING CONDITIONS EXIST:
 - a. WHEN THE LANE GRADE IS 5% OR GREATER, IN EXCESS OF 75m FROM THE SOURCE OF LANE DRAINAGE, THAT PORTION SHALL BE BASED.
 - b. WHEN A 5% OR GREATER GRADE COMES INTO A FLATTER GRADE, THE LATTER SHALL BE BASED FOR THE FOLLOWING LENGTHS: UP TO 2% - 30m
2% TO 3% - 45m
3% AND OVER - TOTAL LENGTH.
4. LANES ADJACENT TO COMMERCIAL ESTABLISHMENTS SHALL BE BASED TO THE PROPERTY LINE.
5. WHEN A SWALE DISCHARGES INTO A LANE, PAVEMENT SHALL BE PLACED DOWNGRADE TO A PERMANENT DRAINAGE COLLECTION LOCATION.
6. LANES SHALL BE DEEP BASED AT INTERSECTIONS FOR 5.0m IN ALL DIRECTIONS (SEE 305.00.02).

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: 20/10/2014 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		THE CITY OF CALGARY ROADS		Drawn: JL Date: 2014-10 Designed: EW		TYPICAL GRAVELLED LANES		Figure 6 File Number 454.1011.003	
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC		Checked: EW									
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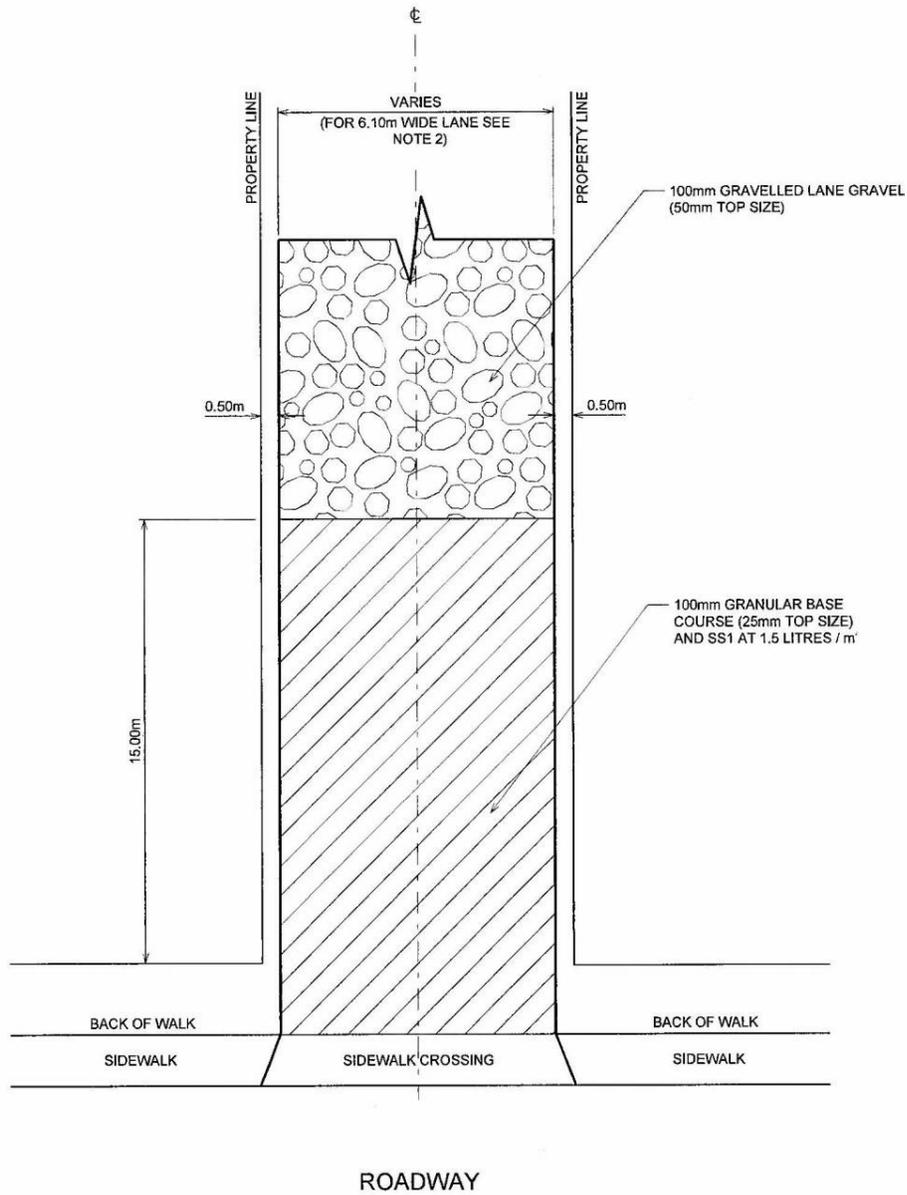
NOTES:

1. LANES SHALL BE OILED WITH SS1 AT 1.5 LITRES/SM. IF THE ORIGINAL LANE WAS OILED OR WHEN THE FOLLOWING CONDITIONS EXIST:
 - a. WHEN THE LANE GRADE IS 5% OR MORE
 - b. WHEN A 5% OR GREATER GRADE COMES INTO A FLATTER GRADE, THE LATTER SHALL BE OILED FOR THE FOLLOWING LENGTHS:

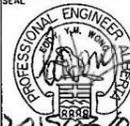
UP TO 2%	30m
2% TO 3%	45m
3% AND OVER	TOTAL LENGTH
2. FOR 6.10m WIDE LANE, GRANULAR MATERIAL SHALL EXTEND FOR THE FULL WIDTH (PROPERTY LINE TO PROPERTY LINE).
3. IF EXISTING LANE IS CONSTRUCTED WITH RECYCLED CRUSHED ASPHALT, CRUSHED ASPHALT SHALL BE USED.
4. REFER TO COC WATER RESOURCES STANDARD SPECIFICATIONS FOR BEDDING REQUIREMENT.

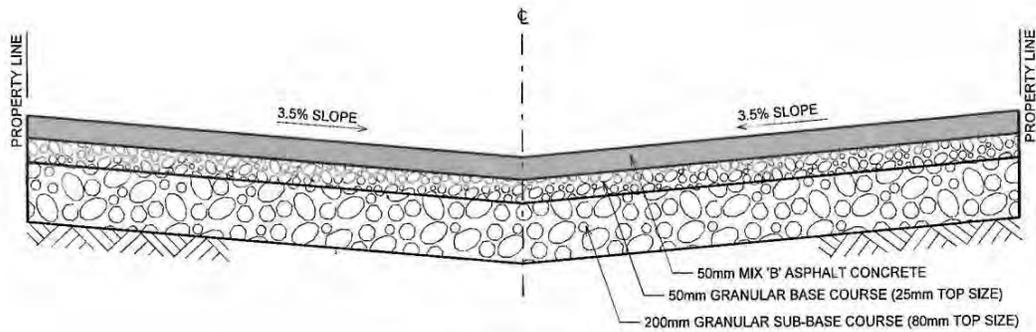
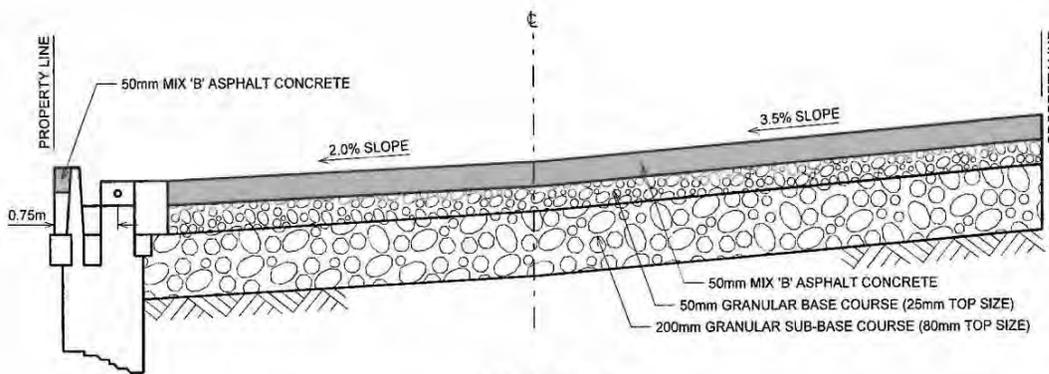
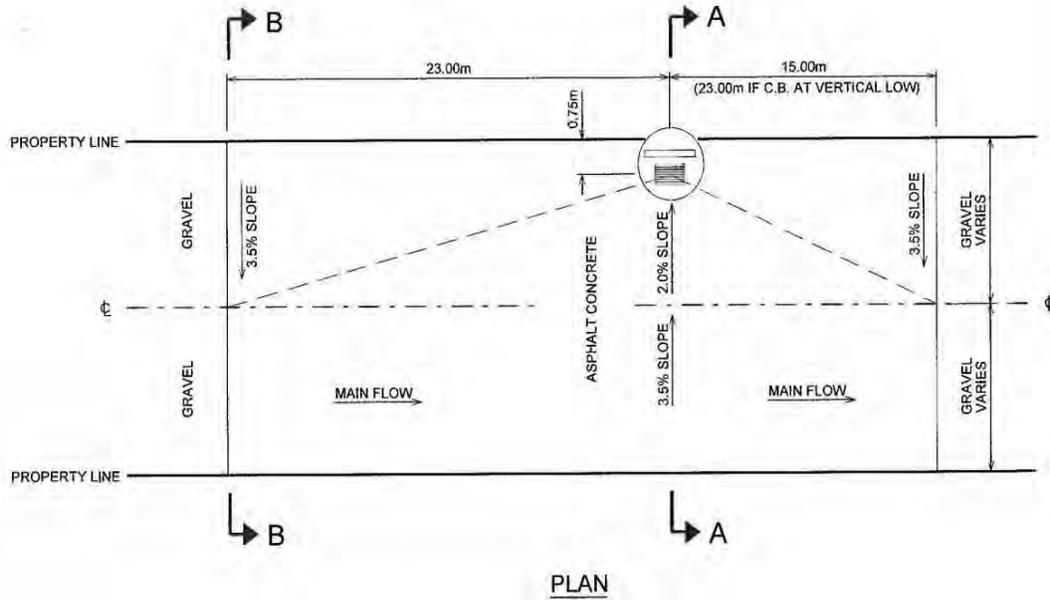
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>[Date]</i> PERMIT NUMBER: 04428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permamentSiteRoadSpecs_2014\Drawing Files\4541011\USTN4541011006_V0.dgn 03-MAR-2015 13:19 ISC: UNRESTRICTED		Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS		GRAVELLED LANE UTILITY REPLACEMENT RESTORATION DETAILS		Figure 7 File Number 454.1011.006

Figure 8: GRAVELLED LANE - APPROACH STABILIZATION (454.1011.004)



- NOTES:
 1. FOR CROSSING DETAILS SEE DWG. 454.1013.005 MONOLITHIC SIDEWALK, DWG. 454.1013.004 SEPARATE SIDEWALK.
 2. FOR 6.10m WIDE LANE, GRAVEL SHALL EXTEND FOR THE FULL WIDTH (PROPERTY LINE TO PROPERTY LINE).

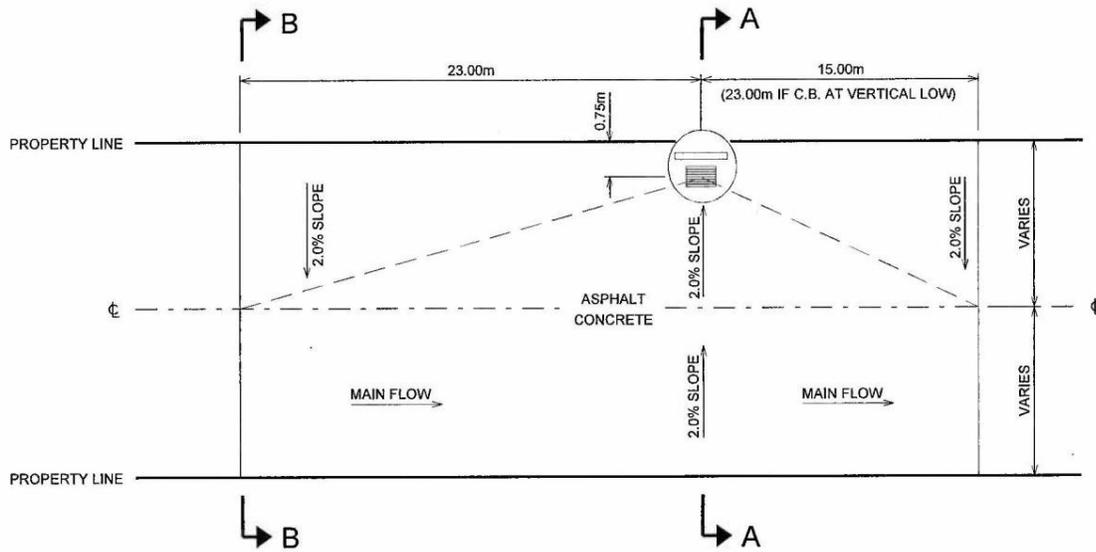
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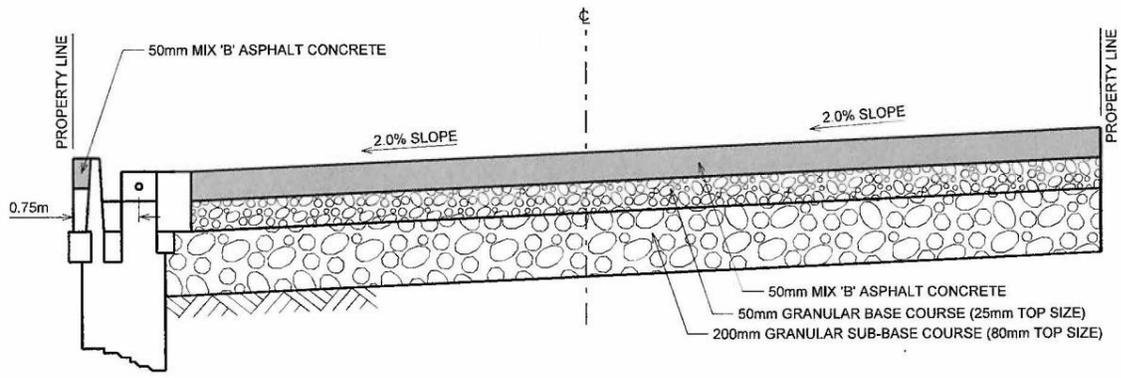
NOTE:
EXTEND PAVEMENT 15.00m ON 'T' INTERSECTION (23.00m IF C.B. AT VERTICAL LOW).

No.	Date	Revision	App'd No.	Date	Revision	App'd No.	Date	Revision	App'd	
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2/15/2010 PERMIT NUMBER: P-46428 The Association of Professional Engineers and Geoscientists of Alberta		 PROFESSIONAL ENGINEER ALBERTA		 THE CITY OF CALGARY ROADS		Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS		GRAVEL DISHED LANE GRADING AND PAVING REQUIREMENT AT CATCH BASIN		Figure 9
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\p\manant\SitRoadSpecs_2014\Drawing Files\4541011\USTN\4541011002_V8.dgn 30-OCT-2014 10:48 ISC: UNRESTRICTED								File Number 454.1011.002		

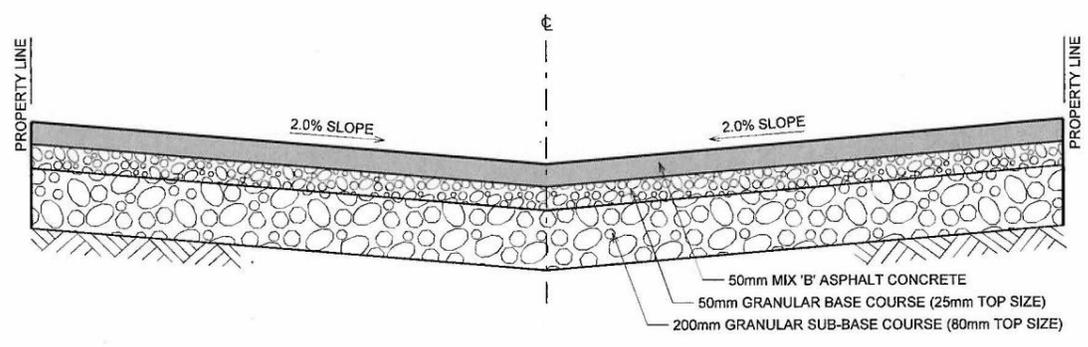
Figure 10: ASPHALT DISHED LANE - GRADING & PAVING REQUIREMENT AT CATCH BASIN (454.1011.007)



PLAN



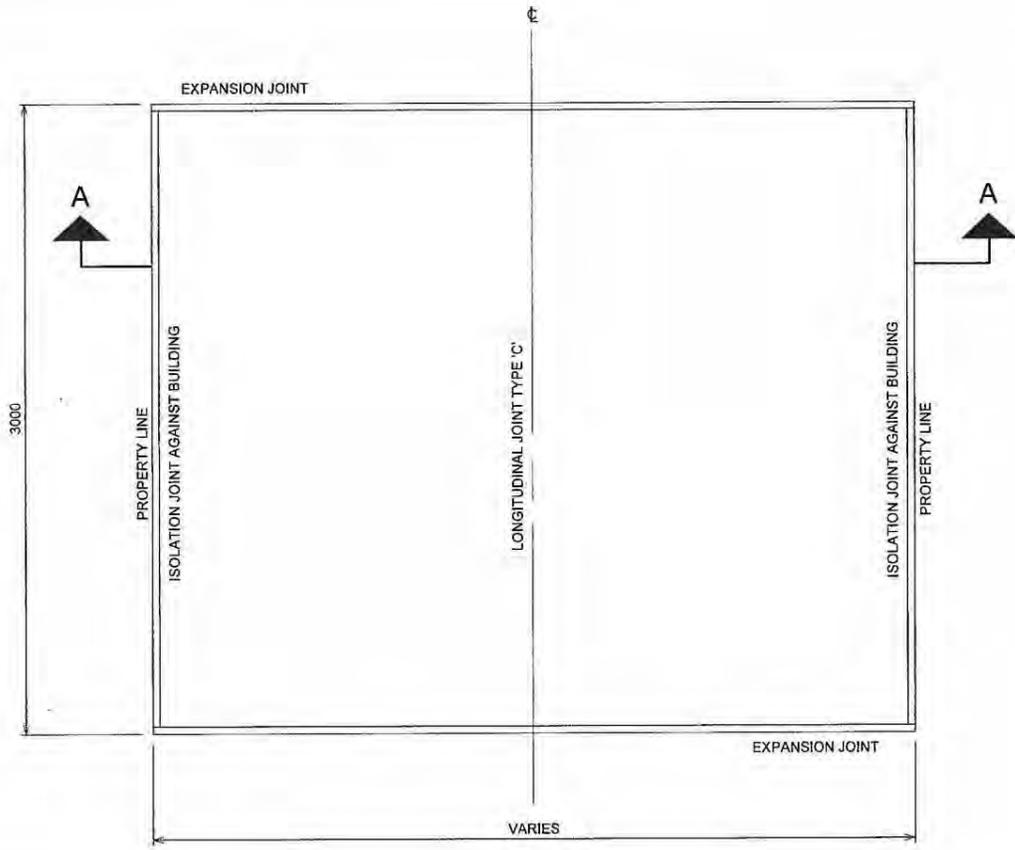
SECTION A-A



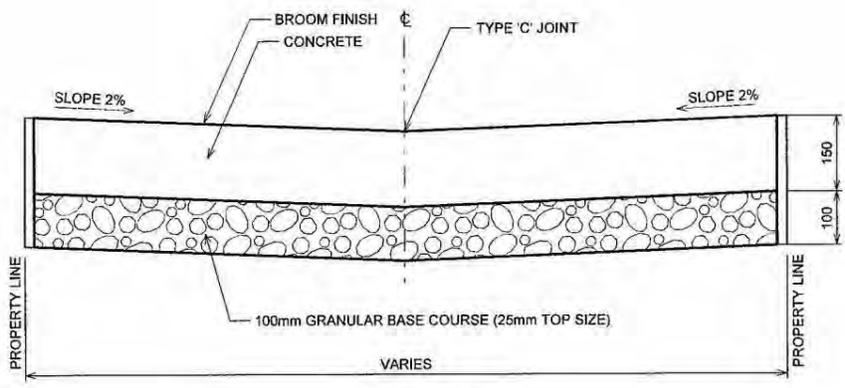
SECTION B-B

NOTE:
ON 'T' INTERSECTION EXTEND PAVEMENT 15.00m (23.00m IF C.B. AT VERTICAL LOW).

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2014-10-10 PERMIT NUMBER: P-03428 The Association of Professional Engineers and Geoscientists of Alberta		PROFESSIONAL ENGINEER SEAL 2014-10-10		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanen\StdRoadSpec\2014\Drawing Files\4541011\JUSTIN\4541011007_V8.dgn 28-OCT-2014 08:59 ISC: UNRESTRICTED		Drawn: JL Date: 2014-10-10 Designed: EW Checked: EW Scale: NTS		ASPHALT DISHED LANE GRADING & PAVING REQUIREMENT AT CATCH BASIN		Figure 10 File Number 454.1011.007



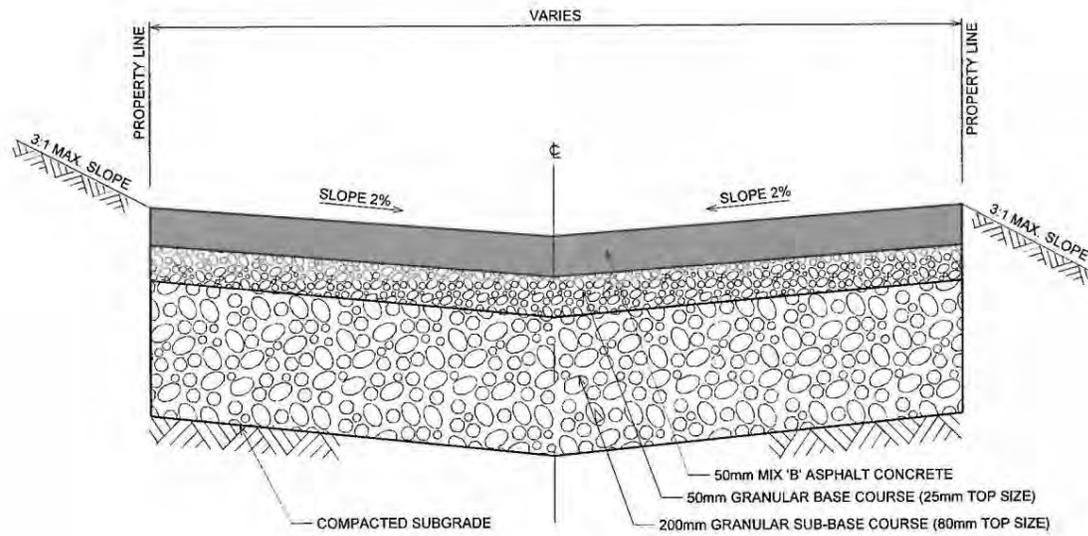
PLAN



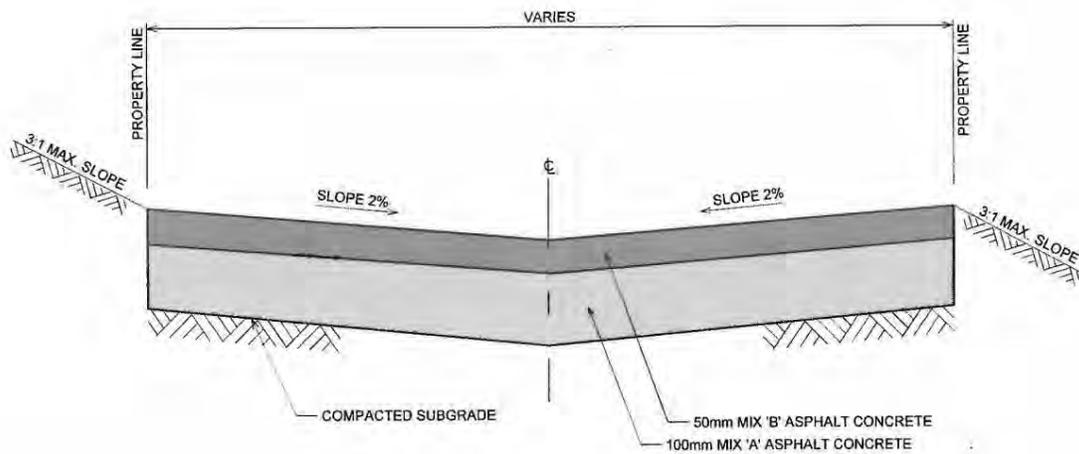
SECTION A

- NOTES:
1. REFER TO SIDEWALK SPECIFICATION FOR QUALITY CONTROL OF CONCRETE.
 2. FOR JOINT DETAILS SEE DWG NO. 454.1015.006.
 3. FIBROUS CONCRETE WITH SYNTHETIC FIBRES, CAN BE USED IN DOWNTOWN AREA ONLY, SEE SECTION 310..02.06.

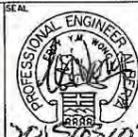
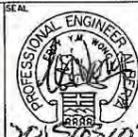
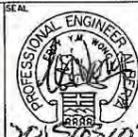
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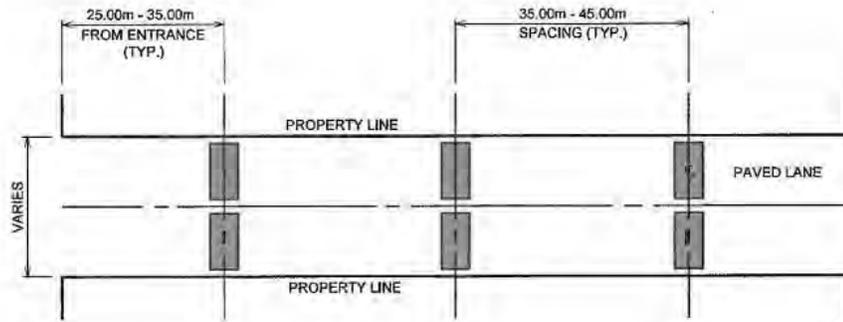


GRANULAR BASE CONSTRUCTION

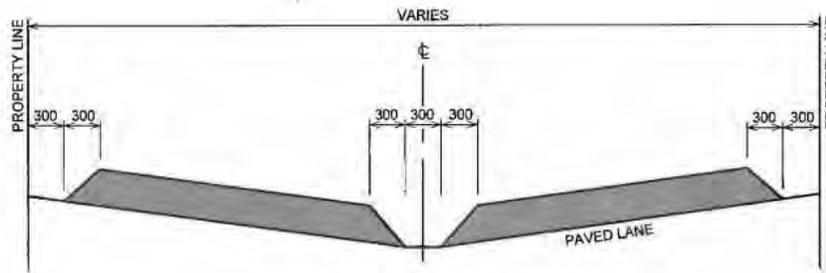


FULL DEPTH ASPHALT CONCRETE CONSTRUCTION

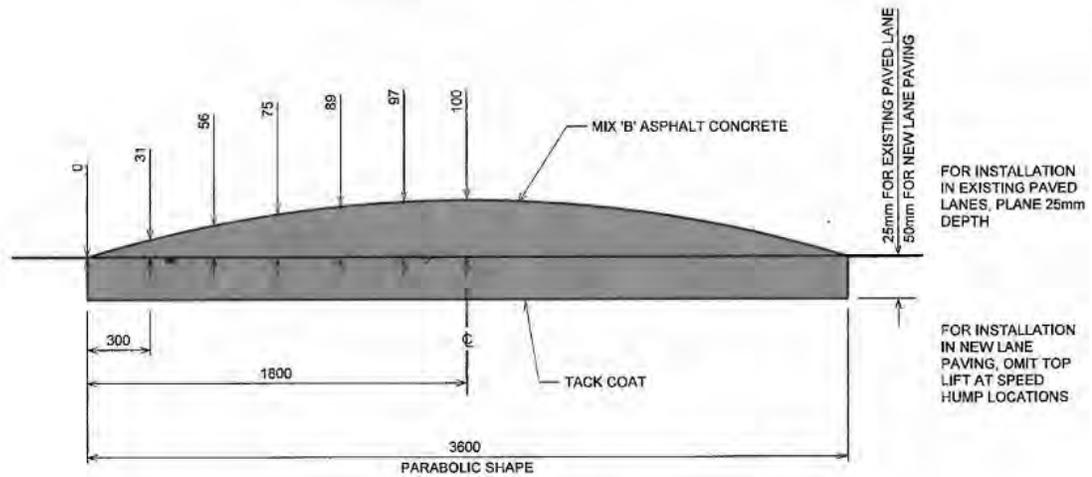
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<p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>Signature: _____</p> <p>Date: _____</p> <p>PERMIT NUMBER: P 04428</p> <p>The Association of Professional Engineers and Geoscientists of Alberta</p>		 <p>THE CITY OF CALGARY ROADS</p> <p><small>DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED</small></p> <p>METRIC</p> <p><small>Z:\permits\1156RoadSpecs_2014\Drawing Files\4541011\USTR\4541011025_1\8.dwg 03-NOV-2014 08:16</small></p>	<p>Drawn: JL</p> <p>Designed: EW</p> <p>Checked: EW</p> <p>Scale: NTS</p>	<p>TYPICAL PAVED LANES</p>	<p>Figure</p> <p style="font-size: 24pt; font-weight: bold;">12</p> <p>File Number</p> <p>454.1011.005</p>												



PLAN VIEW



CROSS-SECTION VIEW



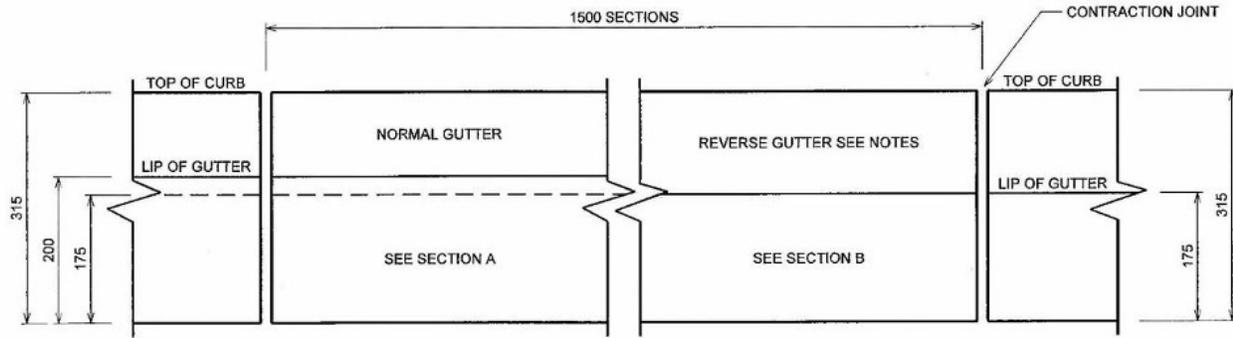
LONGITUDINAL VIEW

NOTES:

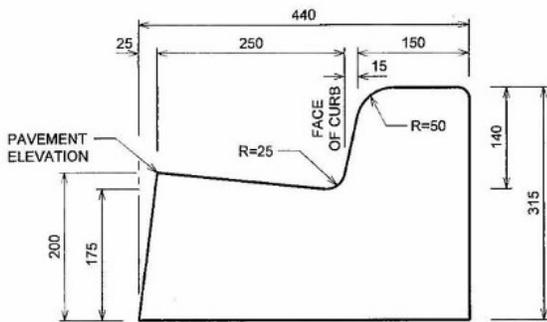
1. LOCATIONS OF HUMPS MUST NOT CONFLICT WITH DRIVEWAYS, DRAINAGE OR UTILITY FACILITIES.
2. SIGNAGE AND LINE PAINTING TO BE INSTALLED AS SPECIFIED BY TRAFFIC DIVISION.
3. MAXIMUM LANE GRADE 8% DESIRABLE MINIMUM GRADE 1%.

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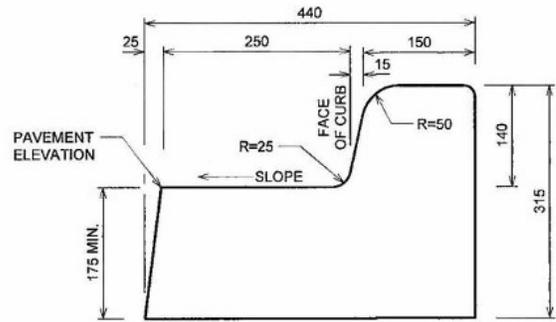
Figure 14: STANDARD CURB WITH 250 GUTTER ON GRAVEL BASE (454.1003.016)



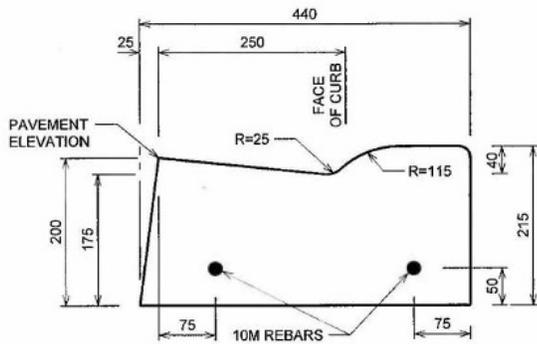
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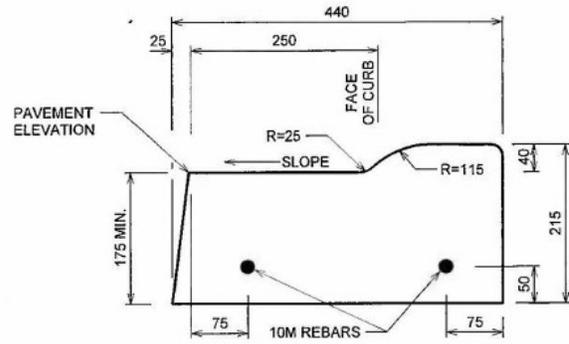
SECTION A



SECTION B



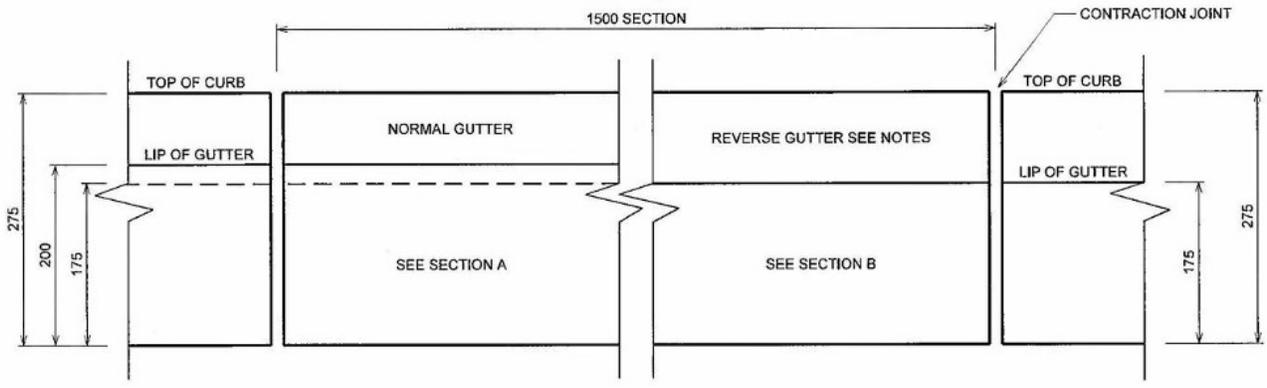
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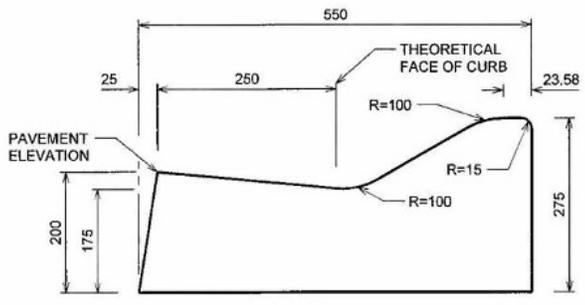
CURB CROSSING B

- NOTES:
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF ROADWAY IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 175mm.

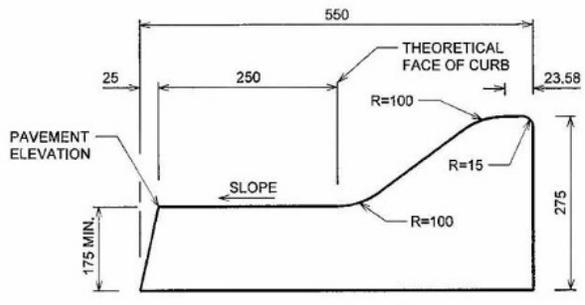
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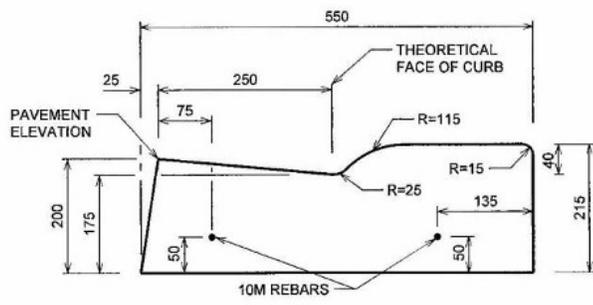
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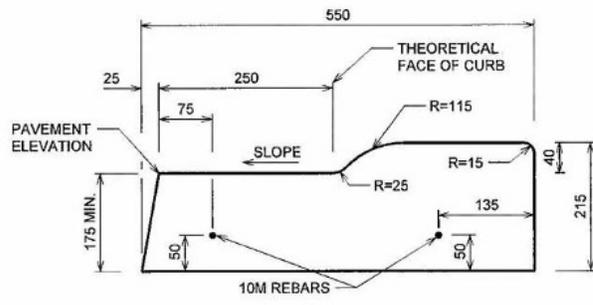
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SECTION B



CURB CROSSING A

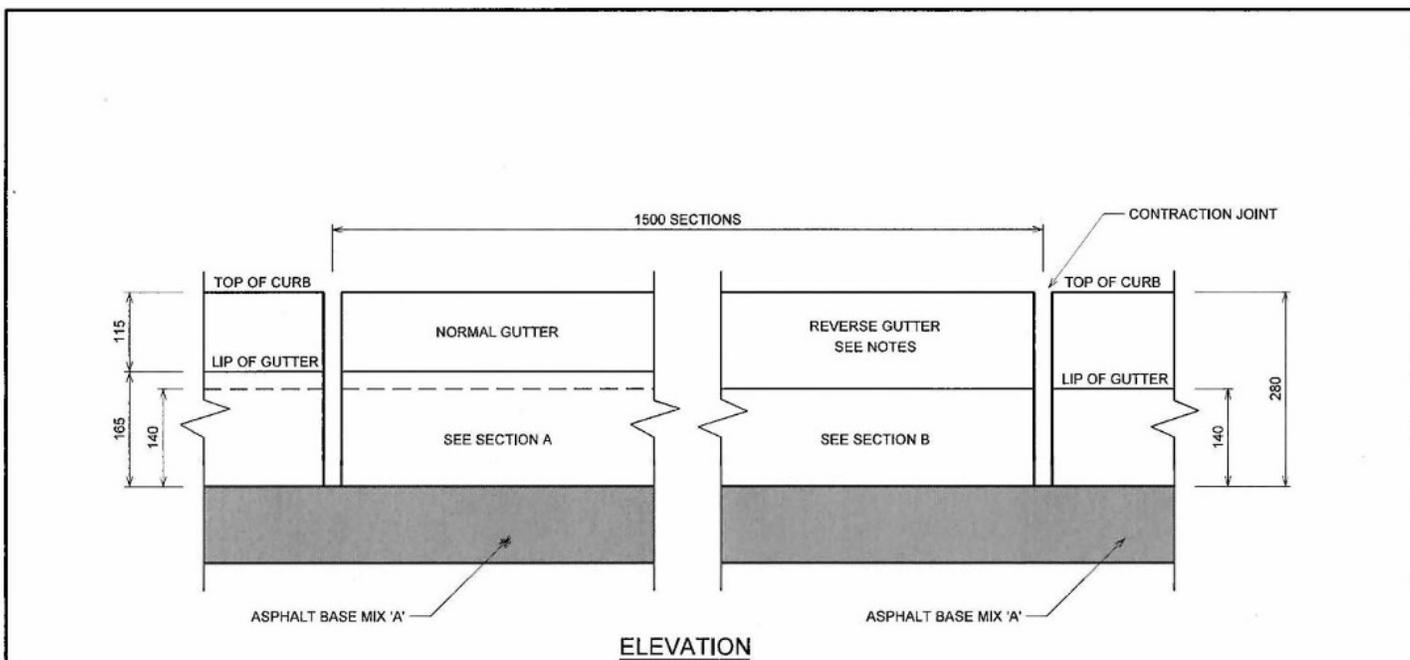


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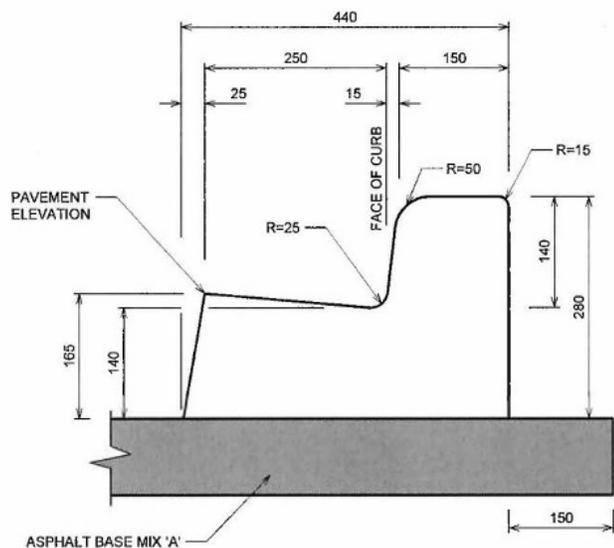
- NOTES:**
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF ROADWAY IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 175mm.

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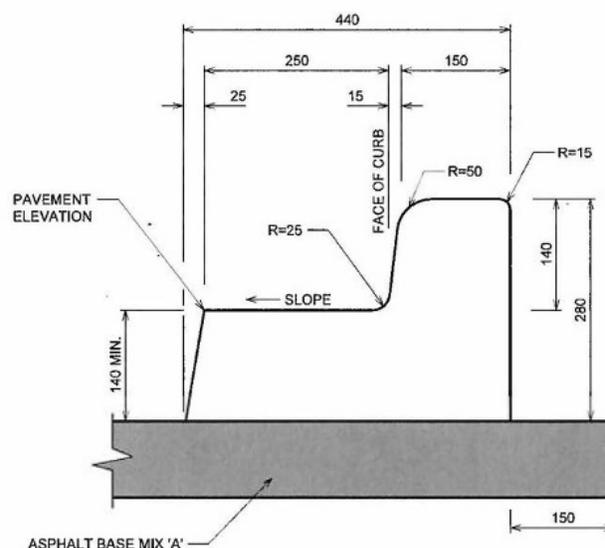
Figure 16: STANDARD CURB WITH 250 mm GUTTER ON ASPHALT BASE (454.1003.009)



ELEVATION



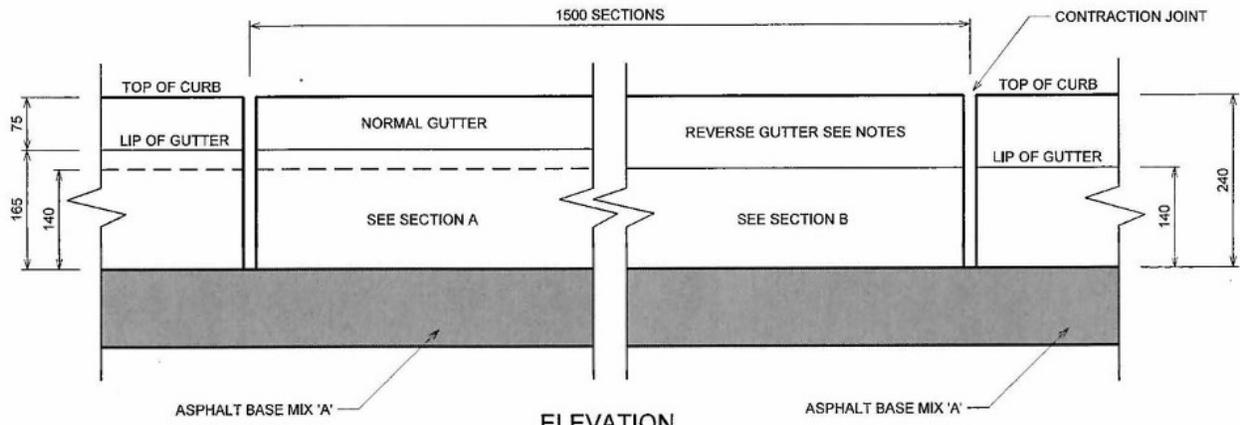
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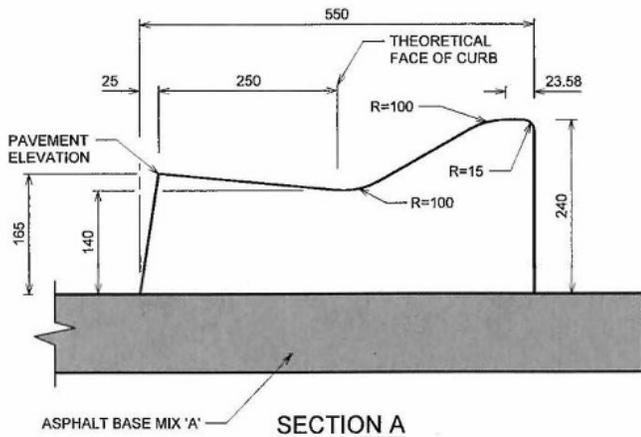
SECTION B

- NOTES:
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 140mm.

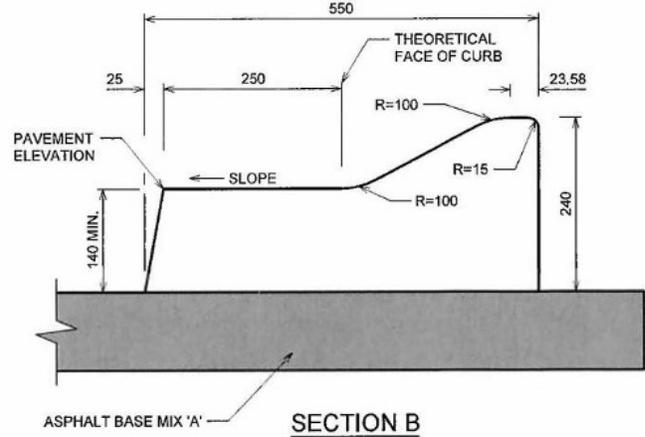
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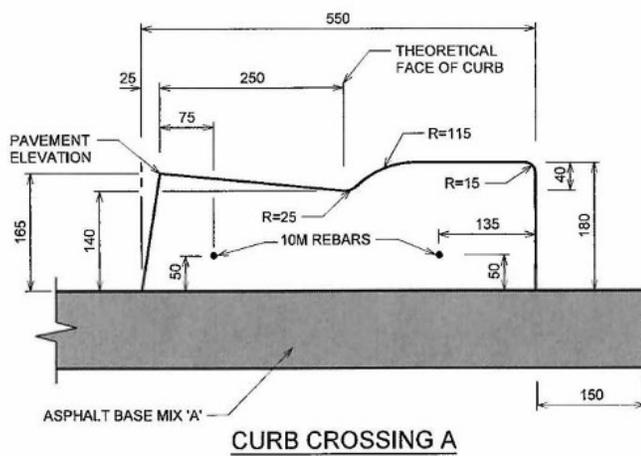
ELEVATION



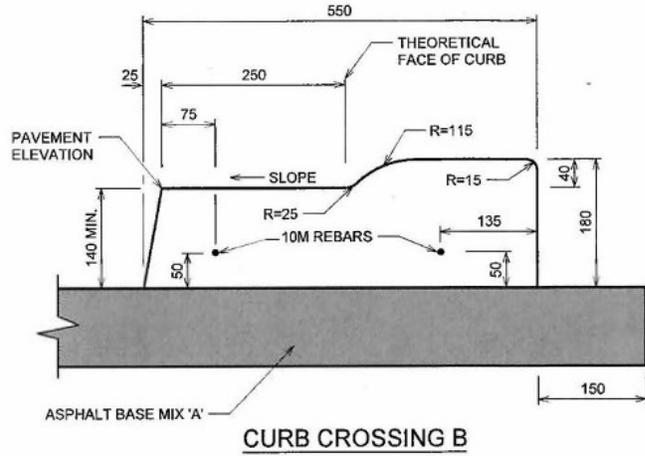
SECTION A



SECTION B



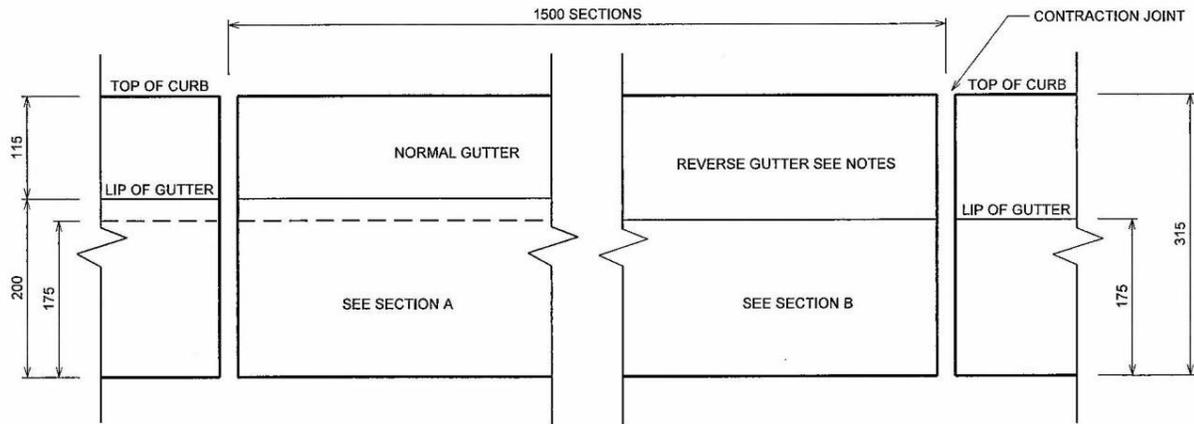
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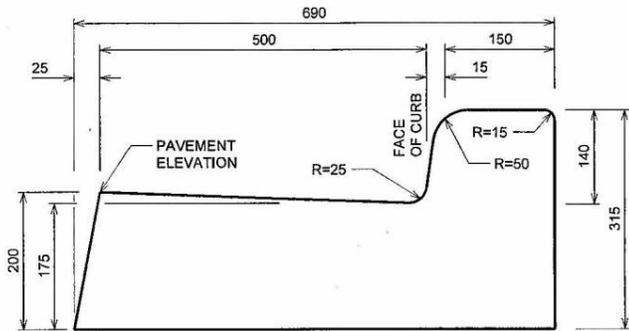
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- NOTES:
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT, GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 140mm.

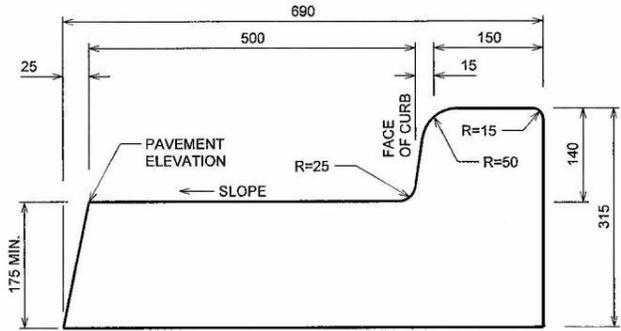
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			Designed	EW																													
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LOW PROFILE ROLLED CURB WITH 250mm GUTTER ON ASPHALT BASE										File Number 454.1003.002																							
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\perm\anont\SttRoadSpec\2014\Drawing\F16014541003X\ST1604541203002_v8.dgn 30-OCT-2014 10:30 ISC: UNRESTRICTED																																	



ELEVATION

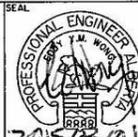


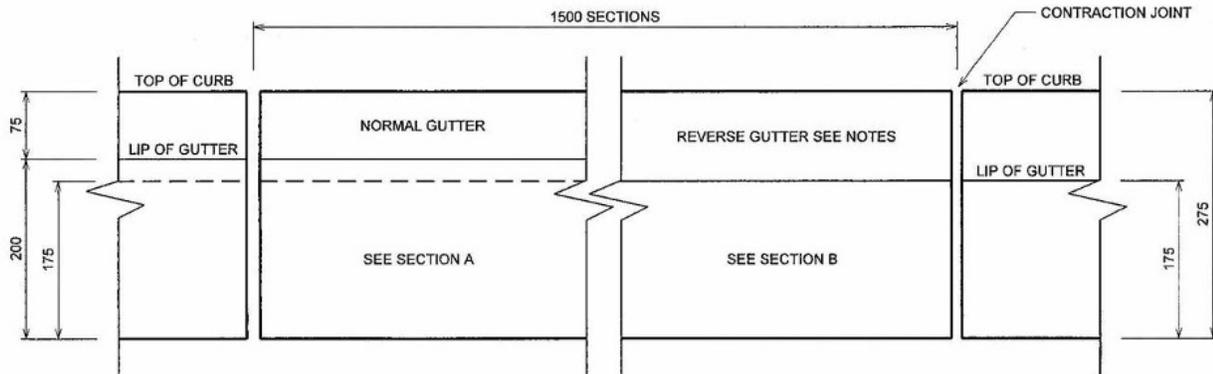
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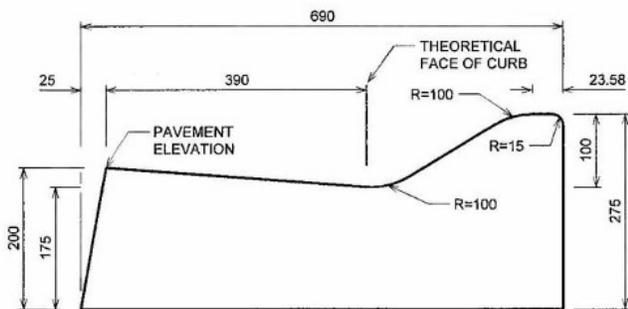
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- NOTES:**
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF ROADWAY IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 175mm.

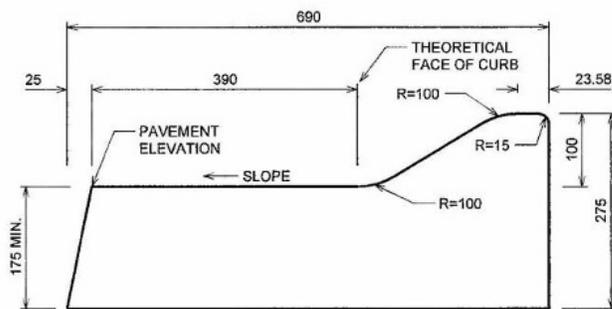
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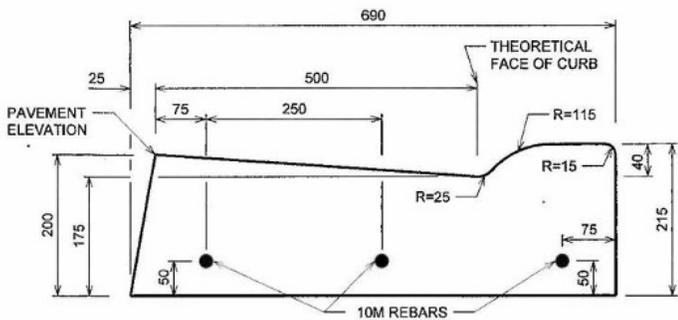
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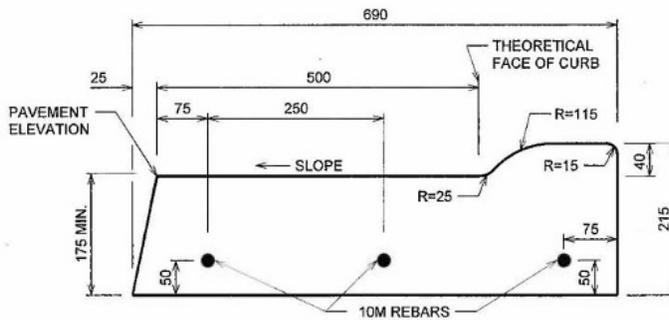
SECTION A



SECTION B



CURB CROSSING A

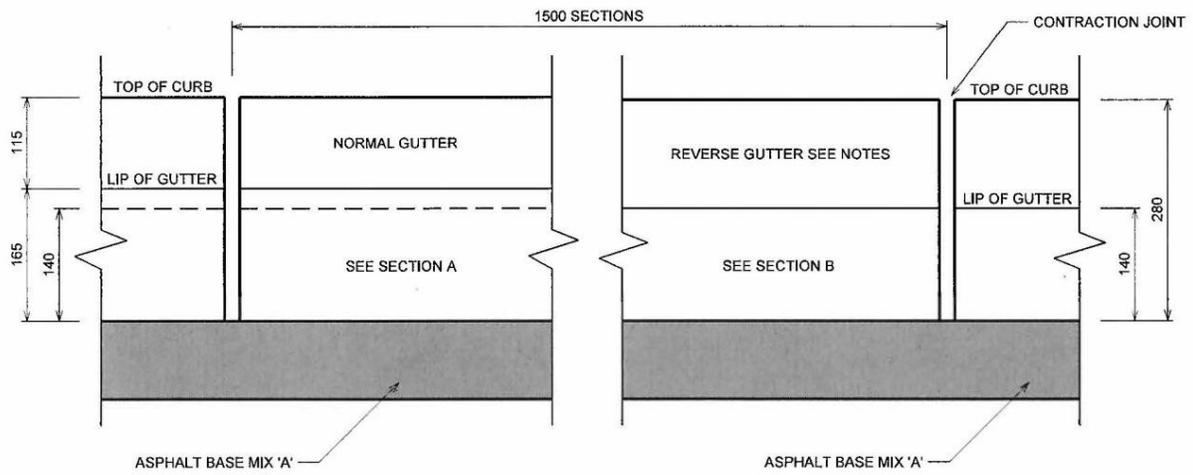


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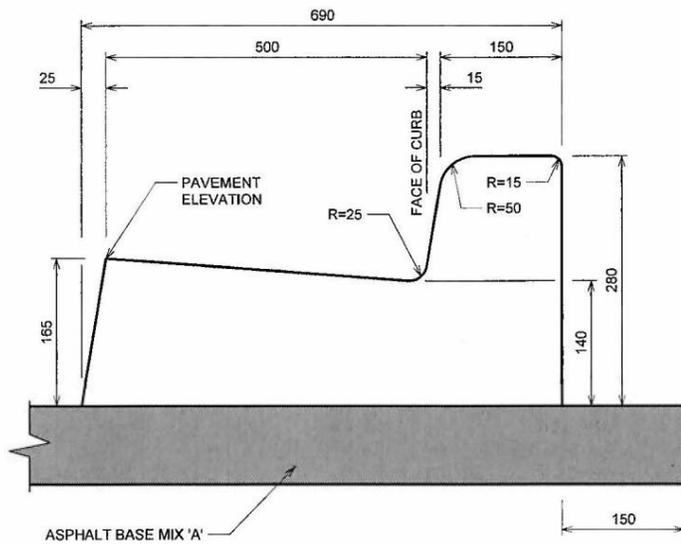
- NOTES:
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 2. MINIMUM GUTTER THICKNESS 175mm.

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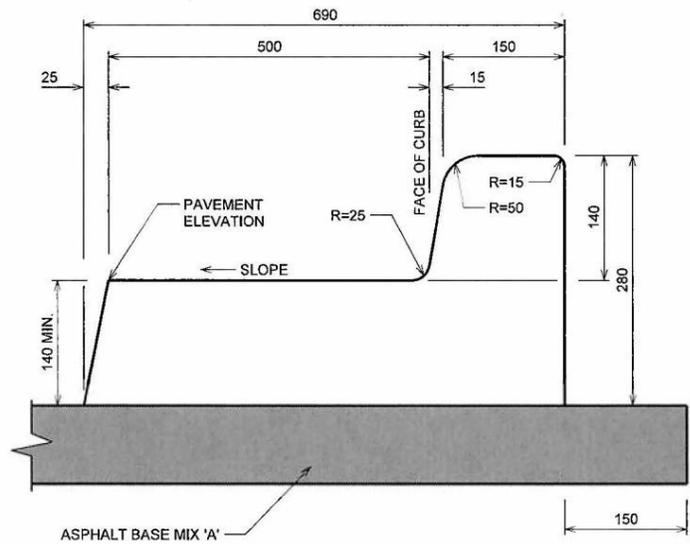
Figure 20: STANDARD CURB WITH 500 mm GUTTER ON ASPHALT BASE (454.1003.010)



ELEVATION



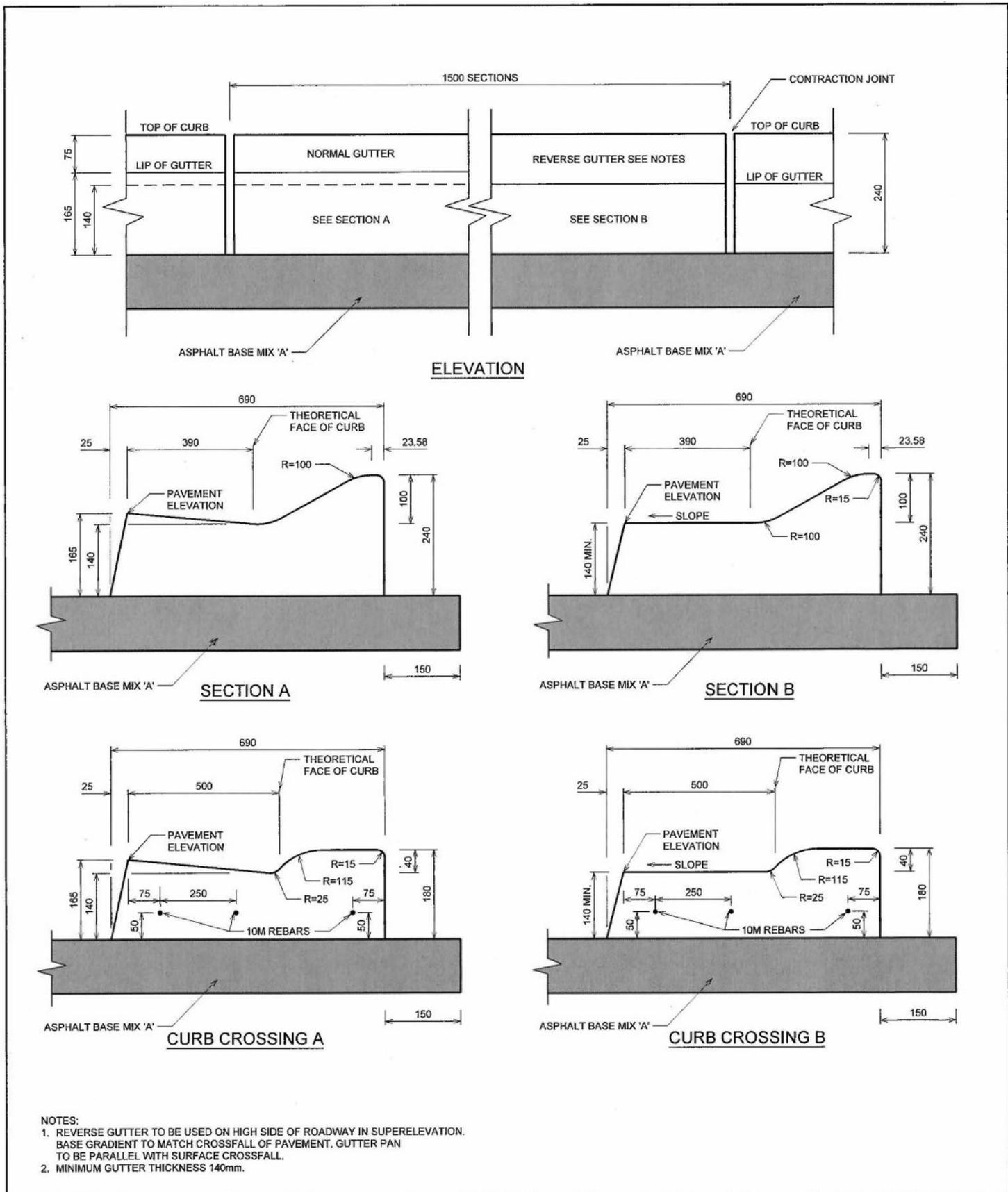
SECTION A



SECTION B

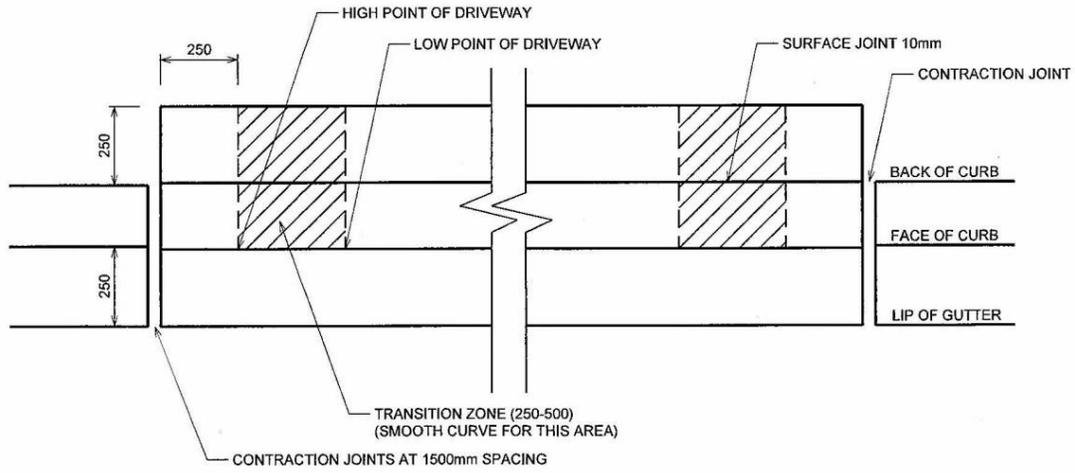
- NOTES:
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF ROADWAY IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 140mm.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																								
<table border="1"> <tr> <td rowspan="4"> PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/21 PERMIT NUMBER: P 04098 The Association of Professional Engineers and Geoscientists of Alberta </td> <td rowspan="4"> </td> <td rowspan="4"> THE CITY OF CALGARY ROADS </td> <td>Drawn</td> <td>Date</td> <td rowspan="4"> STANDARD CURB WITH 500mm GUTTER ON ASPHALT BASE </td> <td rowspan="4"> Figure 20 </td> </tr> <tr> <td>JL</td> <td>2014-10</td> </tr> <tr> <td>Designed</td> <td>EW</td> </tr> <tr> <td>Checked</td> <td>EW</td> </tr> <tr> <td colspan="3"> DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC </td> <td>Scale:</td> <td>NTS</td> <td rowspan="2"> File Number 454.1003.010 </td> </tr> <tr> <td colspan="3"> Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541003\USTN\4541003010_v8.dgn 19-JAN-2015 08:14 ISC: UNRESTRICTED </td> <td colspan="2"></td> </tr> </table>												PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/21 PERMIT NUMBER: P 04098 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS	Drawn	Date	STANDARD CURB WITH 500mm GUTTER ON ASPHALT BASE	Figure 20	JL	2014-10	Designed	EW	Checked	EW	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC			Scale:	NTS	File Number 454.1003.010	Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541003\USTN\4541003010_v8.dgn 19-JAN-2015 08:14 ISC: UNRESTRICTED				
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			JL	2014-10																															
			Designed	EW																															
			Checked	EW																															
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC			Scale:	NTS	File Number 454.1003.010																														
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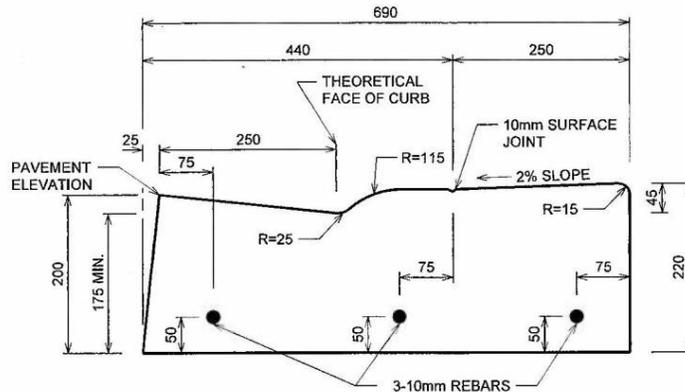


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Figure 22: 250 mm GUTTER CROSSING WITH 250 mm APRON ON GRAVEL BASE (454.1003.012)



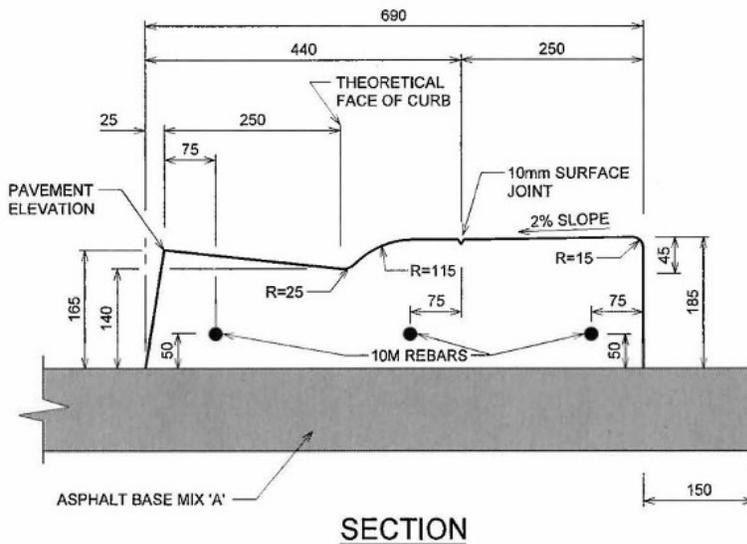
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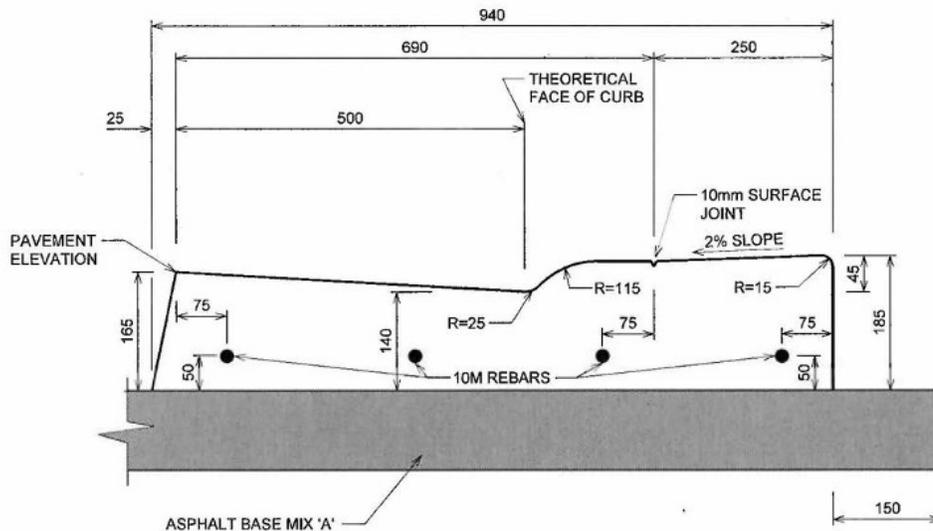
SECTION

NOTE:
FOR COMMERCIAL DRIVEWAYS WITH NO SIDEWALKS IN BOULEVRD.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd						
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Mar 18 PERMIT NUMBER: P 04328 The Association of Professional Engineers and Geoscientists of Alberta			SEAL 			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541003\USTN4541003012_v8.dgn 04-NOV-2014 08:44			METRIC Drawn: JL, Date: 2014-10 Designed: EW Checked: EW Scale: NTS			250mm GUTTER CROSSING WITH 250mm APRON ON GRAVEL BASE			Figure 22 File Number 454.1003.012		



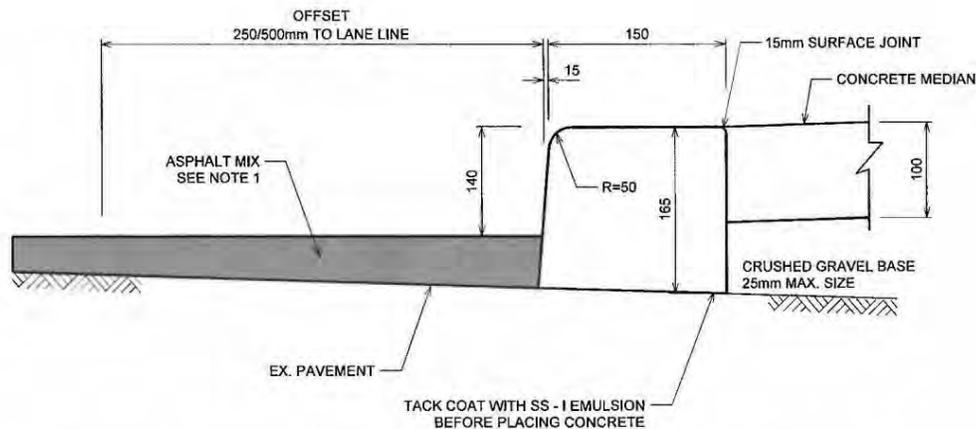
SECTION



SECTION

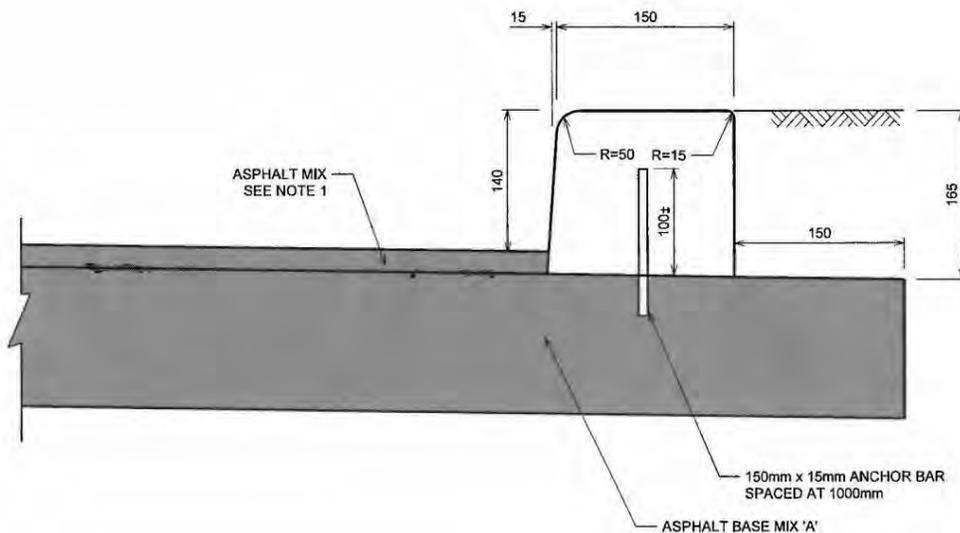
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Figure 24: CONCRETE CURB WALL ON EXISTING & NEW PAVEMENT (454.1003.001)



STANDARD CONCRETE CURB WALL ON EXISTING ASPHALT PAVEMENT

NOTE: THIS DETAIL IS USED WHERE MEDIAN OR ISLAND IS CONSTRUCTED ON TOP OF EX. PAVEMENT

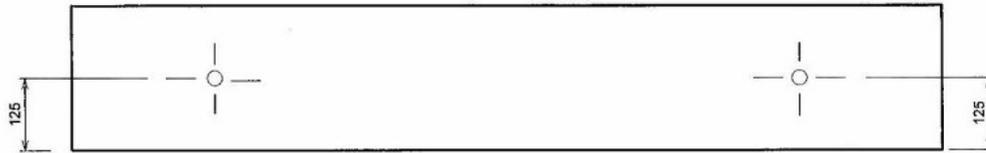


STANDARD CONCRETE CURB WALL ON FULL DEPTH ASPHALT PAVEMENT

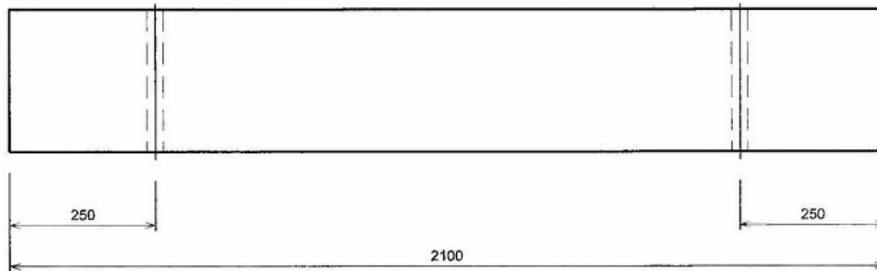
NOTE: DOWELS NOT REQUIRED WHEN CURB WALL IS PLACED ADJACENT TO A WALL

NOTE:
1. MIN. 40mm ASPHALT MIX TO BE USED IN ACCORDANCE WITH 454.1005.002 OR 454.1005.009 DEPENDING ON ROAD CLASSIFICATION.

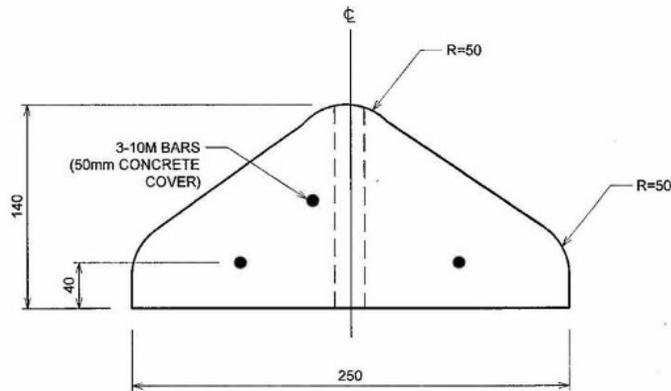
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CONCRETE CURB WALL ON EXISTING AND NEW PAVEMENT														



PLAN



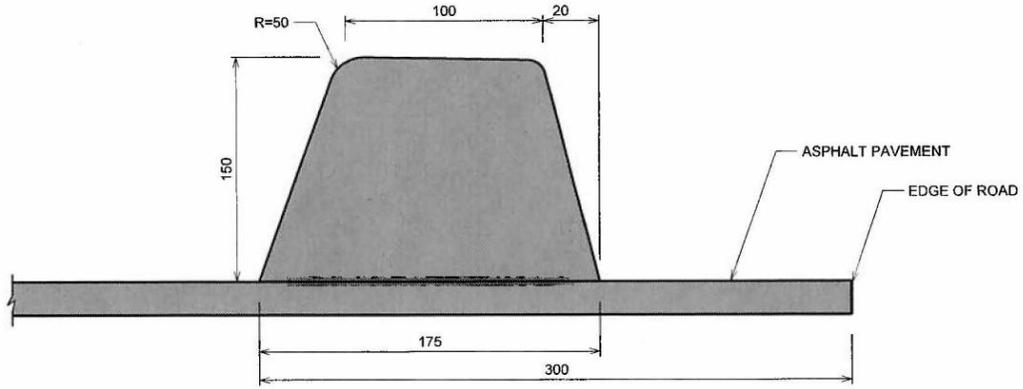
ELEVATION



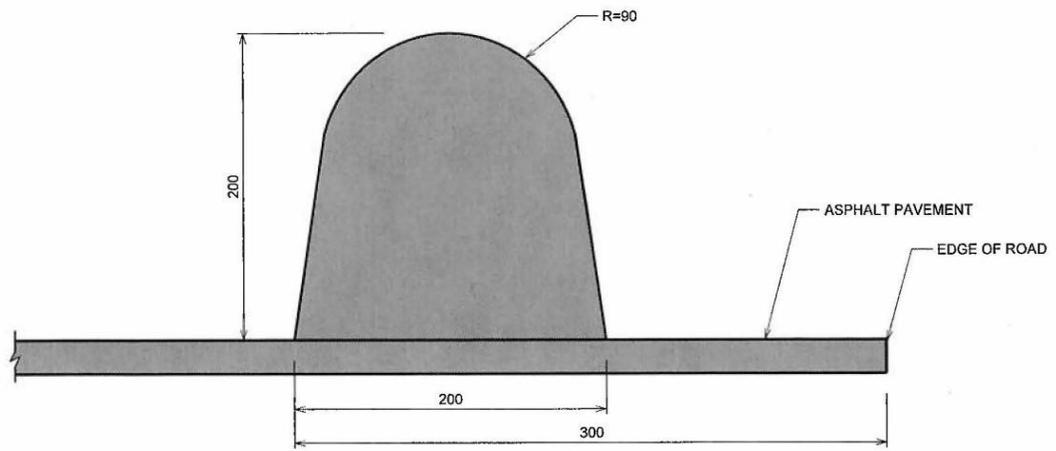
SECTION

- NOTES:
 1. CONCRETE 24 MPa.
 2. CURB TO BE SECURED BY 15mm DIAMETER ANCHORS 450mm LONG.

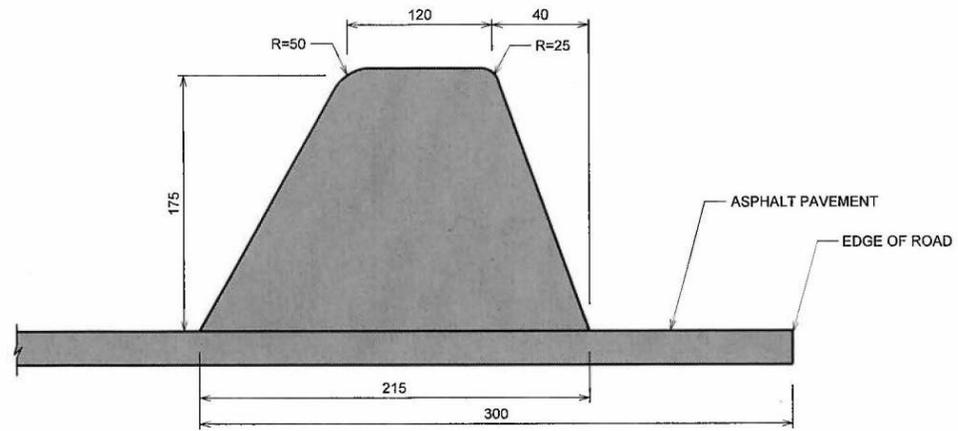
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PRECAST CONCRETE CURB TYPE 'A'															



MOLD A
X-SECTIONAL AREA=0.021 sq.m

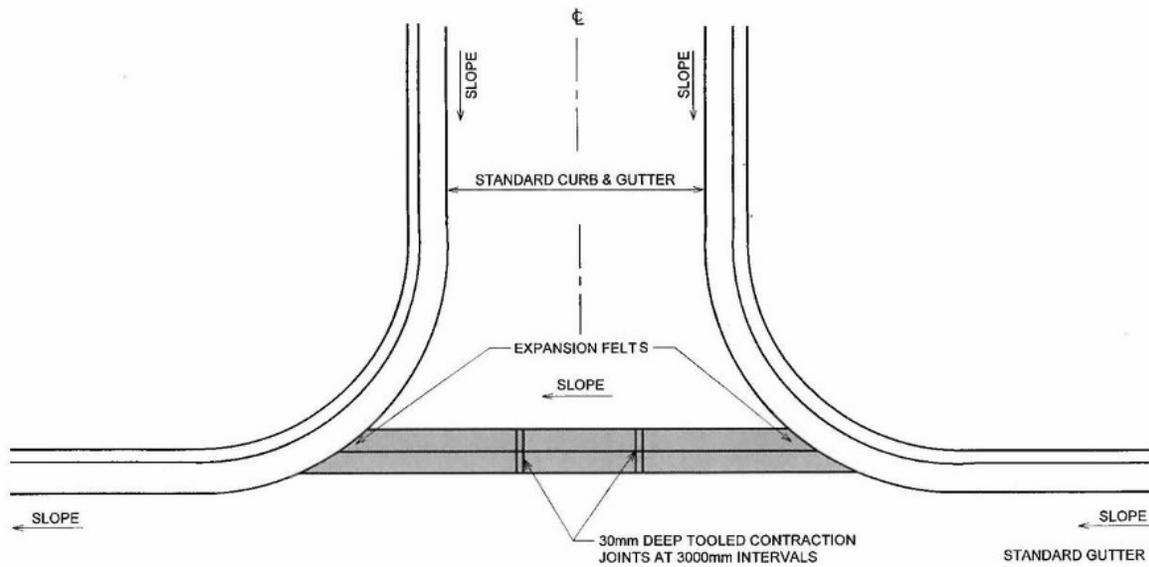


MOLD B
X-SECTIONAL AREA=0.034 sq.m

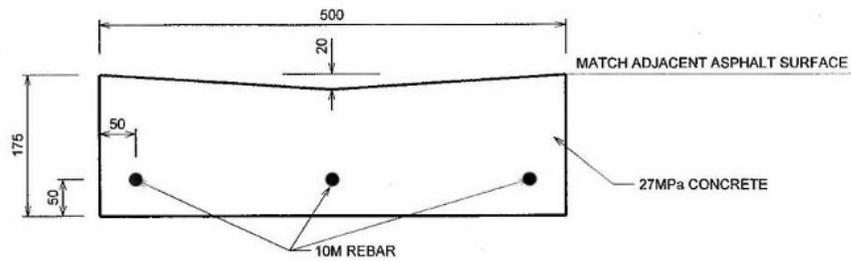


MOLD C
X-SECTIONAL AREA=0.030 sq.m

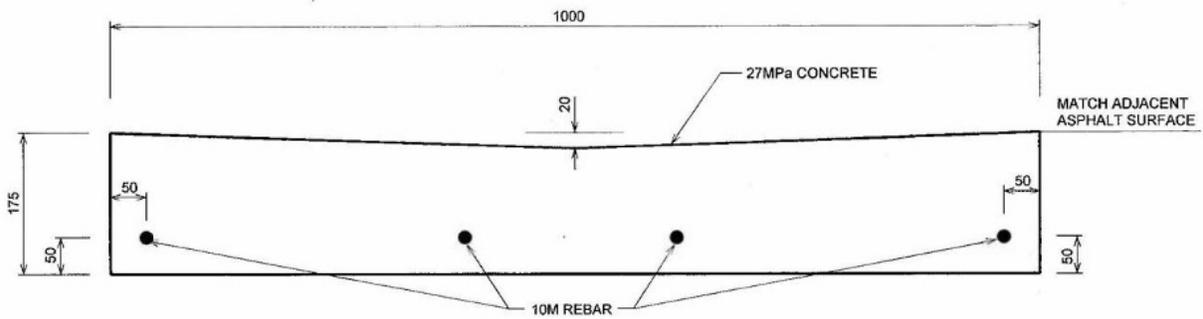
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PLAN OF INVERT CROSSING
(NOT TO BE USED IN NEW SUBDIVISIONS)



SECTION FOR CURB WITH 250 GUTTER

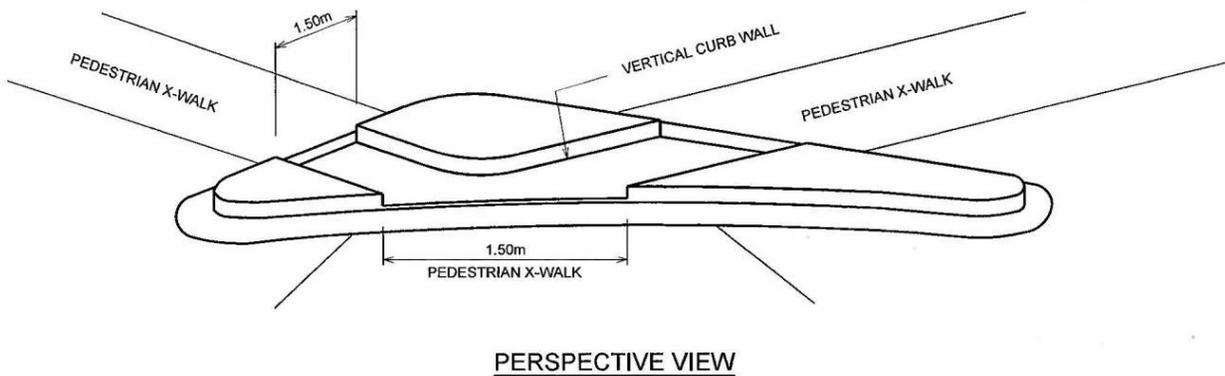
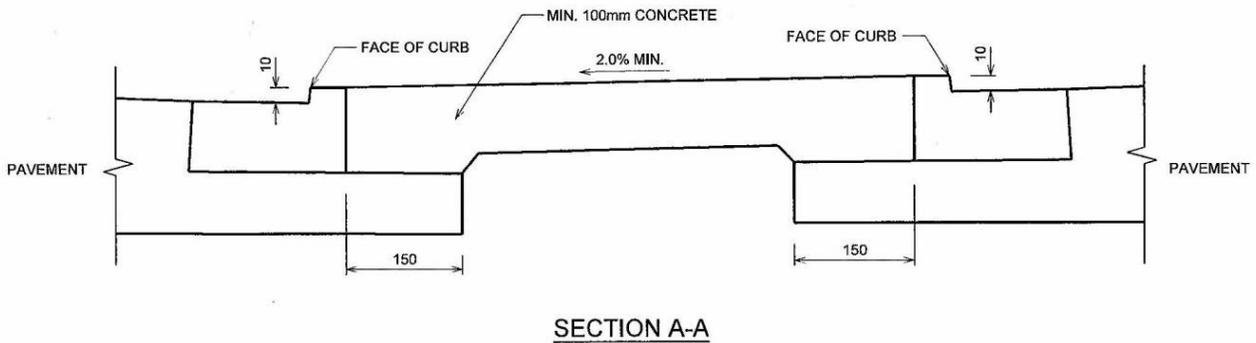
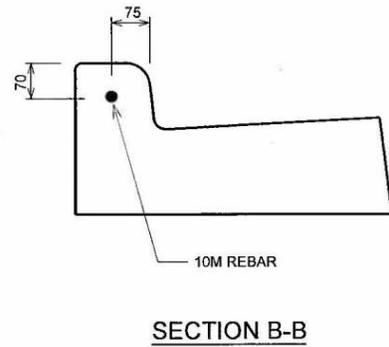
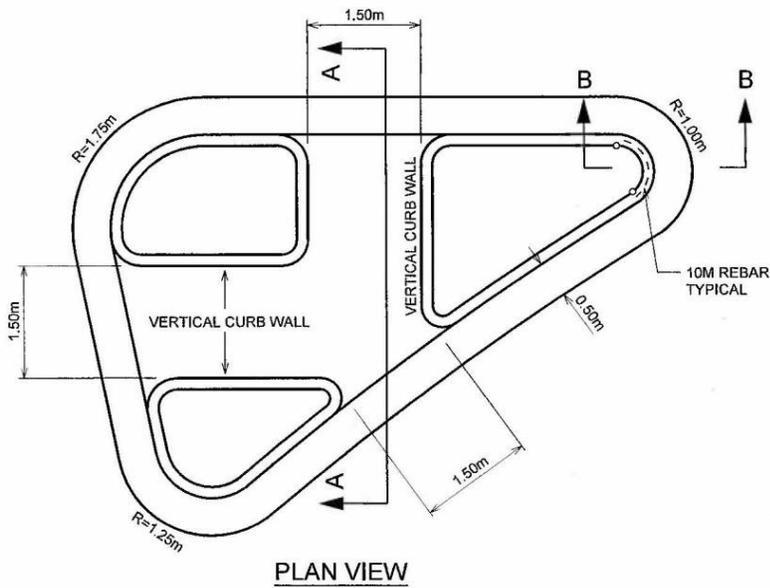


SECTION FOR CURB WITH 500 GUTTER

- NOTES:
1. START FLATTENING CROWN 15.00m FROM CONCRETE INVERT CROSSING.
 2. CONCRETE INVERT IS TO BE USED WHERE DROP ACROSS INTERSECTION IS BETWEEN 0.4% AND 2% SLOPE. ASPHALT INVERT IS TO BE USE ABOVE 2% SLOPE.
 3. BASE TO CONFORM WITH ROAD STANDARDS.

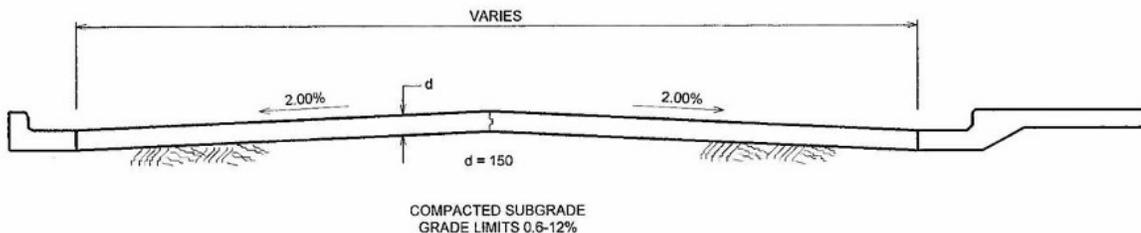
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Mar 18 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS			Drawn: JL Date: 2014-12 Designed: EW Checked: EW Scale: NTS			CONCRETE INVERT CROSSING (FOR RETROFITS ONLY)			Figure: 27 File Number: 454.1003.003		
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\permanent516\RoadSpecs_2014\Drawing Files\4541003\USTM\4541003003_v8.dwg 11-DEC-2014 14:37 ISC - UNRESTRICTED																	

Figure 28: TRAFFIC ISLAND WITH RAMPS (LESS THAN 3 METERS IN WIDTH) (454.1009.005)



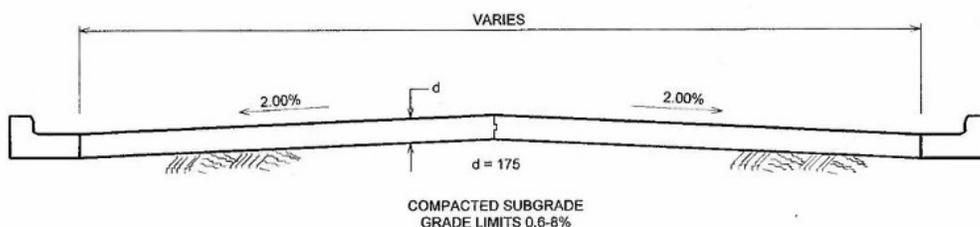
- NOTES:
- DESIGN ALSO APPLIES TO MEDIANS LESS THAN 3.0m IN WIDTH.
 - ADD 10M REBAR TO THE ENDS OF ALL BULLNOSES, MEDIAN & TRAFFIC ISLANDS.
 - A MINIMUM OF 2.0m CLEARANCE FROM ANY FACE OF CURB IS REQUIRED FOR ANY POLES ON AN ISLAND (i.e. MAST ARM).

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd						
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 22/5/2018 PERMIT NUMBER P 04428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED 2:\permanant\StdRoadSpecs_2014\Drawing Files\454.1009\USIN\4541009005_v8.dgn 19-JAN-2015 09:50 ISC: UNRESTRICTED	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	TRAFFIC ISLAND WITH RAMPS (LESS THAN 3 METERS IN WIDTH)	Figure 28 File Number 454.1009.005												

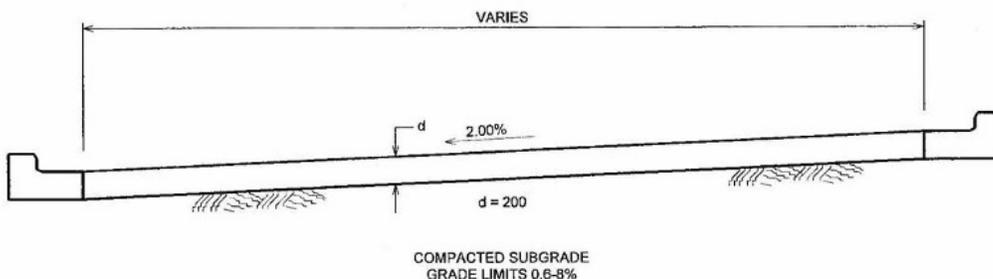


RESIDENTIAL ROADS

(RESIDENTIAL ENTRANCE STREETS, RESIDENTIAL STREETS)



NON-TRANSIT COLLECTOR ROADS



TRANSIT COLLECTOR ROADS

(PRIMARY COLLECTOR STREET, COLLECTOR STREET, ACTIVITY CENTER STREET)

NOTES:

1. ONLY CROSS SECTIONS SHOWN. FOR JOINTING DETAILS REFER TO SHEET No. 454.1015.006.
2. SECTIONS BASED ON MINIMUM CBR VALUES OF 5.0 (3.5 FOR RESIDENTIAL).
3. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
4. CONCRETE SHALL MEET SPECIFICATIONS FOR PORTLAND CEMENT PAVEMENT, SECTION 312.00.00.

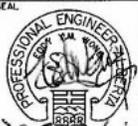
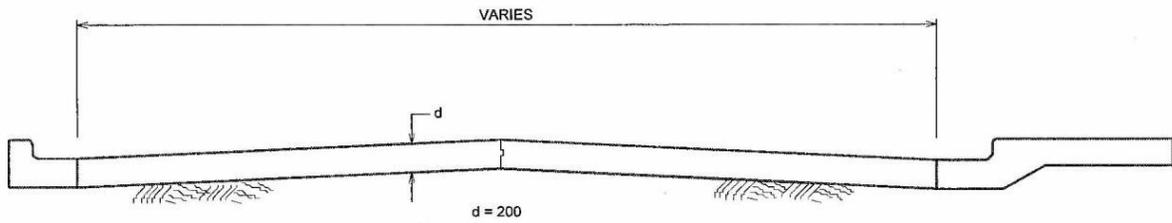
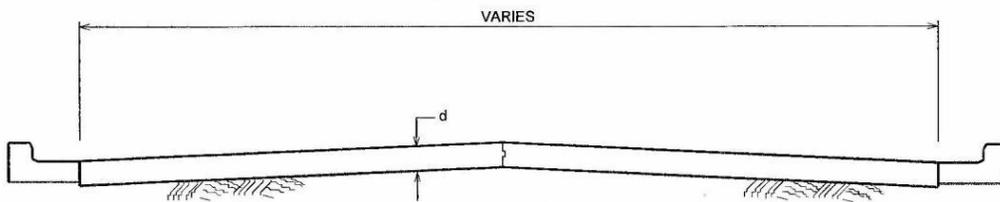
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Figure 30: TYPICAL CONCRETE PAVEMENT STRUCTURE - INDUSTRIAL AND MAJOR ROADS (454.1015.002)



COMPACTED SUBGRADE
GRADE LIMITS 0.6% - 10%

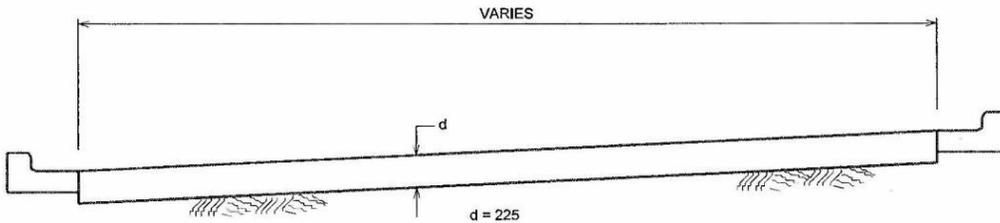
INDUSTRIAL ROADS



COMPACTED SUBGRADE
GRADE LIMITS 0.6% - 8%

UNDIVIDED MAJOR ROADS

(INDUSTRIAL ARTERIAL STREET, NEIGHBOURHOOD BOULEVARD)



COMPACTED SUBGRADE
GRADE LIMITS 0.6% - 8%

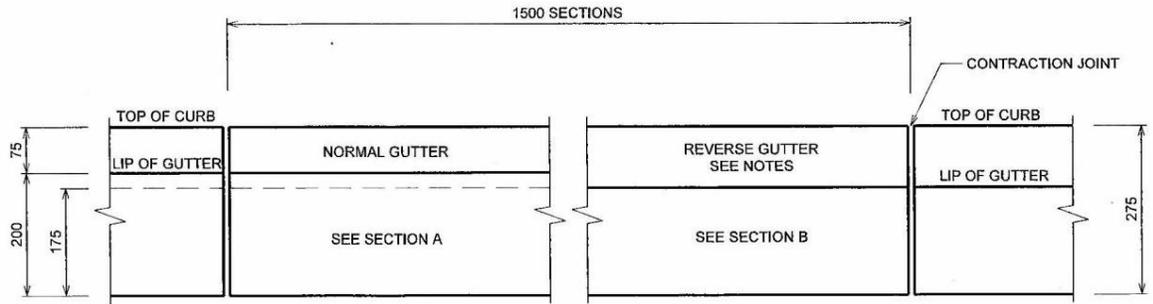
DIVIDED MAJOR ROADS

(SKELETAL ROAD, ARTERIAL STREET, LOCAL ARTERIAL STREET, URBAN BOULEVARD, PARKWAY)

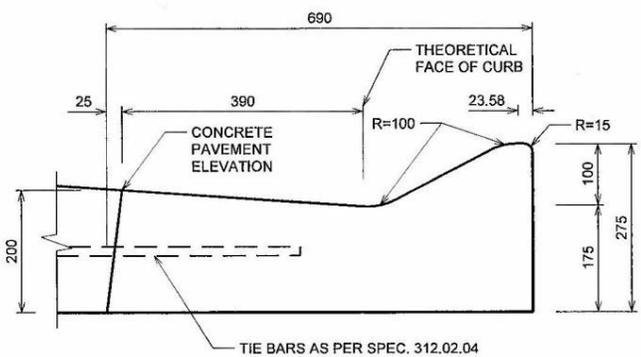
NOTES:

1. ONLY CROSS SECTIONS SHOWN. FOR JOINTING DETAILS REFER TO SHEET No. 454.1015.006.
2. SECTIONS BASED ON MINIMUM CBR VALUES OF 5.0.
3. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
4. PAVEMENT STRUCTURE SHALL BE DESIGNED AS PER SECTION 308.02.00.
5. CONCRETE SHALL MEET SPECIFICATIONS FOR PORTLAND CEMENT PAVEMENT, SECTION 312.00.00.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd							
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/04/28 PERMIT NUMBER: P 164428 The Association of Professional Engineers and Geoscientists of Alberta	 SEAL PROFESSIONAL ENGINEER CIVIL 2015/03/01	 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\permant\Sd\RoadSpecs_2014\Drawing Files\4541015\UJSTN\4541015002_v8.dgn 08-JAN-2015 08:34 ISC: UNRESTRICTED	METRIC	Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS	TYPICAL CONCRETE PAVEMENT STRUCTURE INDUSTRIAL AND MAJOR ROADS	Figure 30 File Number 454.1015.002												

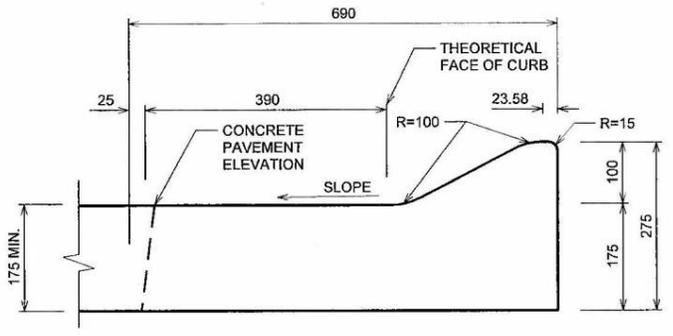


ELEVATION



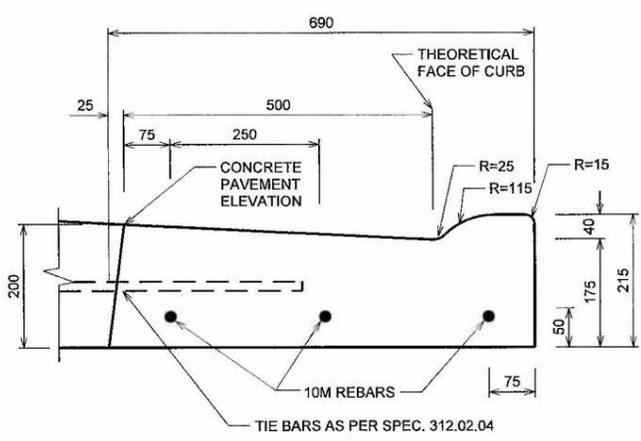
SECTION A

SEPERATE CURB & GUTTER

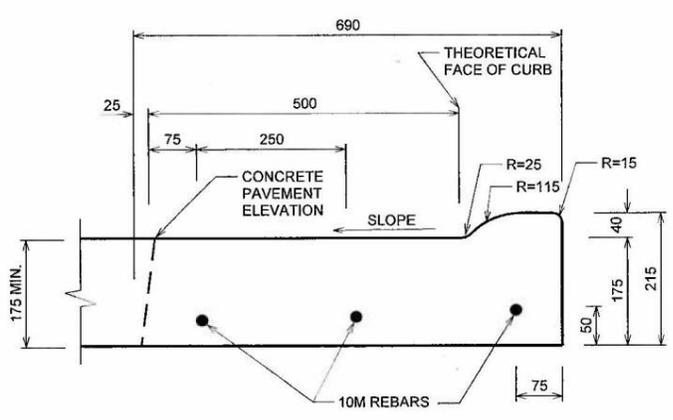


SECTION B

INTEGRAL CURB & GUTTER



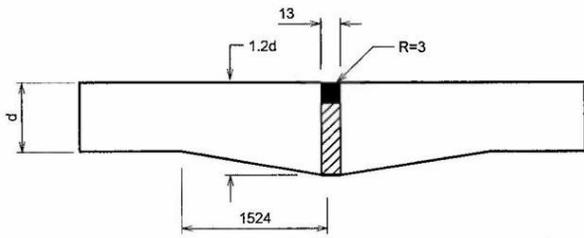
CURB CROSSING A



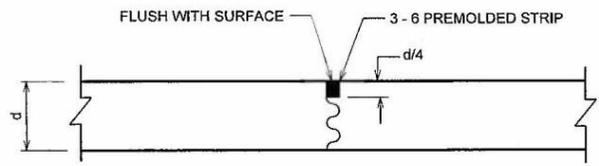
CURB CROSSING B

- NOTES:**
1. REVERSE GUTTER TO BE USED ON HIGH SIDE OF ROADWAY IN SUPERELEVATION. BASE GRADIENT TO MATCH CROSSFALL OF PAVEMENT. GUTTER PAN TO BE PARALLEL WITH SURFACE CROSSFALL.
 2. MINIMUM GUTTER THICKNESS 175mm.

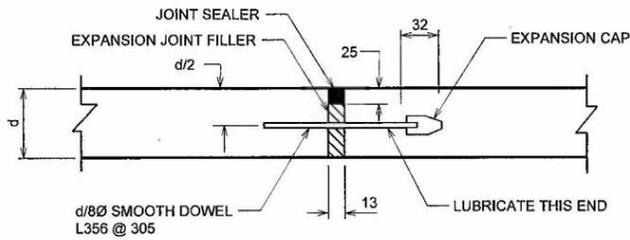
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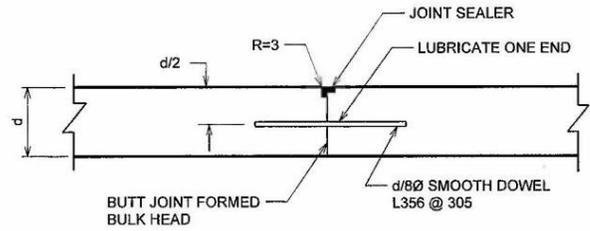
TYPE A
EXPANSION JOINT



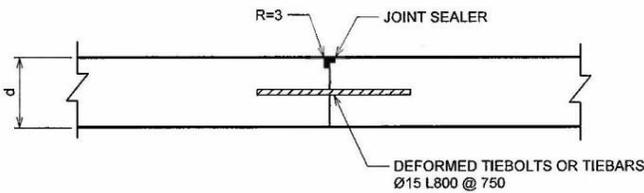
TYPE D
SAWED OR PREMOLDED STRIP
LONGITUDINAL OR TRANSVERSE



TYPE A
ALTERNATE EXPANSION JOINT

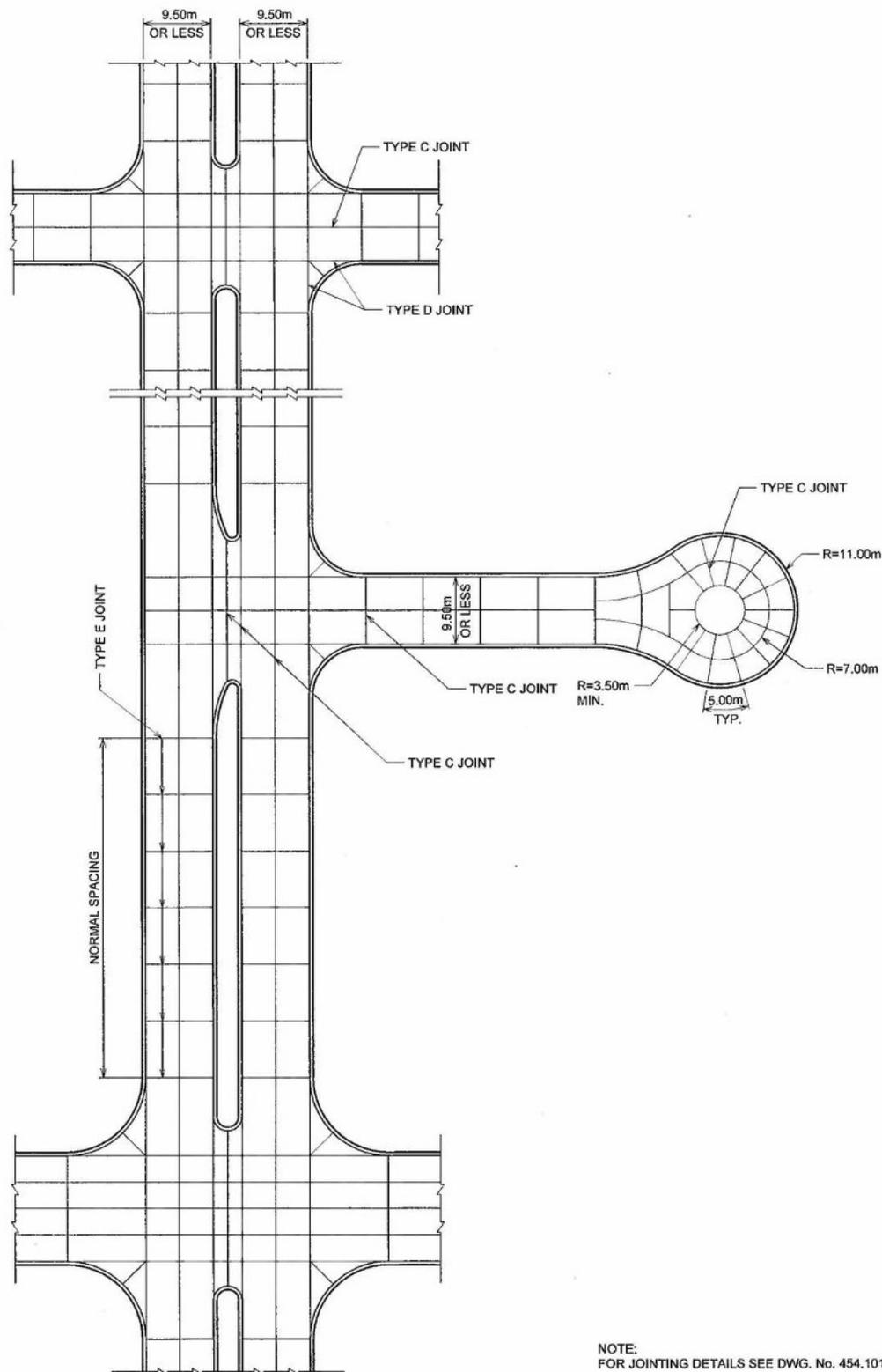


TYPE E
PLANNED TRANSVERSE CONSTRUCTION JOINT
(USED AT NORMAL JOINT SPACING)



TYPE C
TIED BUTT LONGITUDINAL CONSTRUCTION JOINT

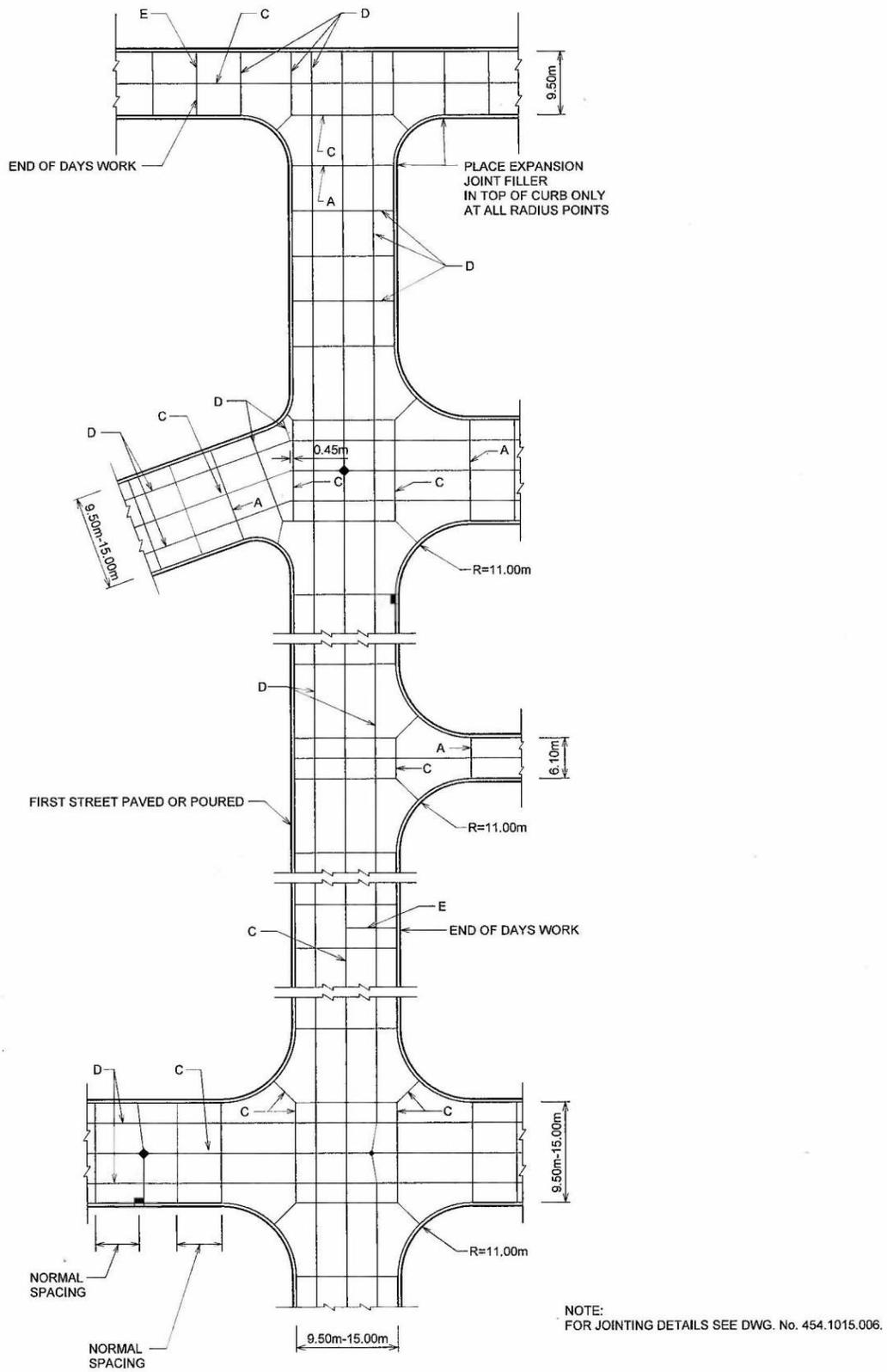
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Mar 07 PERMIT NUMBER: P 06428 The Association of Professional Engineers and Geoscientists of Alberta			SEAL 						Drawn: JL Date: 2014-10 Designed: EW Checked: EW Scale: NTS			Figure 32 File Number 454.1015.006	
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541015\USTN\4541015006_v8.dgn 04-NOV-2014 11:30 ISC: UNRESTRICTED						CONCRETE JOINT DETAILS							

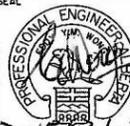


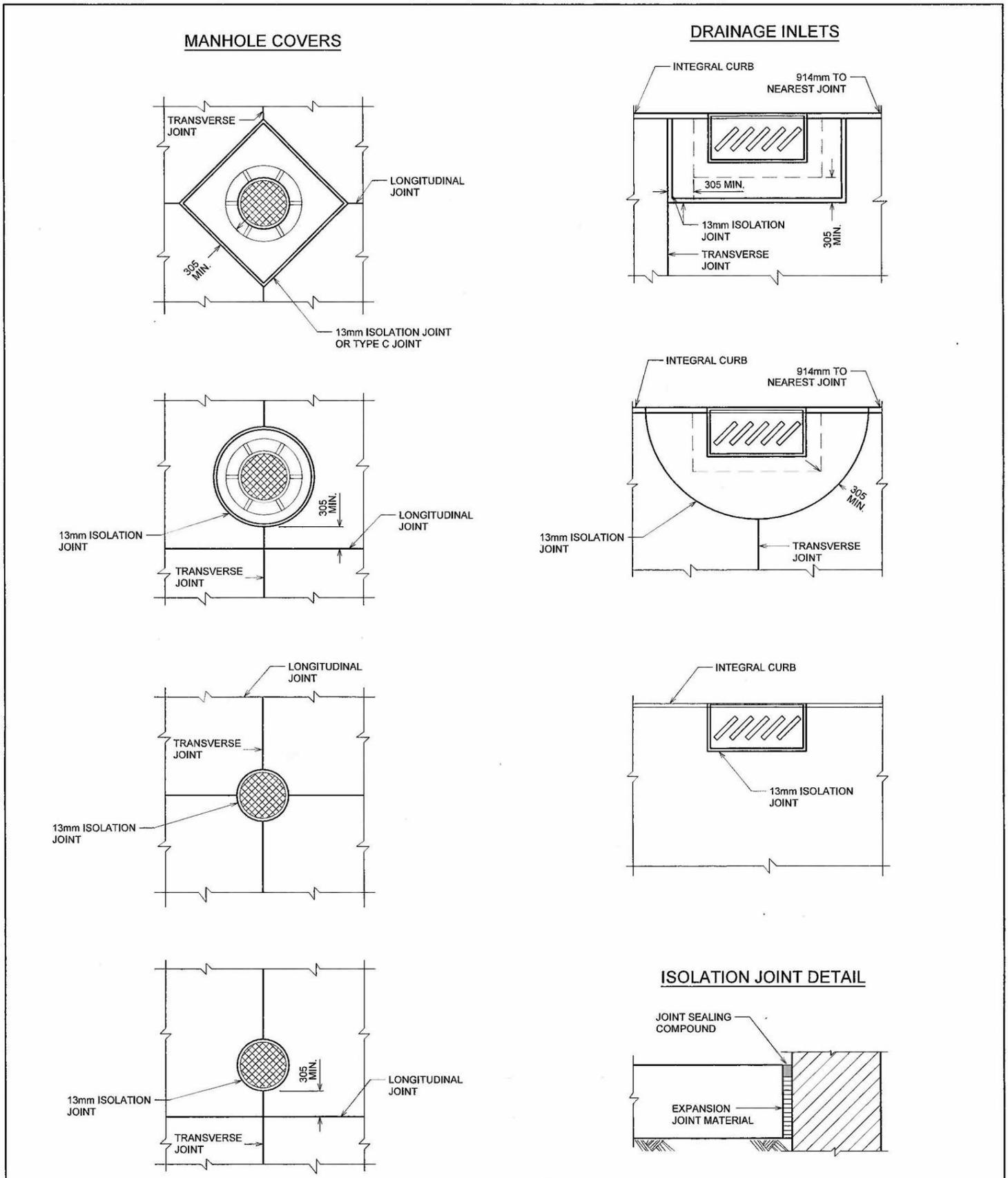
NOTE:
FOR JOINTING DETAILS SEE DWG. No. 454.1015.006.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd				
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/05/25 PERMIT NUMBER: P 84428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		 THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		METRIC		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		CONCRETE JOINTS MEDIANS AND CUL-DE-SACS		Figure 33 File Number 454.1015.004	
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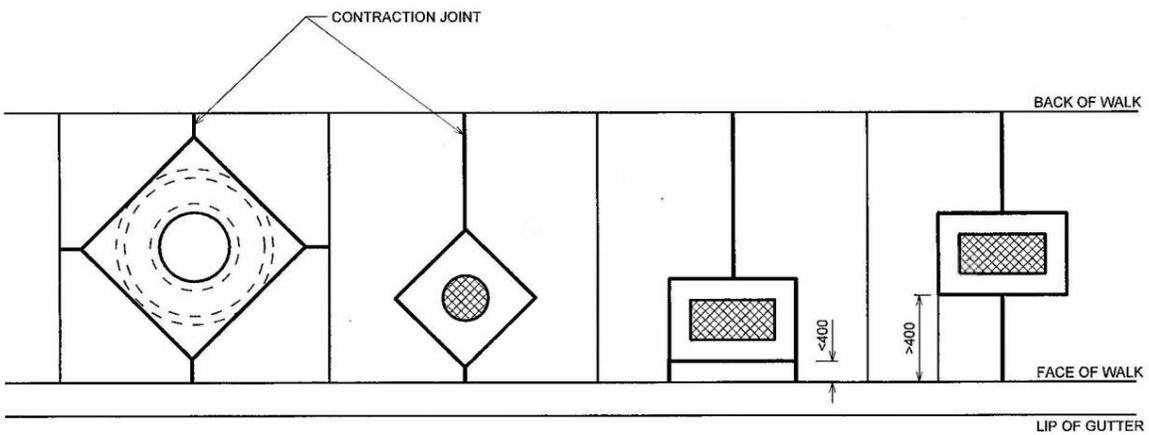
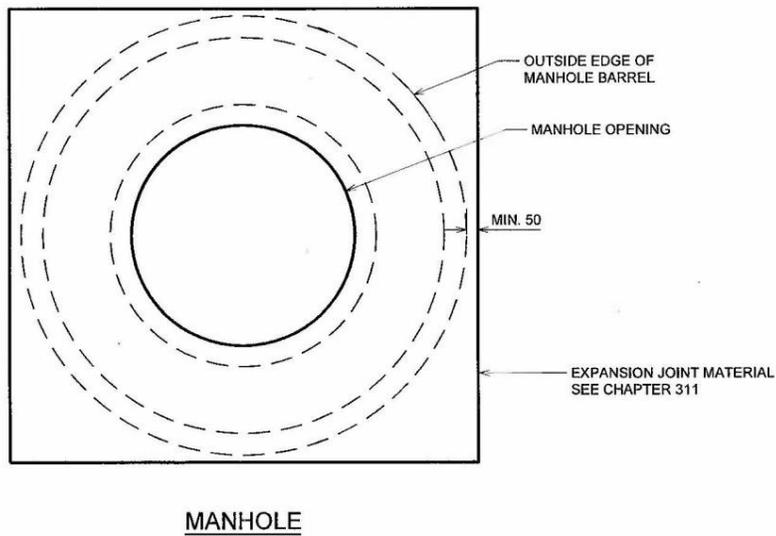
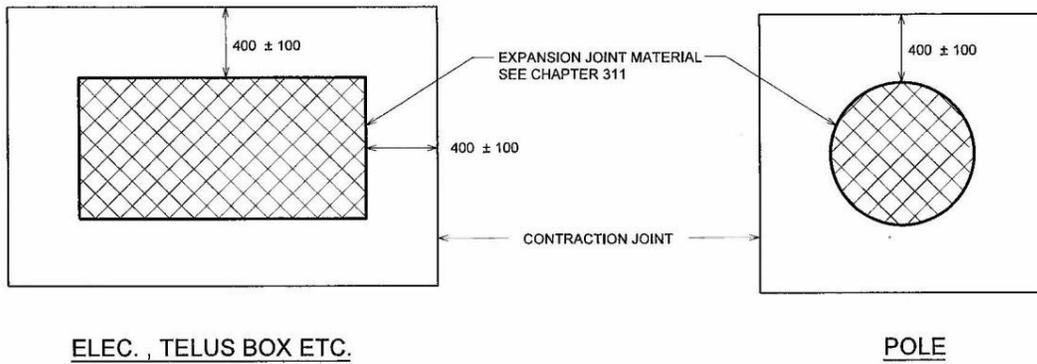
Figure 34: CONCRETE JOINTS - ROADWAYS (454.1015.005)

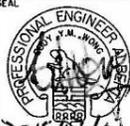
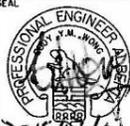
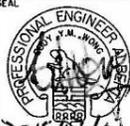


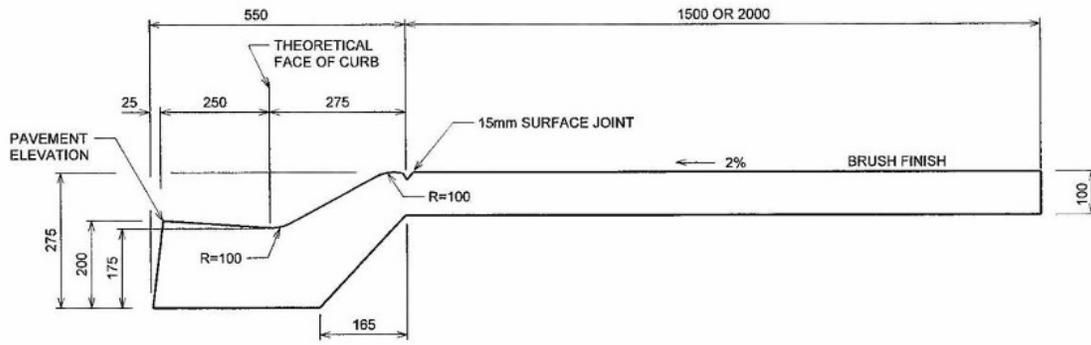
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PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Nov 24 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta				 THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanentStdRoadSpecs_2014\Drawing Files\4541015\USTN\4541015005_v8.dgn 05-JAN-2015 10:30 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		CONCRETE JOINTS ROADWAYS		Figure 34 File Number 454.1015.005



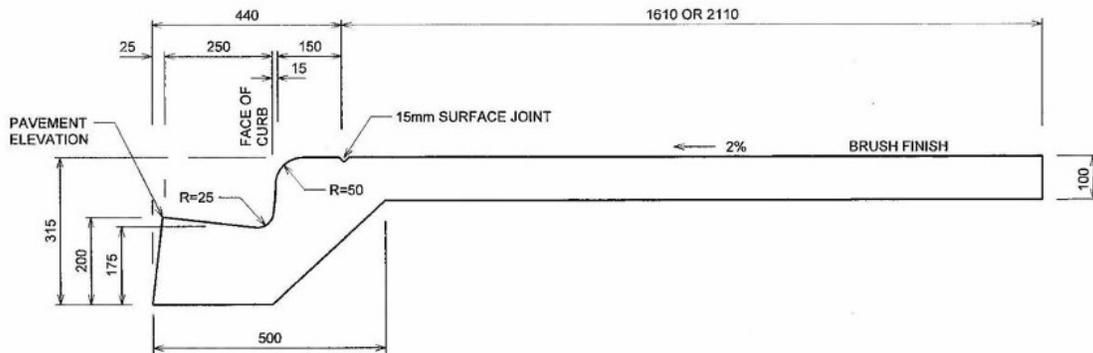
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PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2/25/14 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta	SEAL  PROFESSIONAL ENGINEER CIVIL 2015/63/01	 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC 2:\permanent\StdRoadSpecs_2014\Drawing Files\4541015007_v8.dgn 09-JAN-2015 10:32 ISC: UNRESTRICTED	Drawn JL Date 2014-11 Designed EW Checked EW Scale: NTS	CONCRETE JOINTS AROUND UTILITIES ROADWAYS	Figure 35 File Number 454.1015.007												



No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd							
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/04 PERMIT NUMBER: 12 04428 The Association of Professional Engineers and Geoscientists of Alberta	 2015/03/04	 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	CONCRETE JOINTS AROUND UTILITIES SIDEWALK	Figure 36 File Number 454.1013.018												
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LOW PROFILE ROLLED

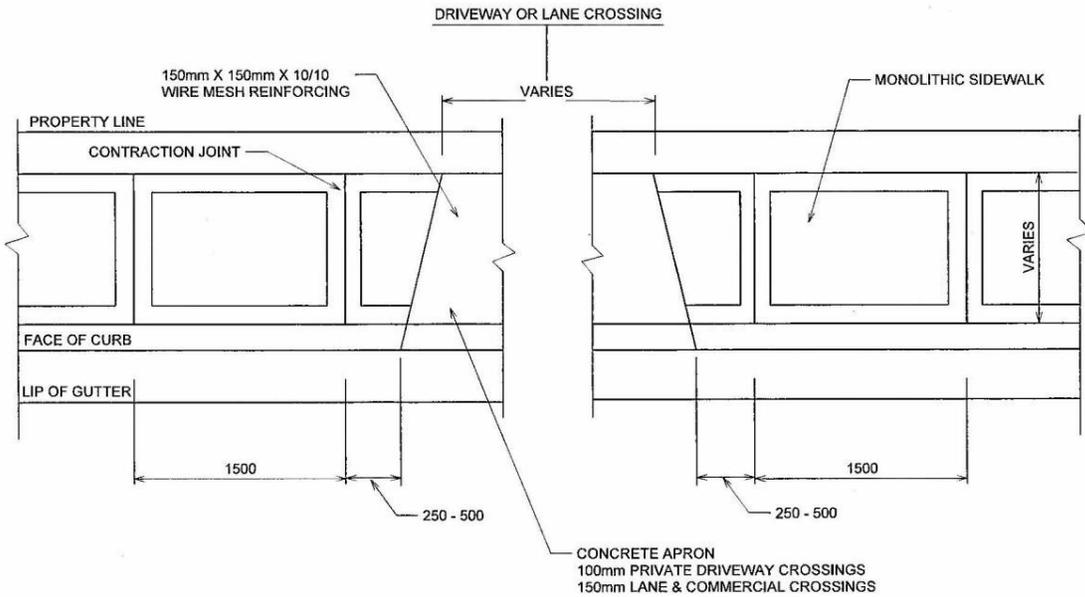


STANDARD

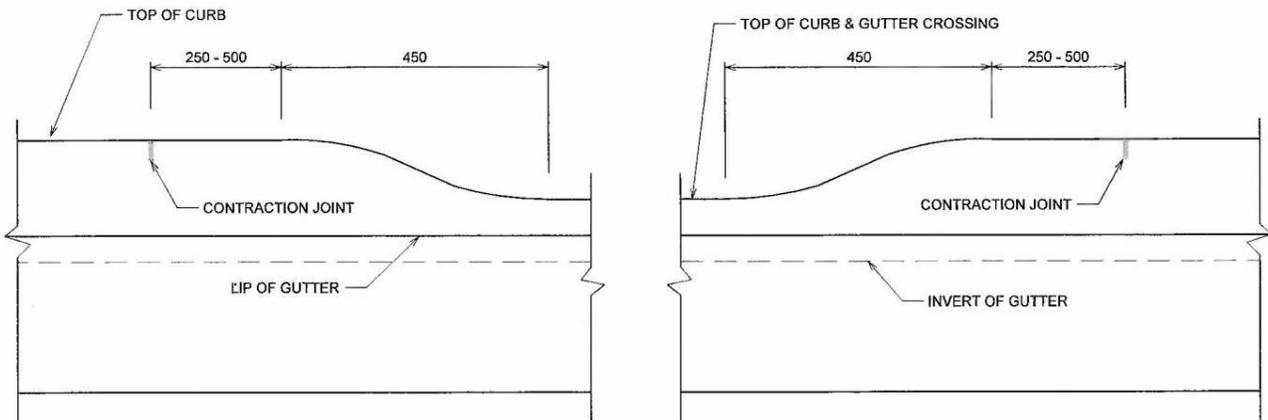
NOTES:

1. CROSSFALL ON WALK PORTION NOT TO EXCEED 2%. EXCESSIVE CROSSWALK SLOPE TO BE APPROVED BY ROADS BUSINESS UNIT.
2. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
3. FOR 1500 AND 2000 MONOLITHIC SIDEWALKS WITH STANDARD CURB THE ACTUAL SIDEWALK WIDTHS ARE 1610 AND 2110 RESPECTIVELY.

No.	Date	Revision	App'd.	No.	Date	Revision	App'd.	No.	Date	Revision	App'd.							
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PERMIT TO PRACTICE CITY of Calgary Signature: <i>[Signature]</i> Date: 2015-10-27 PERMIT NUMBER: P-01428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	MONOLITHIC SIDEWALK	Figure 37 File Number 454.1013.009												



PLAN VIEW

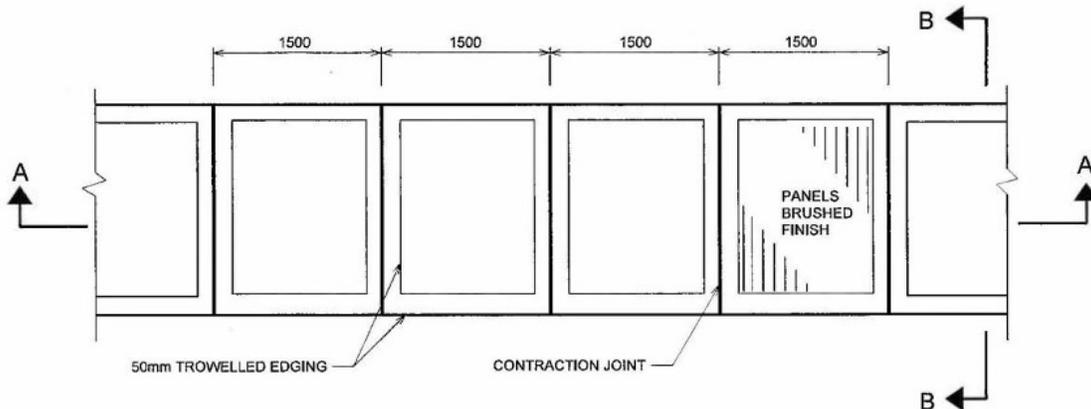


ELEVATION VIEW

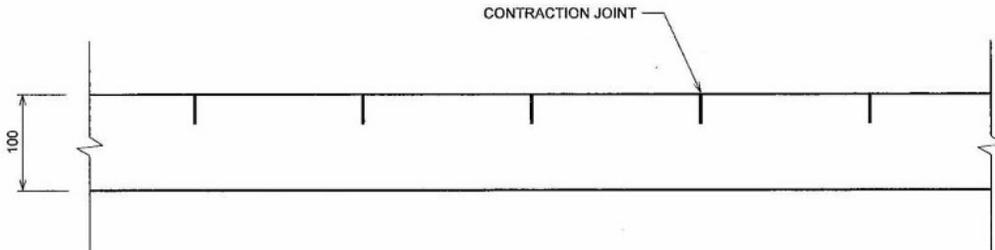
NOTES:

1. SEE CHAPTER 311.
2. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

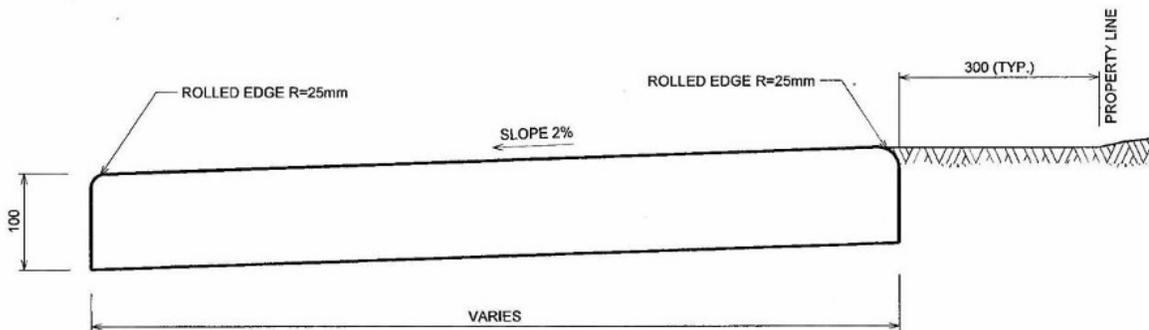
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PLAN VIEW



SECTION A-A

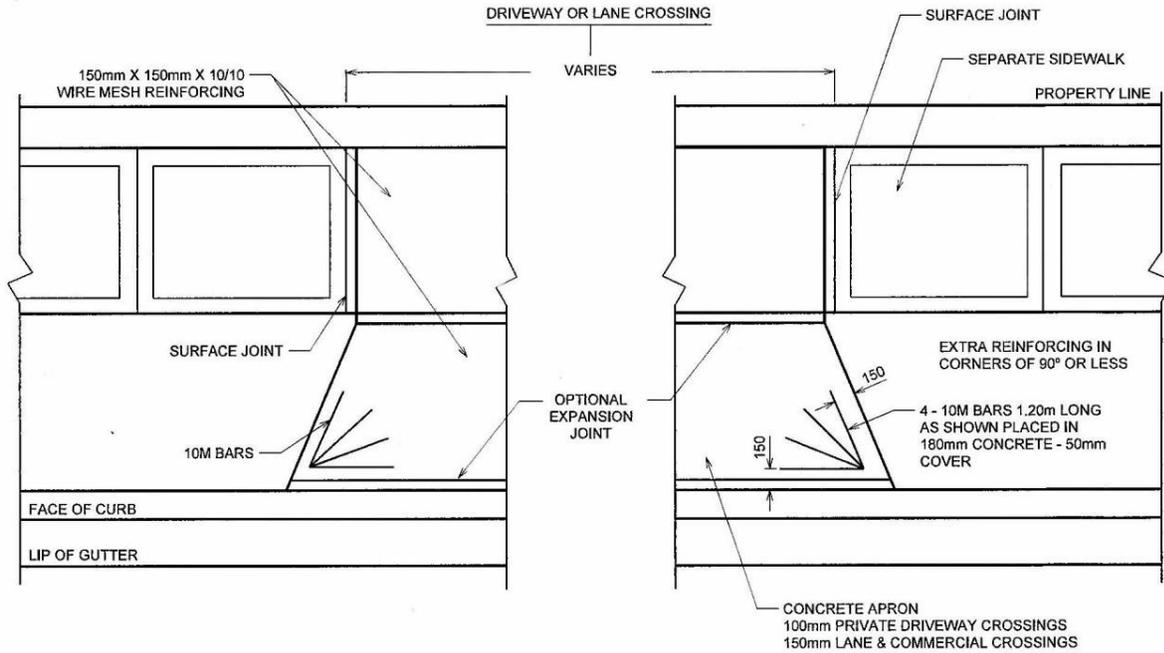


SECTION B-B

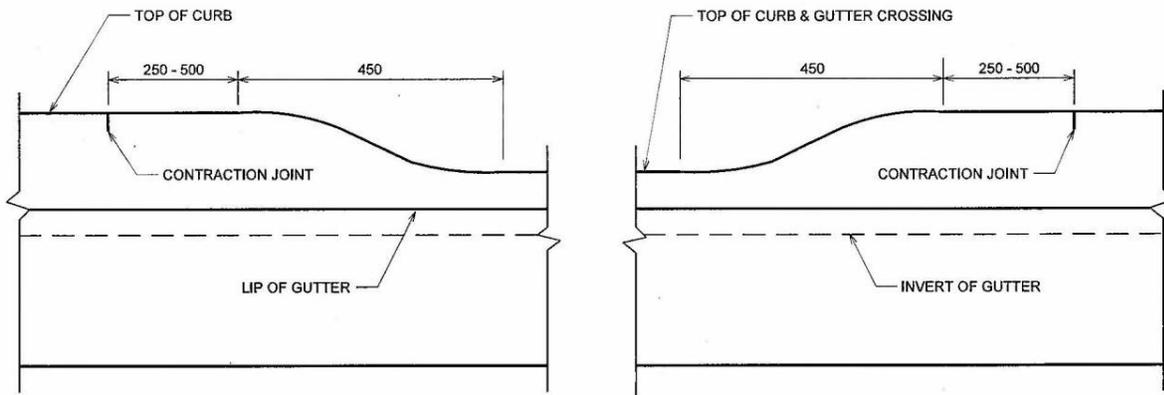
NOTES:

1. CROSSFALL ON WALK PORTION NOT TO EXCEED 2%. EXCESSIVE CROSSWALK SLOPE TO BE APPROVED BY ROADS BUSINESS UNIT.
2. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd			
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/01 PERMIT NUMBER: 04428 The Association of Professional Engineers and Geoscientists of Alberta						 THE CITY OF CALGARY ROADS			Drawn: JL, Date: 2014-11 Designed: EW Checked: EW Scale: NTS			Figure: 39 File Number: 454.1013.003		
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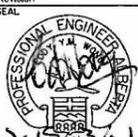
PLAN VIEW

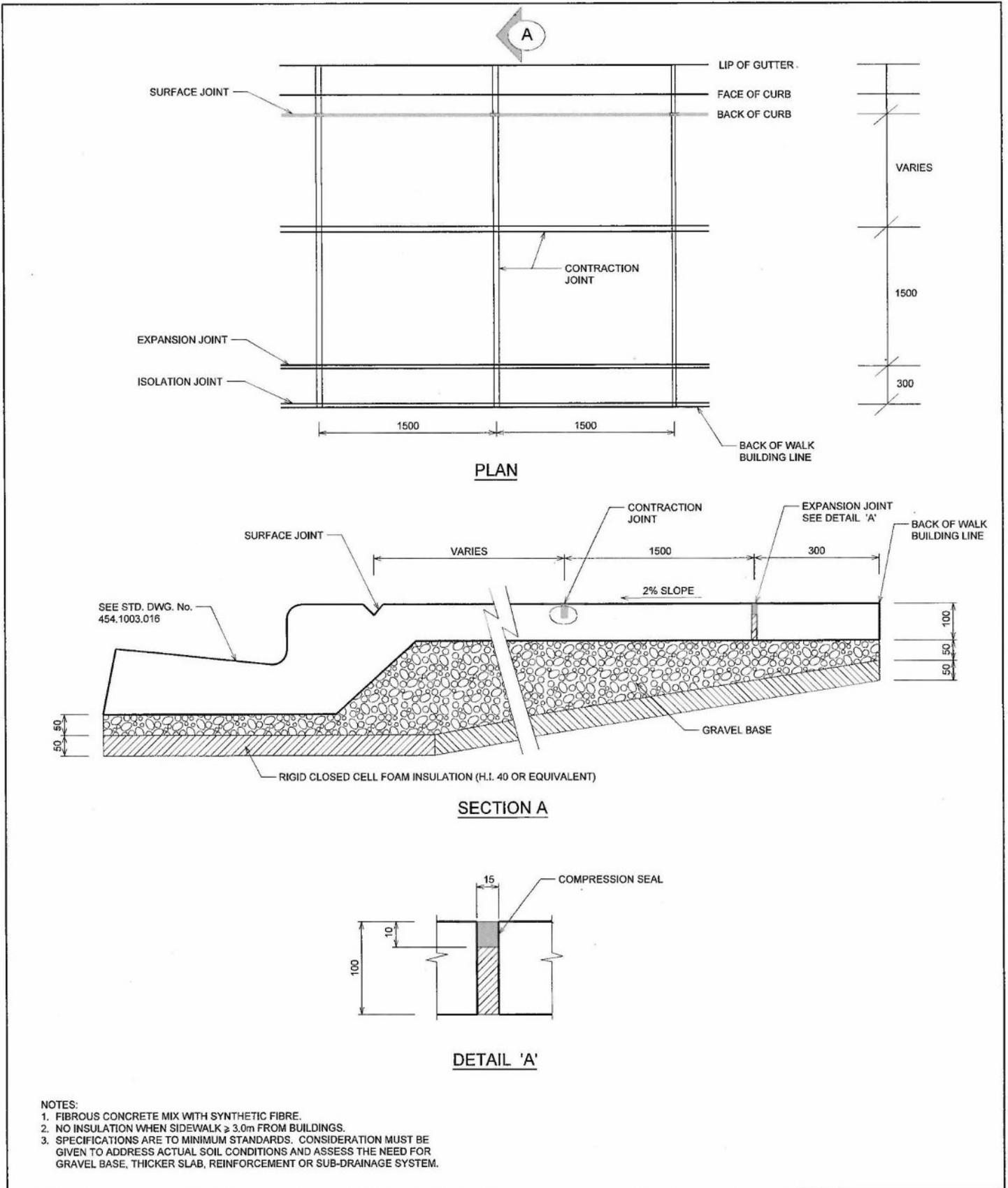


ELEVATION

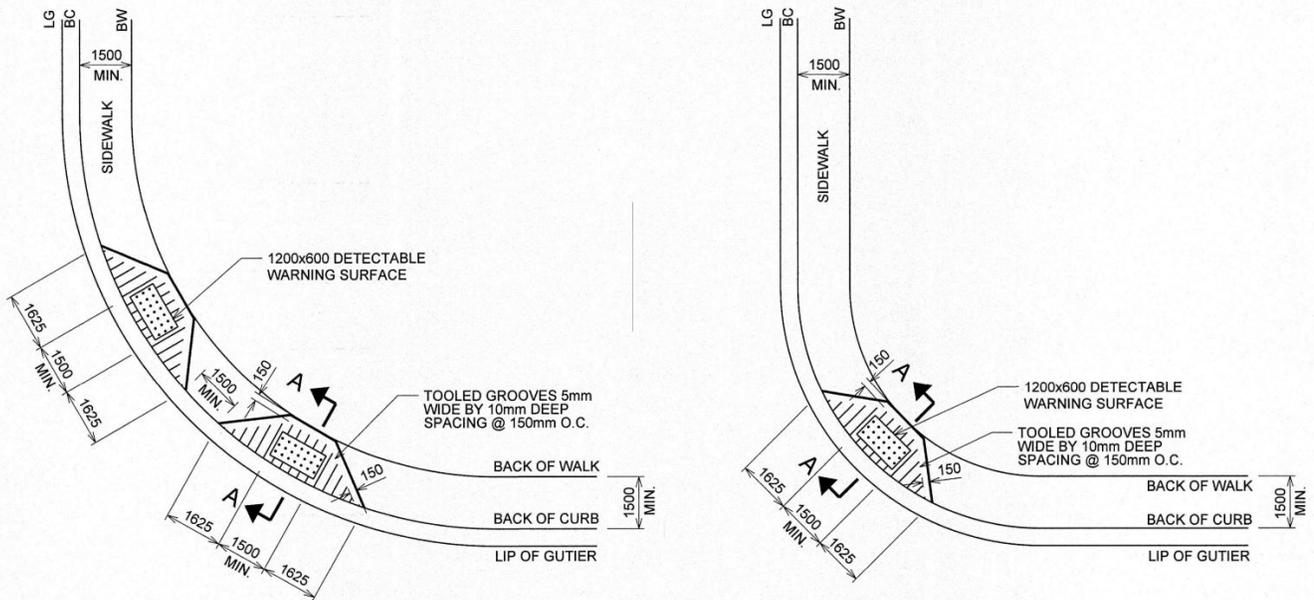
NOTES:

1. THIS DRAWING ONLY APPLIES IF BOULEVARD WIDTH IS GREATER THAN 1.00m. WHEN BOULEVARD WIDTH IS 1.00m OR LESS, THE APRON AND SIDEWALK ARE TO BE POURED AS ONE WITH 30mm DEEP TOOLED JOINT ALONG FACE OF WALK OR AS SPECIFIED BY THE FIELD ENGINEER.
2. SEE CHAPTER 311.
3. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revison	App'd	No.	Date	Revison	App'd	No.	Date	Revison	App'd	
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2/15/2015</i> PERMIT NUMBER: P-044598 The Association of Professional Engineers and Geoscientists of Alberta				 THE CITY OF CALGARY ROADS				Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		SEPARATE SIDEWALK CROSSING		Figure 40 File Number 454.1013.004
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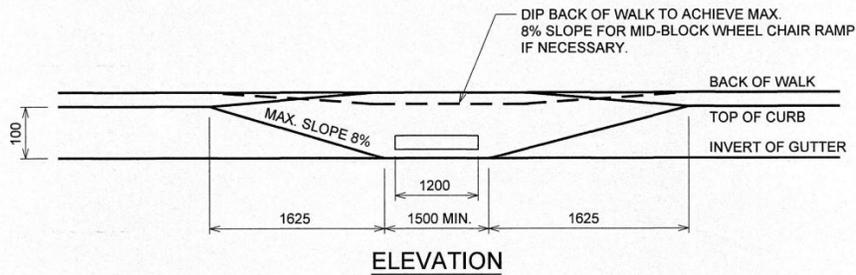


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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-27 PERMIT NUMBER: A 0428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 2015/03/01		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\SS&RoadSpecs_2014\Drawing Files\4541013\4541013011_46.dwg 16-JAN-2015 09:39 ISC - UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		SIDEWALK INSULATION REQUIREMENT (< 3m FROM BUILDING)			Figure: 41 File Number: 454.1013.011	

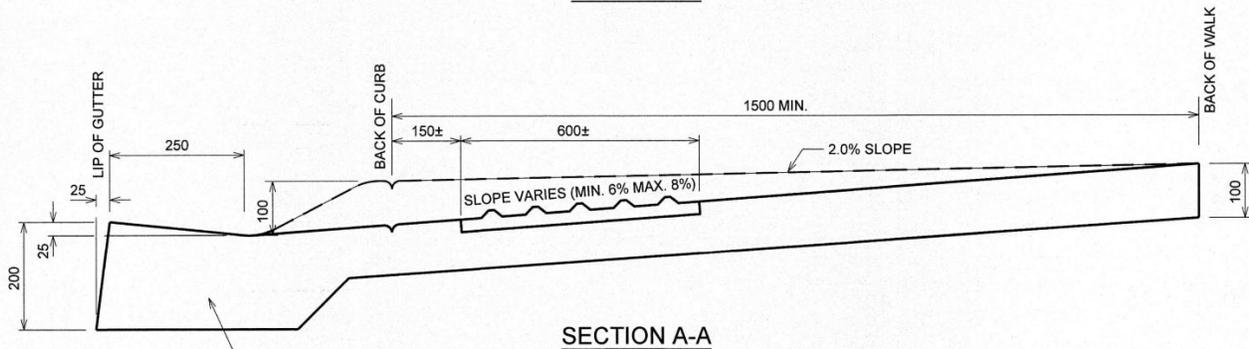


CORNER WHEEL CHAIR RAMP - DOUBLE PLAN

CORNER WHEEL CHAIR RAMP - SINGLE PLAN



ELEVATION

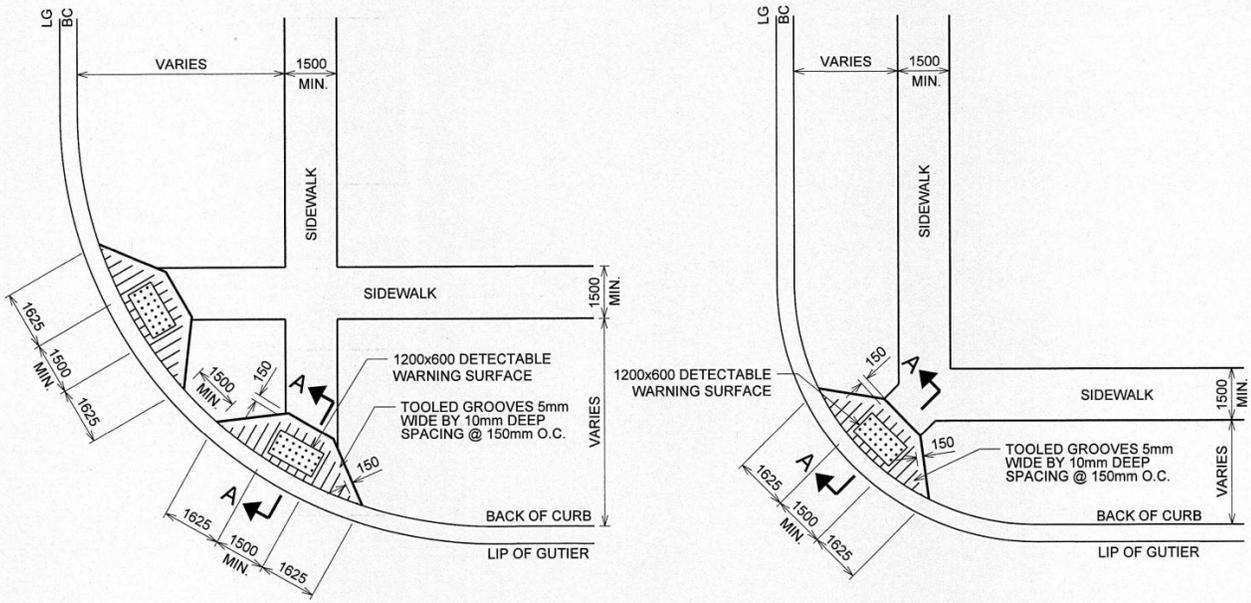


SECTION A-A

NOTES:

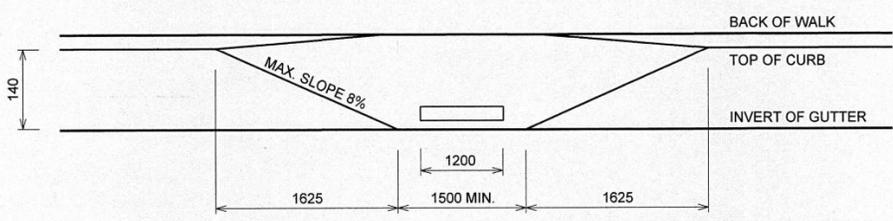
1. TWO DIRECTIONAL WHEEL CHAIR RAMPS SHOULD BE INSTALLED AT ALL STREET INTERSECTION CORNERS (IF CORNER RADII AND CATCH BASIN LOCATIONS PERMIT).
2. MINIMUM 1.50m SEPARATION BETWEEN CORNER WHEEL CHAIR RAMPS.
3. MINIMUM WIDTH OF RAMP 1500.
4. RAMP SURFACE TO BE TEXTURED CONCRETE.
5. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
6. INSTALL DETECTABLE WARNING SURFACE SO THAT THE TOP OF THE PLATE IS FLUSH WITH THE SURFACE OF THE ADJACENT SIDEWALK.

2	FEB. 2017	REVISE ZERO LIP, DETECTABLE WARNING SURFACE																		
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	Figure		42		File Number		454.1013.001		
						Drawn JL 2014-11		Date 2014-11		Designed EW		WHEEL CHAIR RAMP FOR MONOLITHIC SIDEWALK		Checked EW		Scale: NTS		Figure 42 File Number 454.1013.001		
PERMIT NUMBER: P004428 DATE: 2017-02-27		27 October 2017		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		METRIC		2:\permanent\StdRoadSpecs_2017\dwg\4541013001_V8.dgn 03-MAY-2017 11:49		ISC: UNRESTRICTED										

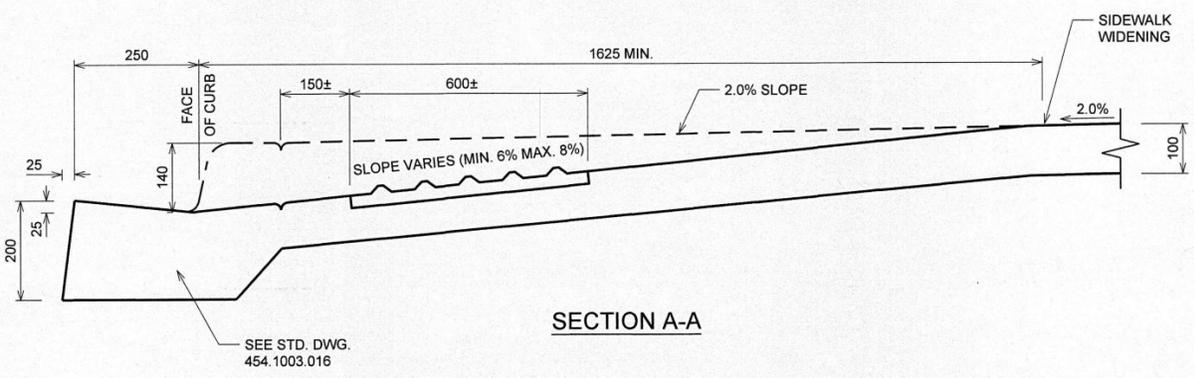


CORNER WHEEL CHAIR RAMP - DOUBLE PLAN

CORNER WHEEL CHAIR RAMP - SINGLE PLAN



ELEVATION

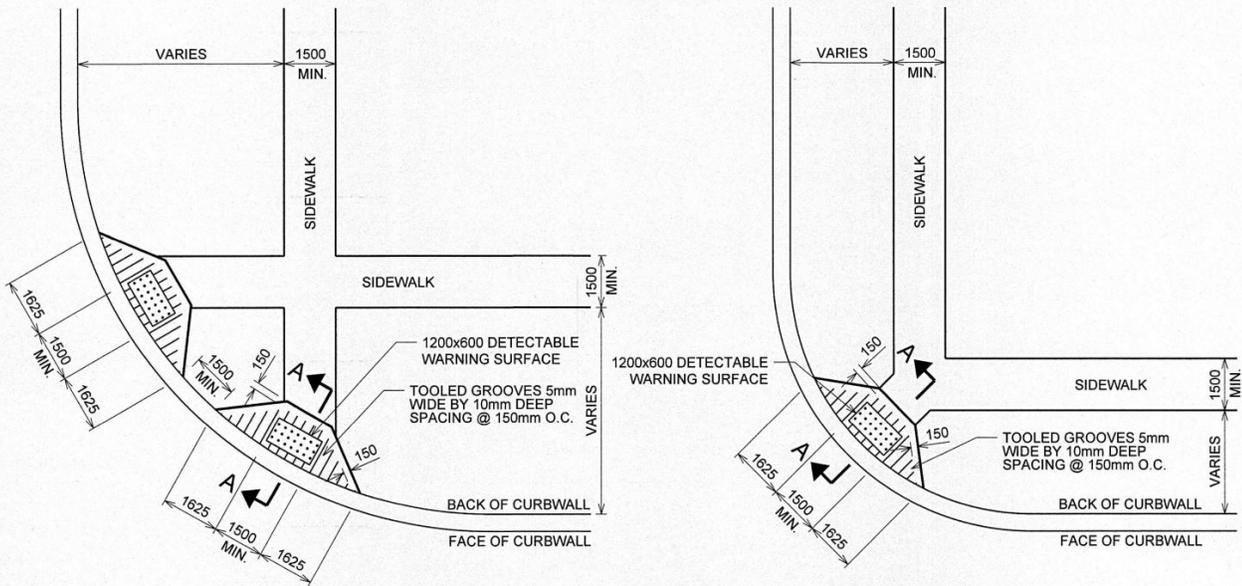


SECTION A-A

- NOTES:**
1. TWO DIRECTIONAL WHEEL CHAIR RAMPS SHOULD BE INSTALLED AT ALL STREET INTERSECTION CORNERS (IF CORNER RADII AND CATCH BASIN LOCATIONS PERMIT).
 2. MINIMUM 1.50m SEPARATION BETWEEN CORNER WHEEL CHAIR RAMPS.
 3. MINIMUM WIDTH OF RAMP 1500.
 4. RAMP SURFACE TO BE TEXTURED CONCRETE.
 5. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
 6. INSTALL DETECTABLE WARNING SURFACE SO THAT THE TOP OF THE PLATE IS FLUSH WITH THE SURFACE OF THE ADJACENT SIDEWALK.

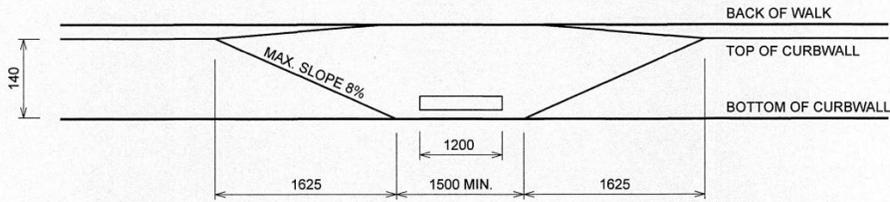
8	FEB. 2017	REVISE ZERO LIP, DETECTABLE WARNING SURFACE	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd		
PERMIT PERMIT TO PRACTICE CITY OF CALGARY DATE: 2020 OCT 28 PERMIT NUMBER: P004425 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)			SEAL PROFESSIONAL ENGINEER ALBERTA ROBERT J. TAMM 27 Oct 2020			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\permanent\StdRoadSpecs_2017\dwg\4541013012_V8.dgn 03-MAY-2017 11:50 ISC: UNRESTRICTED			Drawn: JL, Date: 2014-11 Designed: EW Checked: EW Scale: NTS			Figure 43 File Number 454.1013.012	

Figure 44: WHEEL CHAIR RAMP WITH CONCRETE CURB WALL (454.1013.017)

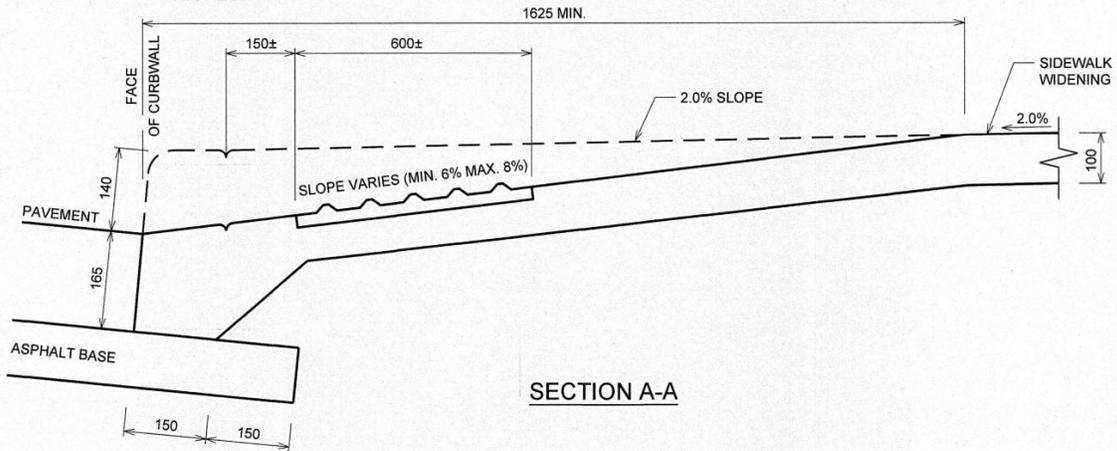


CORNER WHEEL CHAIR RAMP - DOUBLE PLAN

CORNER WHEEL CHAIR RAMP - SINGLE PLAN



ELEVATION

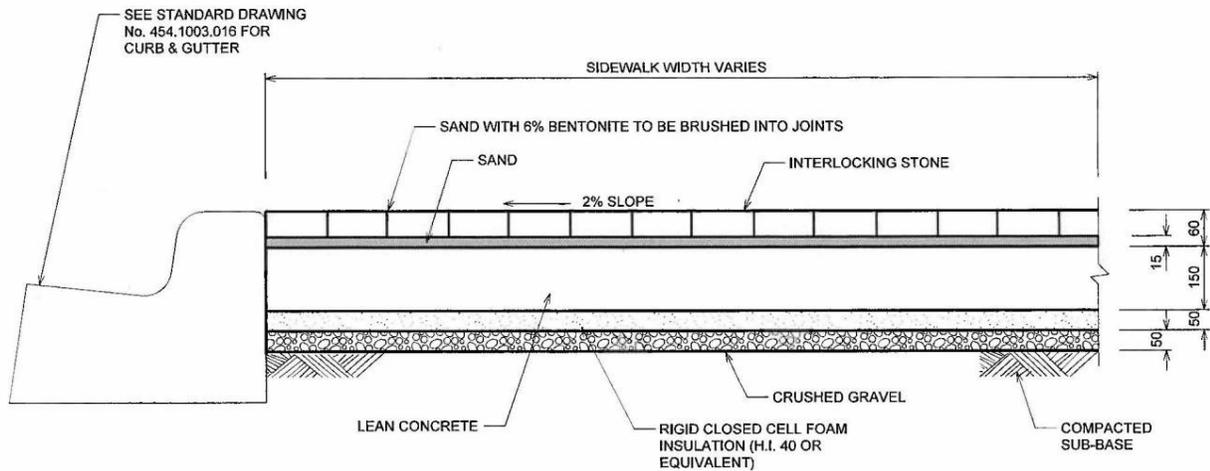


SECTION A-A

NOTES:

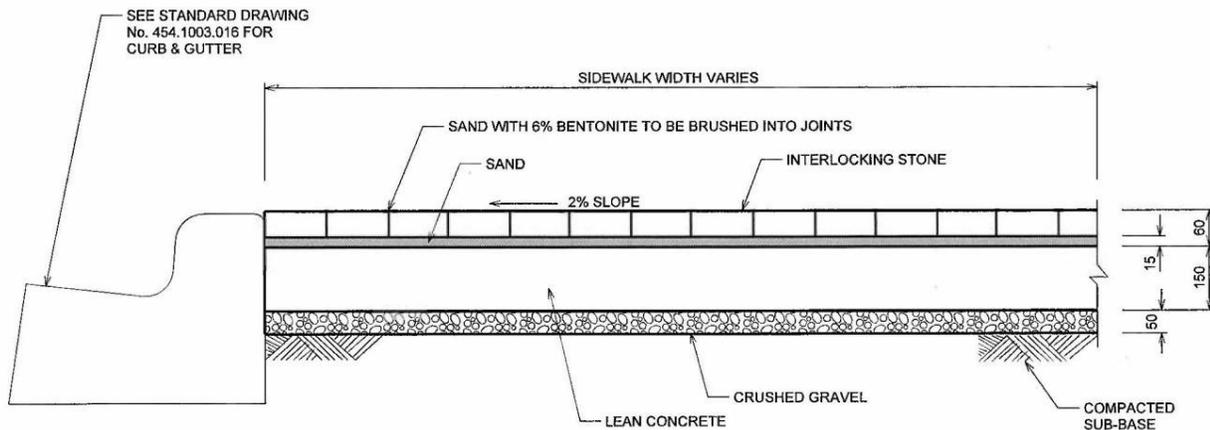
1. TWO DIRECTIONAL WHEEL CHAIR RAMPS SHOULD BE INSTALLED AT ALL STREET INTERSECTION CORNERS (IF CORNER RADII AND CATCH BASIN LOCATIONS PERMIT).
2. MINIMUM 1.50m SEPARATION BETWEEN CORNER WHEEL CHAIR RAMPS.
3. MINIMUM WIDTH OF RAMP 1500.
4. RAMP SURFACE TO BE TEXTURED CONCRETE.
5. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
6. INSTALL DETECTABLE WARNING SURFACE SO THAT THE TOP OF THE PLATE IS FLUSH WITH THE SURFACE OF THE ADJACENT SIDEWALK.

8	FEB, 2017	REVISE ZERO LIP, DETECTABLE WARNING SURFACE	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd			
PERMIT PERMIT TO PRACTICE CITY OF CALGARY FROM APPLICANT: <i>[Signature]</i> DATE: <i>26-02-2017</i> PERMIT NUMBER: P004428 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)			SEAL PROFESSIONAL ENGINEER ROBERT J. TALAMON 27			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanentStdRoadSpecs_2017\dwg\4541013017_V8.dgn 03-MAY-2017 11:51 ISC - UNRESTRICTED			Drawn JL Date 2014-11 Designed EW Checked EW Scale: NTS			Figure 44 File Number 454.1013.017		



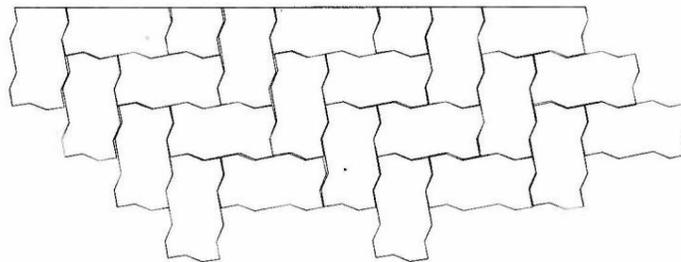
TYPICAL CROSS SECTION WITH INSULATION

WHERE B.O.W. < 3.0 m FROM BUILDING



TYPICAL CROSS SECTION WITH NO INSULATION

WHERE B.O.W. ≥ 3.0 m FROM BUILDING



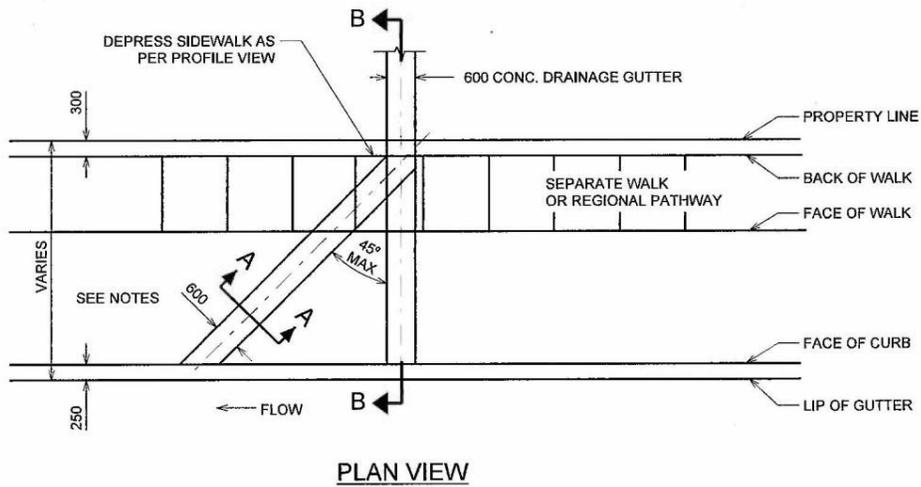
TYPICAL LAYING PATTERN

NOTES :

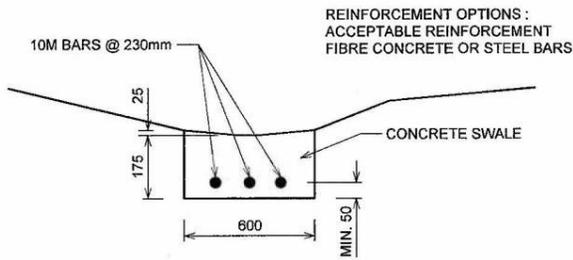
1. BLOCKS SHALL MEET THE REQUIREMENTS OF A.S.T.M. C936-82.
2. USE OF THIS TYPE OF SIDEWALK REQUIRES A MAINTENANCE AGREEMENT TO BE IN PLACE.
3. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/01 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta				THE CITY OF CALGARY ROADS		Drawn: JL Date: 2014-11 Designed: EW		INTERLOCKING CONCRETE PAVING STONE (FOR RETROFITS ONLY)		Figure: 45 File Number: 454.1013.013	
				Checked: EW							
				Scale: NTS							
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541013\USTN\4541013013_V8.dgn 03-MAR-2015 13:42 ISC - UNRESTRICTED											

Figure 46: BOULEVARD DRAINAGE CROSSING FOR SEPARATE SIDEWALK (454.1013.015)

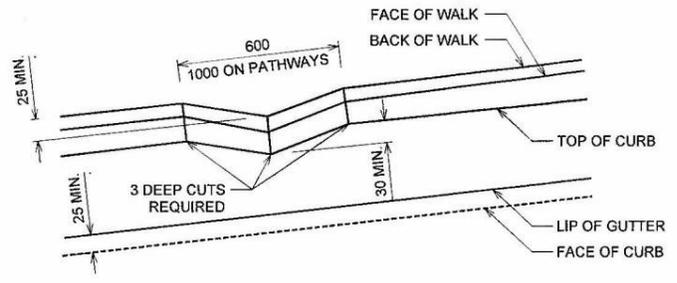


PLAN VIEW

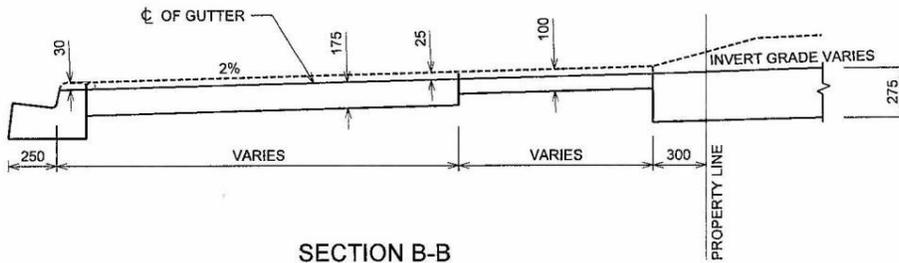


SECTION A - A

REINFORCEMENT OPTIONS :
ACCEPTABLE REINFORCEMENT
FIBRE CONCRETE OR STEEL BARS



PROFILE VIEW

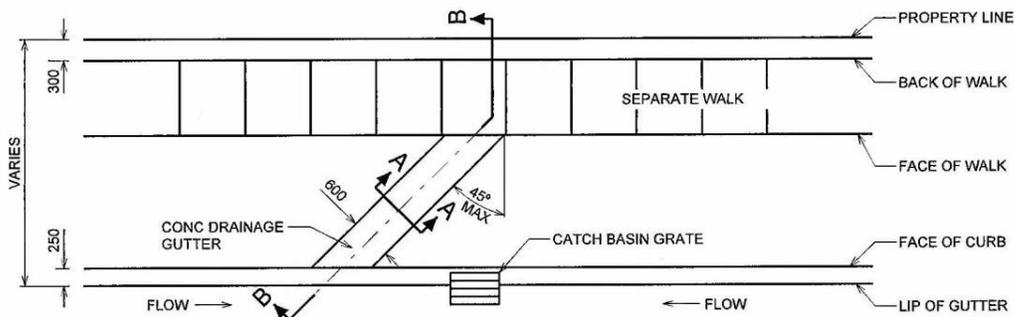


SECTION B - B

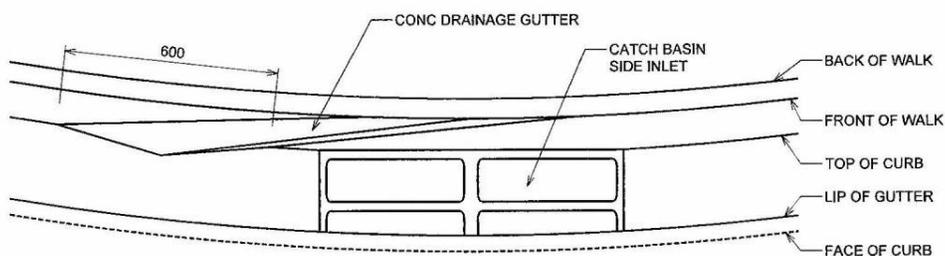
NOTES:

1. ON ROAD WITH GRADE > 3% THE GUTTER MUST BE "ANGLED" TO ALLOW BETTER FLOW.
2. TYPE 'C' JOINT DETAIL REQUIRED WHEN TYING DRAINAGE GUTTER TO SIDEWALK AND CURB & GUTTER. REFER TO DRAWING 454.1015.006.
3. CONCRETE AS SET OUT UNDER STANDARD SPECIFICATIONS - SEWER CONSTRUCTION SECTION 403.1008 OR UNDER ROADS CONSTRUCTION STANDARD SPECIFICATION CHAPTER 310.

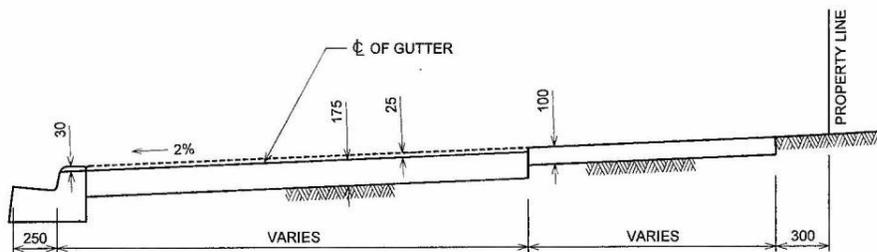
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd						
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-15 PERMIT NUMBER: P 08428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541013\USTN\4541013015_v6.dgn 05-JAN-2015 11:16 ISC: UNRESTRICTED			Drawn: JL, Date: 2014-11 Designed: EW Checked: EW Scale: NTS			BOULEVARD DRAINAGE CROSSING FOR SEPARATE SIDEWALK			Figure: 46 File Number: 454.1013.015		



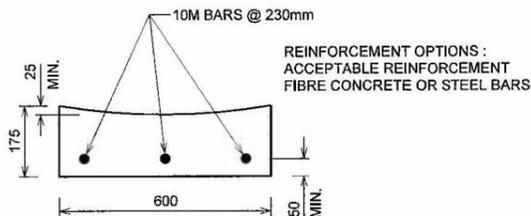
PLAN VIEW



PROFILE VIEW



SECTION B-B

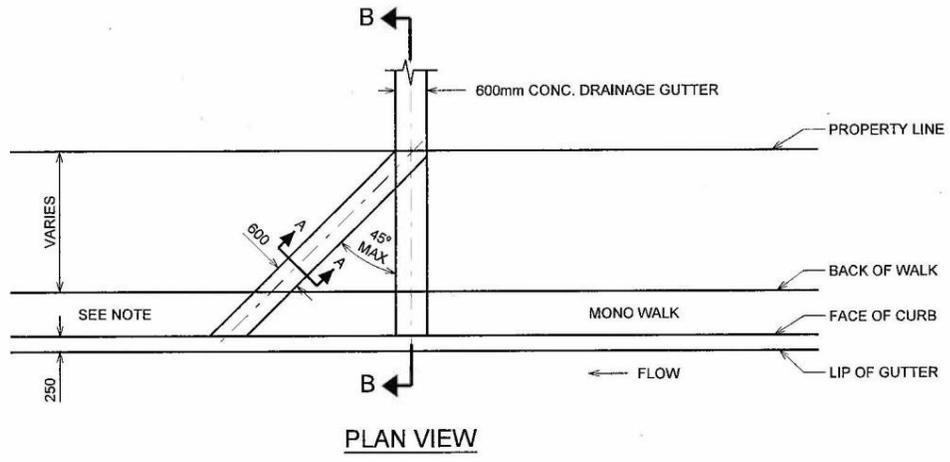


SECTION A-A

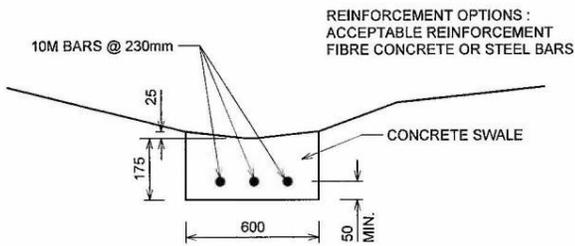
- NOTES:
1. ON ROAD WITH GRADE > 3% THE GUTTER MUST BE "ANGLED" TO ALLOW BETTER FLOW.
 2. TYPE 'C' CONSTRUCTION DETAIL REQUIRED WHEN TYING DRAINAGE GUTTER TO SIDEWALK AND CURB & GUTTER. REFER TO DRAWING 454.1015.006.
 3. CONCRETE AS SET OUT UNDER STANDARD SPECIFICATIONS - SEWER CONSTRUCTION SECTION 403.1008 OR UNDER ROADS CONSTRUCTION STANDARD SPECIFICATION CHAPTER 310.

No.		Date		Revision		App'd No.		Date		Revision		App'd	
PERMIT		SEAL		THE CITY OF CALGARY		ROADS		Drawn J.L.		Date 2014-11		Figure 47	
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: 2015-04-15 PERMIT NUMBER: 04426 The Association of Professional Engineers and Geoscientists of Alberta		PROFESSIONAL ENGINEER [Seal]		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC		Checked: EW Scale: NTS		BOULEVARD DRAINAGE CROSSING FOR SEPARATE SIDEWALK AT TRAPPED LOW		File Number 454.1013.019	
Z:\permanent\Std\RoadSpecs_2014\Drawing Files\4541013\USTN\4541013019_v6.dgn		03-MAR-2015 13:48		ISC: UNRESTRICTED									

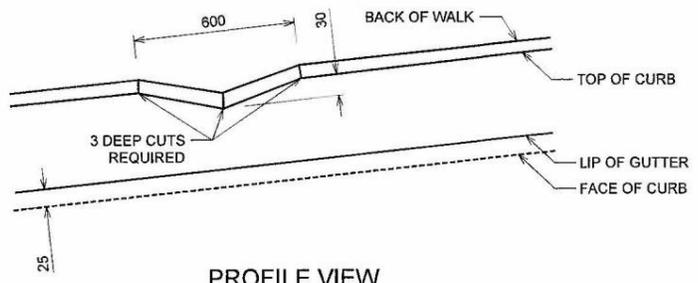
Figure 48: BOULEVARD DRAINAGE CROSSING FOR MONOLITHIC SIDEWALK (454.1013.016)



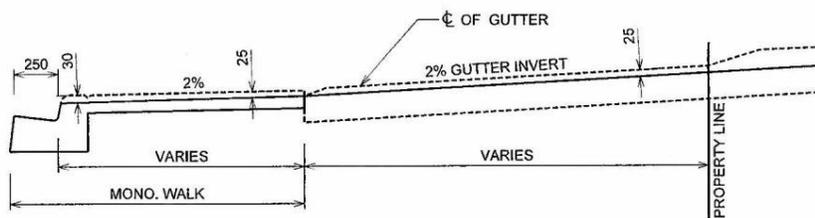
PLAN VIEW



SECTION A - A



PROFILE VIEW

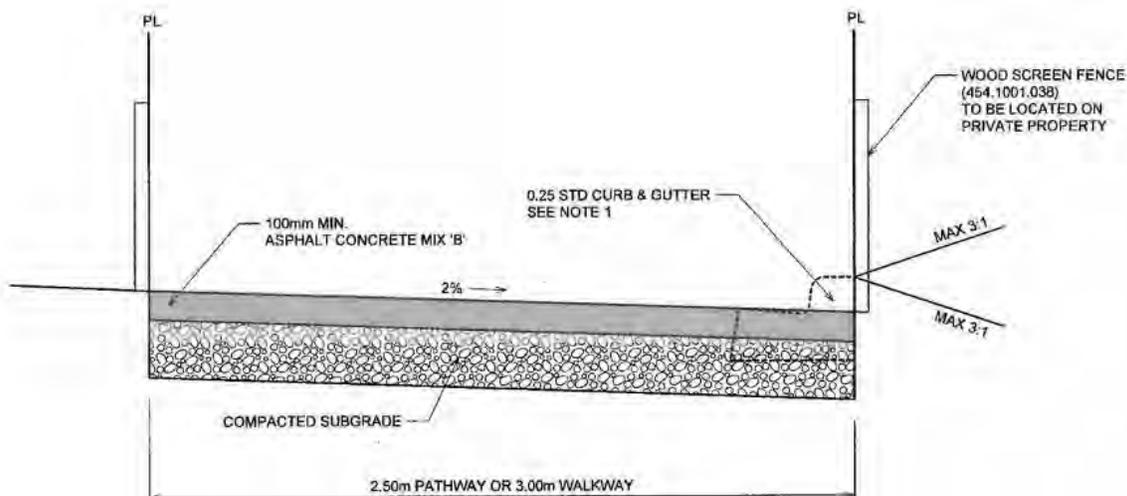


SECTION B-B

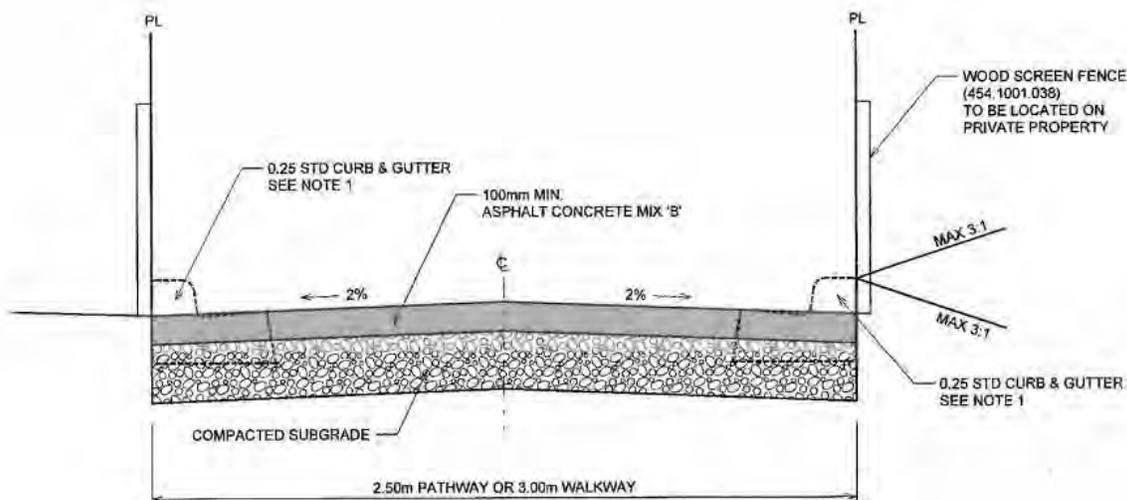
NOTES:

1. ON ROAD WITH GRADE > 3% THE GUTTER MUST BE "ANGLED" TO ALLOW BETTER FLOW.
2. TYPE 'C' JOINT DETAIL REQUIRED WHEN TYING DRAINAGE GUTTER TO SIDEWALK AND CURB & GUTTER. REFER TO DRAWING 454.1015.006.
3. CONCRETE AS SET OUT UNDER STANDARD SPECIFACATIONS SEWER CONSTRUCTION SECTION 403.1008 OR UNDER ROADS COSTRUCTION STANDARD SPECIFACATIONS CHARPTER 310.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-16 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		THE CITY OF CALGARY ROADS		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		BOULEVARD DRAINAGE CROSSING FOR MONOLITHIC SIDEWALK				Figure 48 File Number 454.1013.016
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\pmanent\SidRoadSpecs_2014\Drawing Files\4541013\UST1N4541013016_v8.dgn 06-JAN-2015 11:28 ISC: UNRESTRICTED												



SLOPED



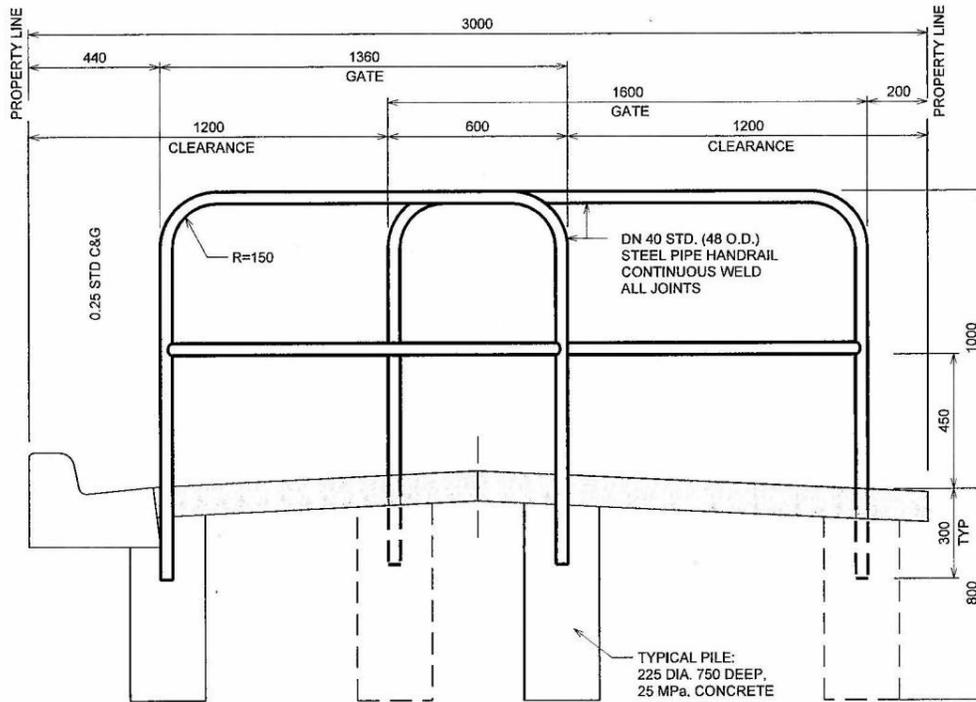
CROWNED

NOTES:

1. 250mm STD C&G SHALL BE INSTALLED AS REQUIRED FOR DRAINAGE CONTROL. THE FINAL GRADING SHALL BE DONE TO THE TOP OF CURB ELEVATION.
2. COMPACTED SUBGRADE MINIMUM 95% OF MAXIMUM DRY DENSITY.
3. FOR LOCAL AND REGIONAL PATHWAYS USE DRAWINGS 454.1005.010 AND 454.1005.016.
4. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

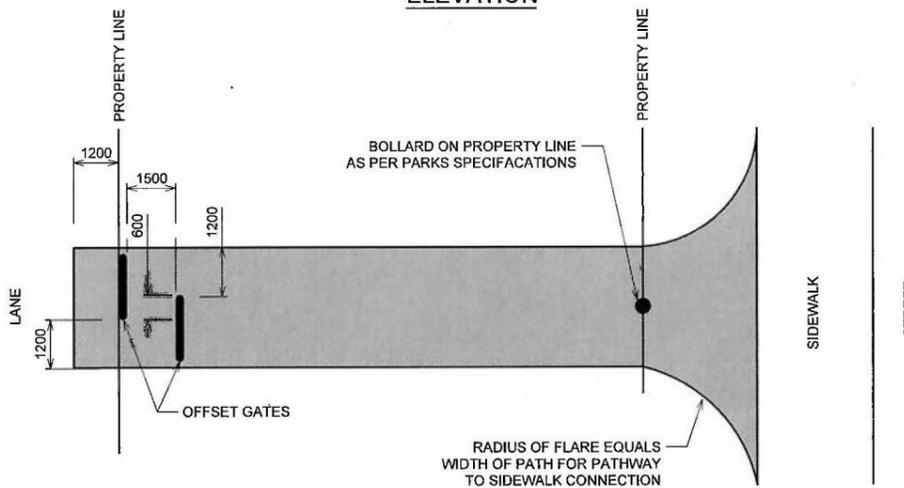
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd		
PERMIT PERMIT TO PRACTISE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2017/03/11 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL  2017/03/11		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		MBTRIC		Drawn: JL Date: 2016-11 Designed: EW Checked: EW Scale: NTS		Figure: 49 File Number: 454.1005.008	

Figure 50: WALKWAY OFFSET GATES (454.1002.003)



IF GUTTER ON ONE SIDE, SHORTEN ONE GATE FOR 1.2m CLEARANCE.
IF GUTTER ON BOTH SIDES, SHORTEN BOTH GATES FOR 1.2m CLEARANCE.

ELEVATION

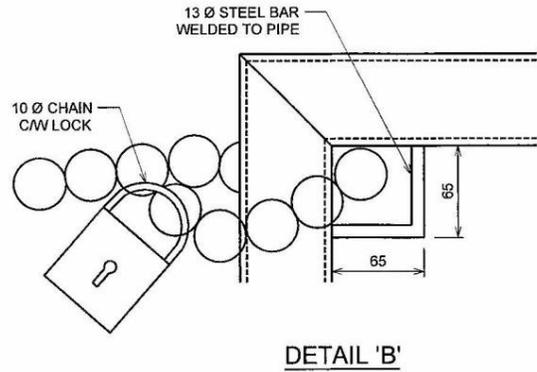
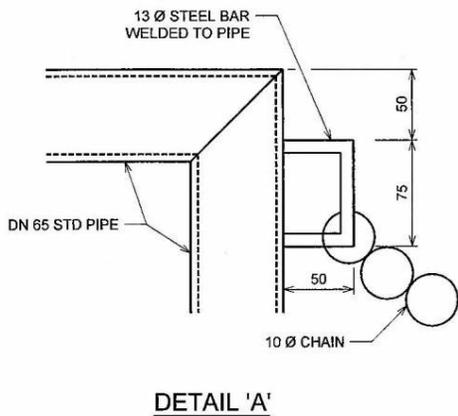
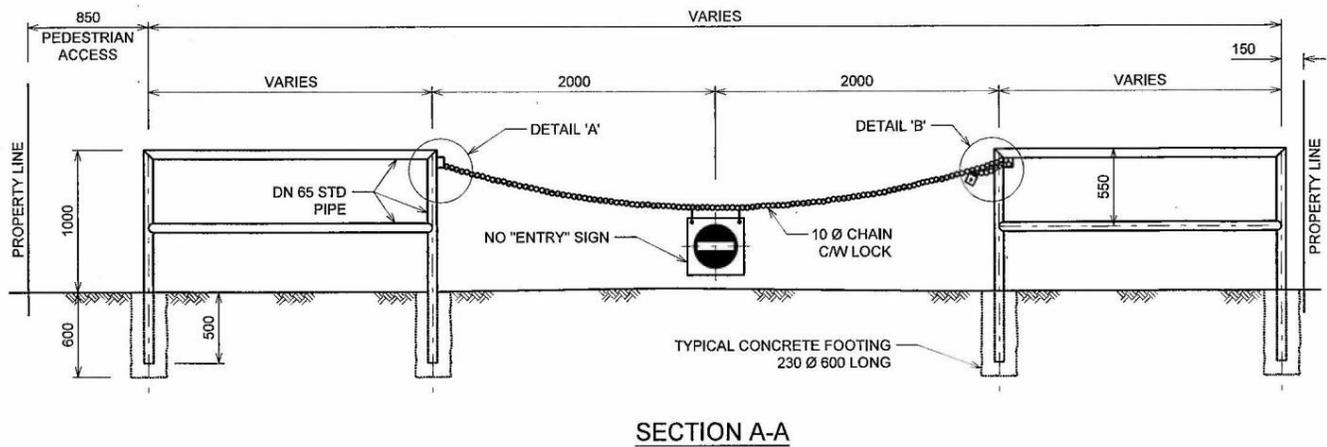
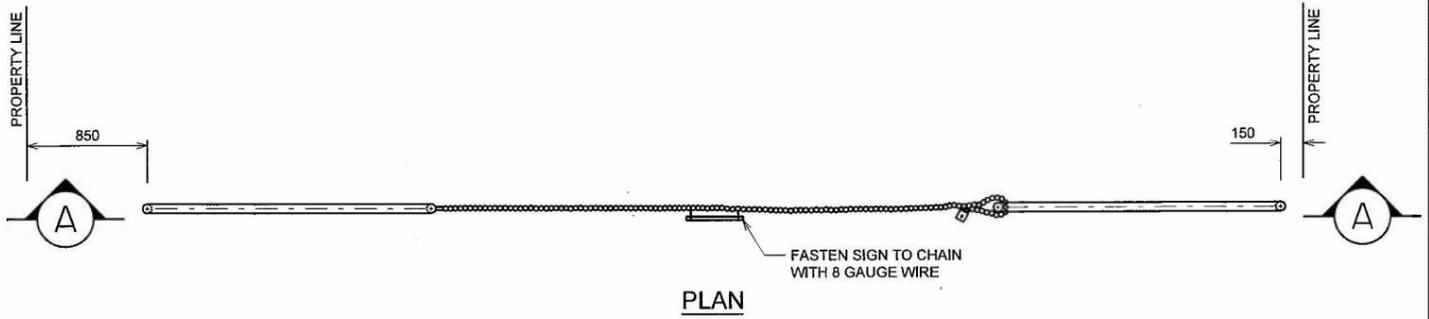


PLAN

NOTES:

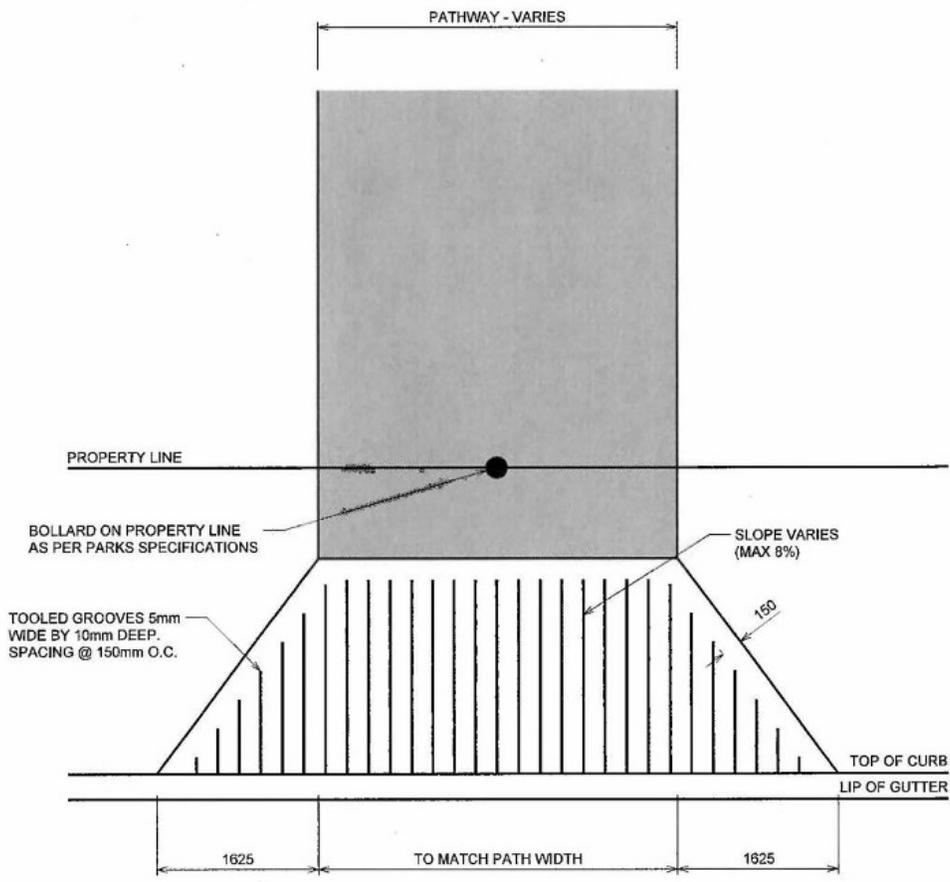
1. CHARACTERISTICS OF ASPHALTIC HOT MIX IDENTICAL AS DESCRIBED UNDER MAIN CONTRACT FOR THE CONSTRUCTION OF ASPHALT PAVEMENTS.
2. THE MAX. ALLOWABLE GRADE FOR ASPHALT WALKWAYS IS 12%. ABOVE THIS GRADE, APPROVED CONCRETE STEPS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE NATIONAL BUILDING CODE.
3. PAINTING - INSTALLED GATES TO RECEIVE ONE COAT METAL PRIMER & TWO COATS BRIGHT YELLOW PAINT. ANY DEVIATION FROM THE ABOVE SPECIFICATION TO BE APPROVED IN WRITING BY THE CITY ENGINEER.
4. MIN. SIDE SLOPE TO BE 3:1 OR APPROVED RETAINING WALL.
5. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revision	App'd No.	Date	Revision	App'd No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-13 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Scale: NTS		Drawn: JL Date: 2014-11 Designed: EW Checked: EW		WALKWAY OFFSET GATES			Figure: 50 File Number: 454.1002.003

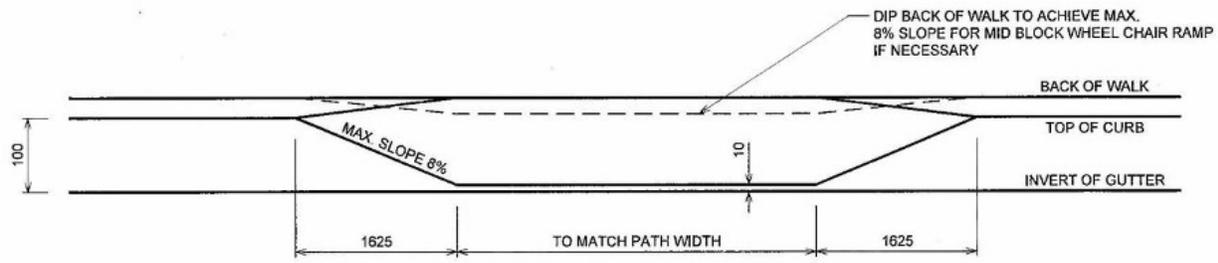


- NOTES:**
1. POSTS TO RECEIVE ONE COAT METAL PRIMER. TWO COATS WHITE PAINT.
 2. ALL JOINTS TO BE WELDED.
 3. ALL PIPE TO BE STANDARD WEIGHT.
 4. CHAIN TO BE 1.00m LONGER THAN OPENING.
 5. SIGN TO BE SUPPLIED BY TRAFFIC DIVISION.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																																			
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PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2014-11-11 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\SiteRoadSpecs_2014\Drawing Files\4541002\USTN\4541002005_v8.dgn 20-NOV-2014 08:18 ISC - UNRESTRICTED	Drawn	JL	Date	2014-11	LANE CHAIN CLOSURE	Figure 52																																						
			Designed	EW																																										
			Checked	EW																																										
			Scale:	NTS																																										
								File Number	454.1002.005																																					



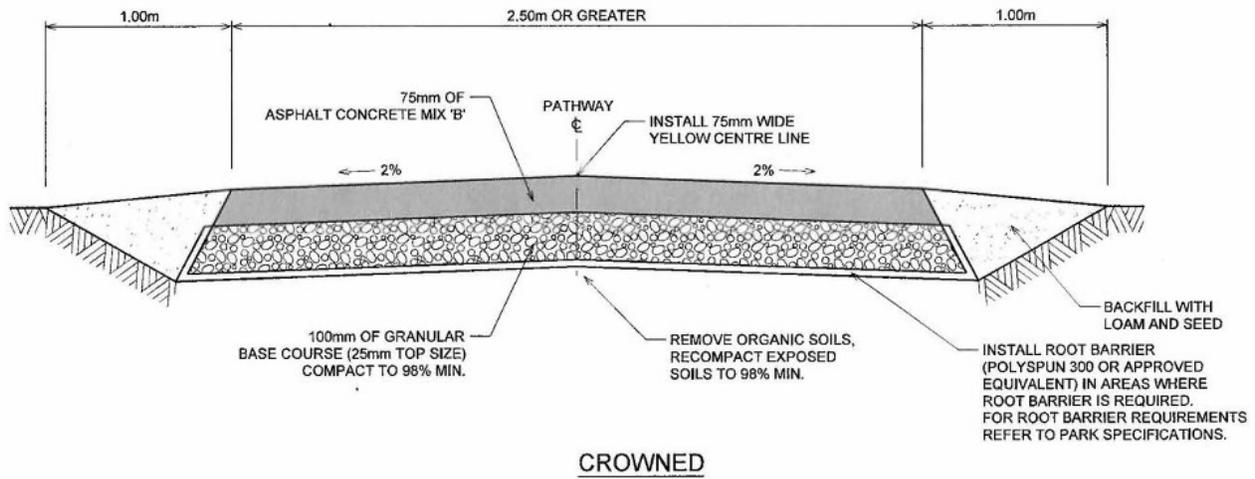
PLAN



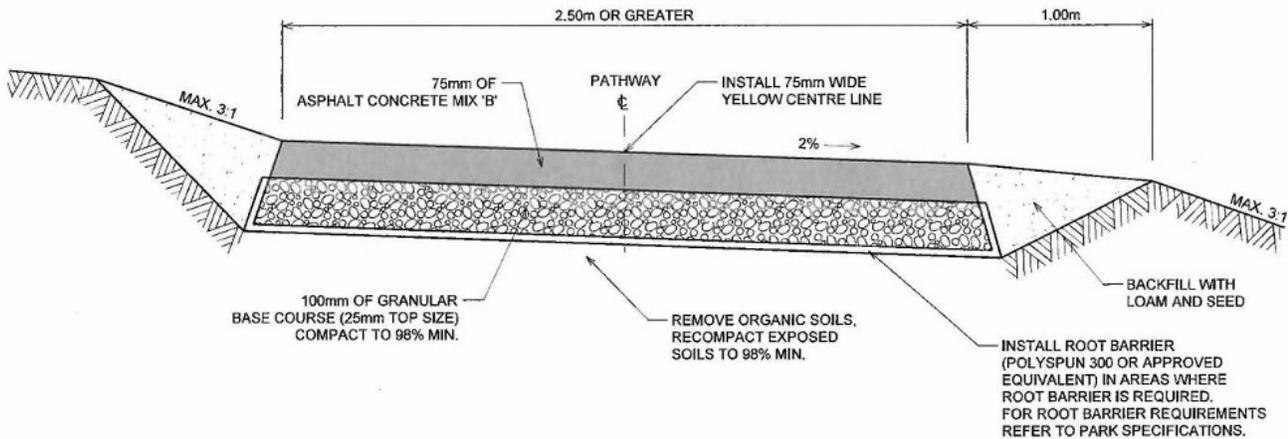
ELEVATION

- NOTES:
1. WHEN PATH WIDTH EXCEEDS 3000mm LOCATE BOLLARDS AT 1500mm ON CENTRE.
 2. PATHWAYS THAT LEAD TO A PARK SPACE MAY REQUIRE A REMOVABLE BOLLARD.
 3. PATHWAYS (WALKWAY) THAT CONNECT ROADWAYS REQUIRE A FIXED BOLLARD.
 4. PATHWAYS IN AN OPEN AREA REQUIRE FIXED BOLLARDS.
 5. PATHWAYS / EMERGENCY ACCESS (4.0m OR GREATER) USE BREAK-AWAY POSTS (454.1001.015).
 6. FOR SEPARATE WALK, CONCRETE PATH CONNECTION IS REQUIRED FROM SEPARATE WALK TO BACK OF WHEEL CHAIR RAMP.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Jan 15 PERMIT NUMBER: 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL  2015/03/01		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\pms\mnet\StdRoadSpecs_2014\Drawing Files\4541001\USTN4541001023_v6.dgn 18-MOV-2014 10:02 ISC: UNRESTRICTED		Drawn JL Date 2014-11 Designed EW Checked EW Scale: NTS		PATHWAY AND WHEEL CHAIR RAMP CONNECTION		Figure 53 File Number 454.1001.023



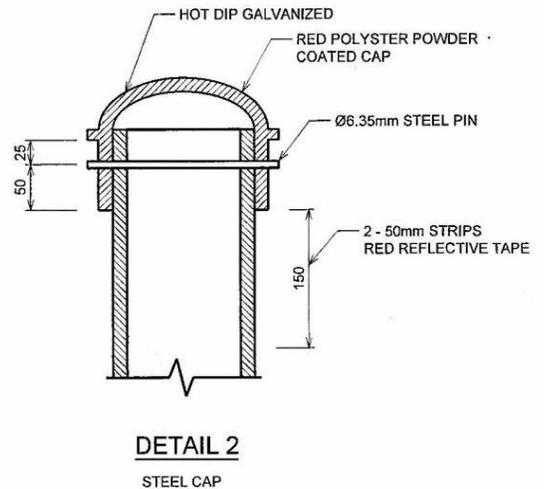
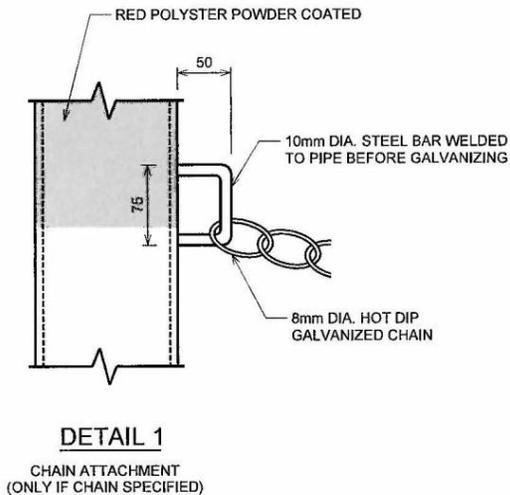
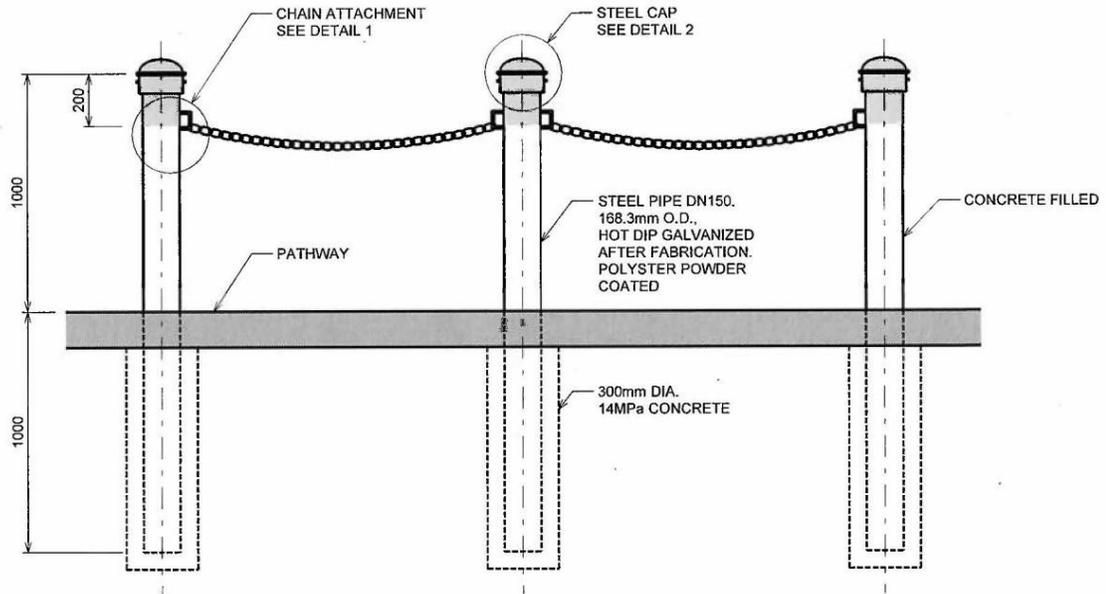
CROWNED



SLOPED

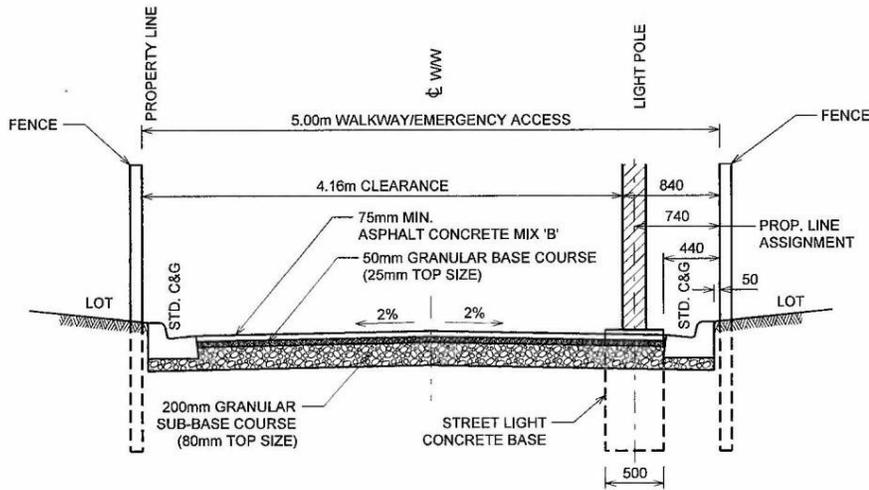
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-15 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		 2015/03/01		 THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		REGIONAL PATHWAY		Figure 55 File Number 454.1005.016

Figure 56: STEEL BOLLARD DETAILS (454.1001.035)

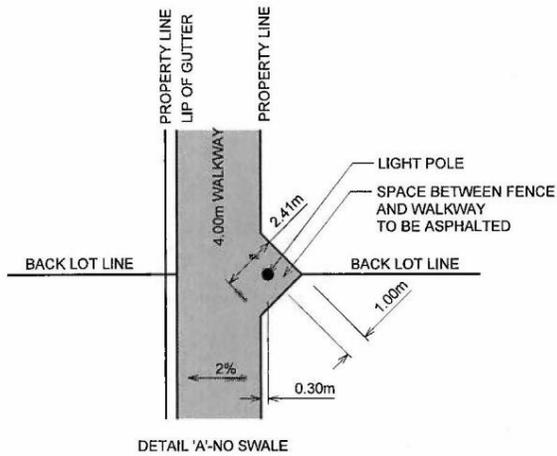
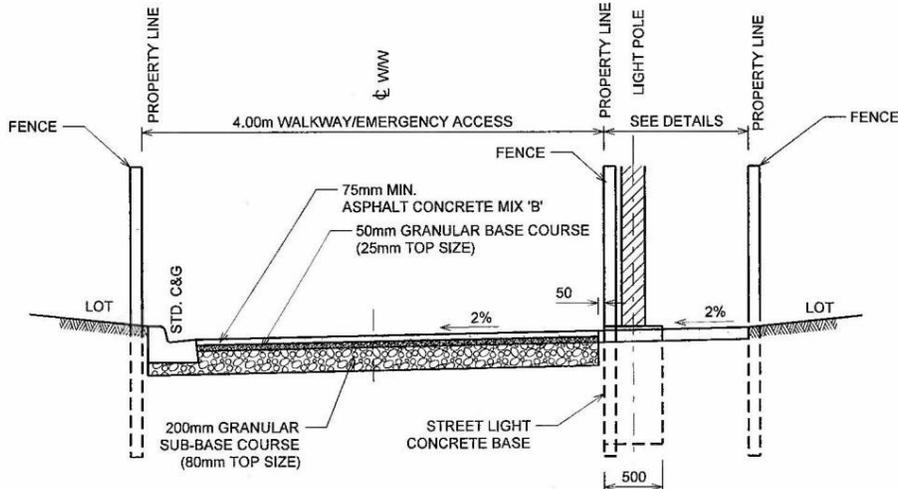


- NOTES:
1. FOR REMOVABLE BOLLARD DETAIL REFER TO PARK SPECIFICATIONS.
 2. SPACING BETWEEN BOLLARDS TO BE DETERMINED IN FIELD.
 3. EXTERIOR OF PIPE TO BE BRUSH BLASTED TO SSPC-SP7 STANDARD.
 4. CHAIN TO BE 0.25m LONGER THAN PIPE SPACING.
 5. FOR BOLLARDS IN WALKWAYS OR REGIONAL PATHWAYS REFER TO PARK SPECIFICATIONS.

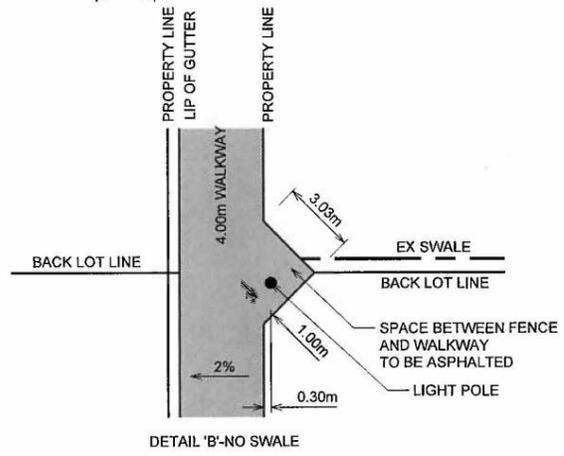
No.	Date	Revision	App'd No.	Date	Revision	App'd No.	Date	Revision	App'd
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: 29/10/2015 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL PROFESSIONAL ENGINEER ALBERTA 2015/03/10		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541001\USTN\4541001035_v8.dgn 25-FEB-2015 09:31 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		Figure 56 File Number 454.1001.035	



PROPOSED 5.00m WALKWAY/EMERGENCY ACCESS WITH C&G



DETAIL 'A'-NO SWALE



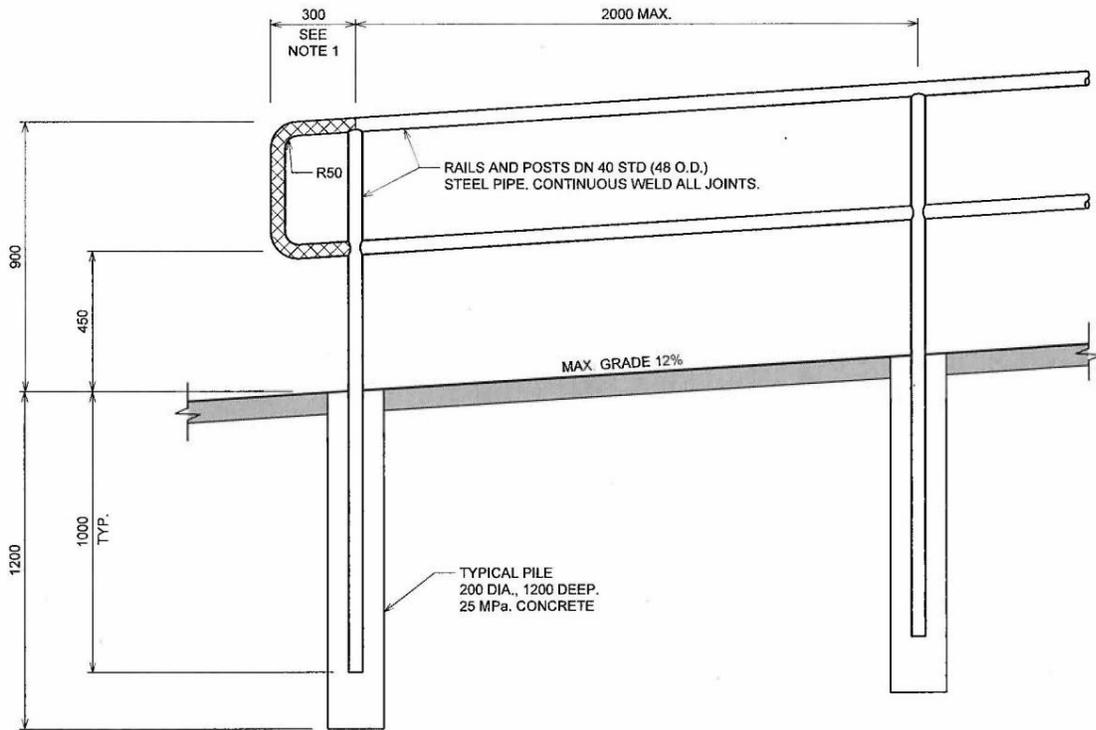
DETAIL 'B'-NO SWALE

PROPOSED 4.00m WALKWAY/EMERGENCY ACCESS WITH POCKET EASEMENT

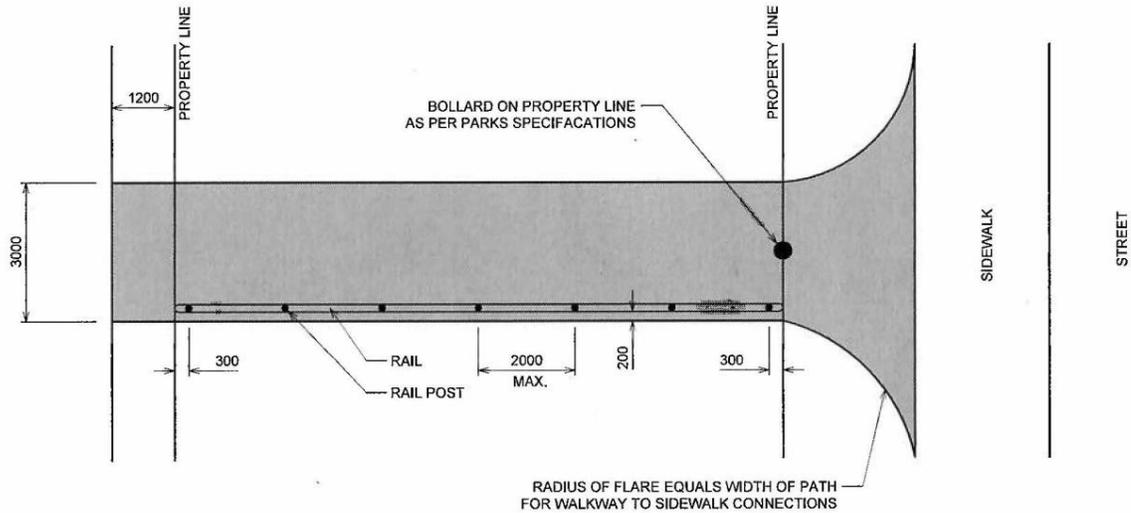
NOTES:

1. WATER RESOURCES WILL PERMIT ZERO HORIZONTAL SEPARATION BETWEEN AN ENCASED WATERMAIN ALIGNMENT AND WALKWAY/EMERGENCY ACCESS WITH STREETLIGHTING WHERE NECESSARY TO MINIMIZE THE EASEMENT ENCUMBRANCES ON ADJOINING LOTS.
2. SPECIFICATIONS ARE TO MIN. STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR GRAVEL BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd							
<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:15%; vertical-align: top;"> PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015-11-11</i> PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta </td> <td style="width:15%; text-align: center;">  2015-11-11 </td> <td style="width:20%; text-align: center;">  THE CITY OF CALGARY ROADS </td> <td style="width:10%; text-align: center;"> DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric </td> <td style="width:10%; text-align: center;"> Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS </td> <td style="width:40%; text-align: center;"> WALKWAY WITH EMERGENCY ACCESS </td> <td style="width:10%; text-align: center;"> Figure 57 File Number 454.1005.015 </td> </tr> </table>												PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015-11-11</i> PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta	 2015-11-11	 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	WALKWAY WITH EMERGENCY ACCESS	Figure 57 File Number 454.1005.015
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>2015-11-11</i> PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta	 2015-11-11	 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	WALKWAY WITH EMERGENCY ACCESS	Figure 57 File Number 454.1005.015												



ELEVATION

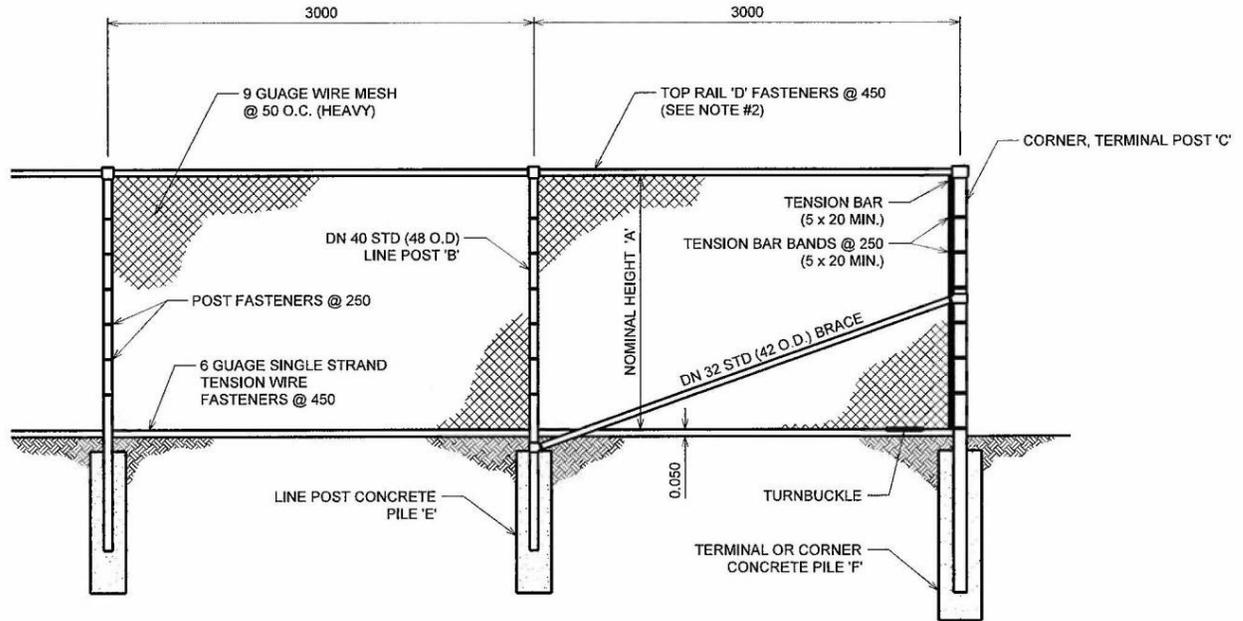


PLAN

NOTES:

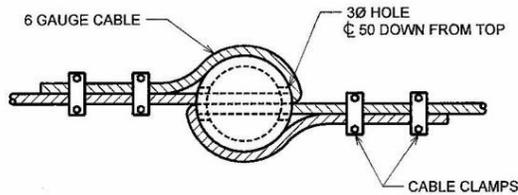
1. HANDRAIL TEXTURE TO CHANGE IN FINAL 300mm TO WARN USERS WITH VISUAL INPAIRMENTS THAT THEY ARE APPROACHING THE END.
2. FOR CROSS-FALLED WALKWAY HANDRAIL TO BE LOCATED ON HIGH SIDE. FOR CROWNED WALKWAY HANDRAIL ON EITHER SIDE.
3. 200mm MIN. CLEARANCE REQ'D FROM HANDRAIL TO PROPERTY LINE.
4. CROWNED WALKWAY DESIGN TO BE USED WHERE HANDRAIL & LIGHT POLE ARE REQUIRED.
5. BARRICADE TO RECEIVE ONE COAT METAL PRIMER & TWO COATS PAINT. ANY DEVIATION FROM THE ABOVE SPECIFICATIONS TO BE APPROVED IN WRITING BY THE CITY ENGINEER.
6. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLBA, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-3-10 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL  PROFESSIONAL ENGINEER CIVIL 2015/03/10		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\p\manant\StdRoadSpecs_2014\Drawing Files\4541001\USTN\4541001034_v8.dgn 05-JAN-2015 12:12 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		WALKWAY HANDRAIL		Figure: 58 File Number: 454.1001.034	

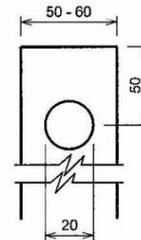


NOMINAL HEIGHT 'A'	POST SIZE				TOP RAILS 'D'	
	LINE POST 'B'		END, CORNER, STRAIN POST 'C'		OUTSIDE DIAMETER	WEIGHT (kg/m)
	HEAVY	MEDIUM	HEAVY	MEDIUM		
1000		1750		2100	30	2.50
1250		2100		2400	30	2.50
1400	2400			2700	45	3.40
1800	2700			3000	45	3.40
OUTSIDE DIAMETER	60	50	90	75		
WEIGHT (kg/m)	5.40	4.10	11.30	8.60		

PILES (15 MPa CONCRETE)			
LINE POST 'E'		TERMINAL OR CORNER POST 'F'	
DIAMETER	DEPTH	DIAMETER	DEPTH
250	1000	300	1200



DETAIL OF CORNER AND STRAINING POSTS
PLAN VIEW



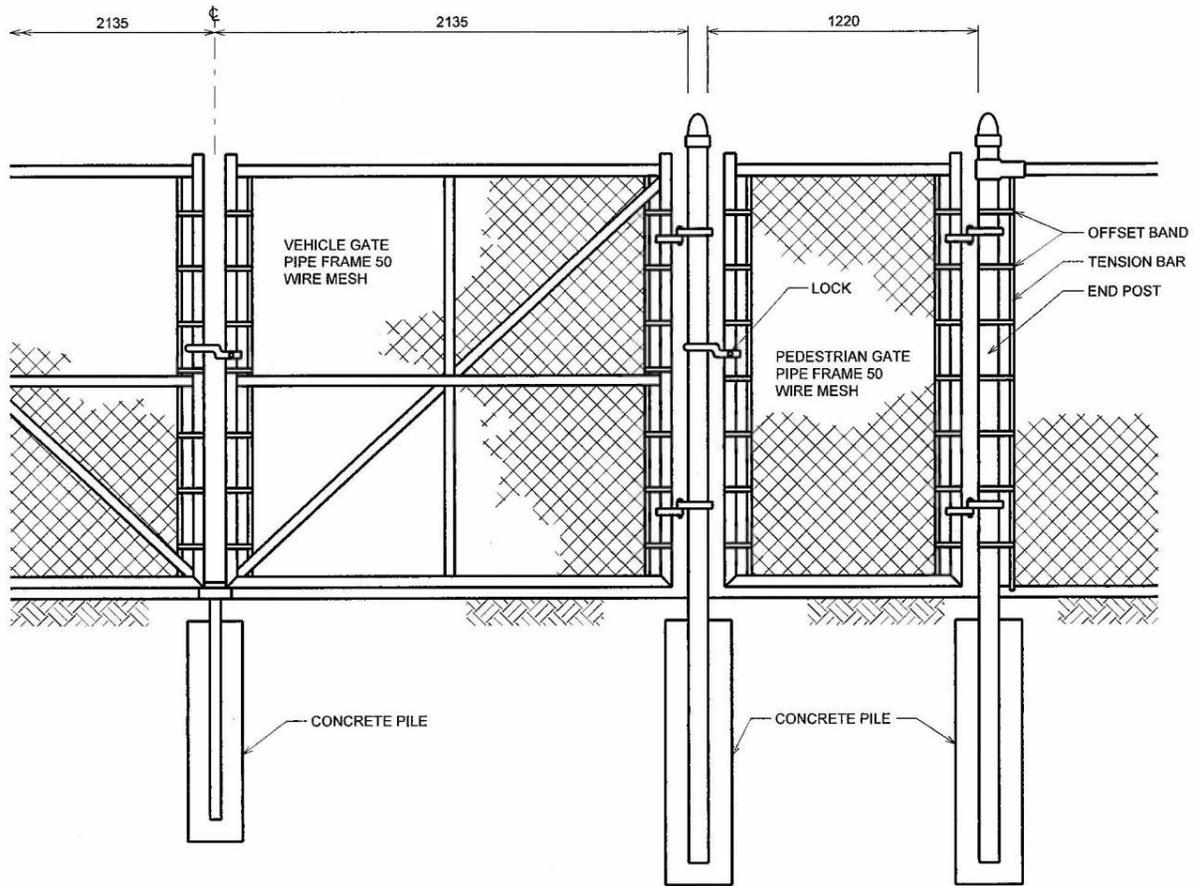
DETAIL OF INTERMEDIATE POST
SIDE VIEW

NOTES:

1. STRAIN POST SHALL BE INSTALLED AT A SPACING OF 150m OR LESS WITH BRACES SIMILAR TO THOSE USED AT END AND CORNER POSTS (SEE TABLE 'C'). THE PILES SHALL BE THE SAME AS FOR CORNER OR END POSTS. FENCING SHALL BE GALVANIZED STEEL.
2. FOR FENCE APPLICATIONS IN MEDIAN ON DIVIDED ROADWAYS, TOP RAIL TO BE REPLACED WITH 6 GAUGE SINGLE STRAND TENSION WIRE, FASTENERS @ 450. CABLE TO BE FASTENED TO STRAIN POST BY LOOPING CABLE AND USING APPROPRIATE SIZE CABLE CLAMP (SEE DETAIL).

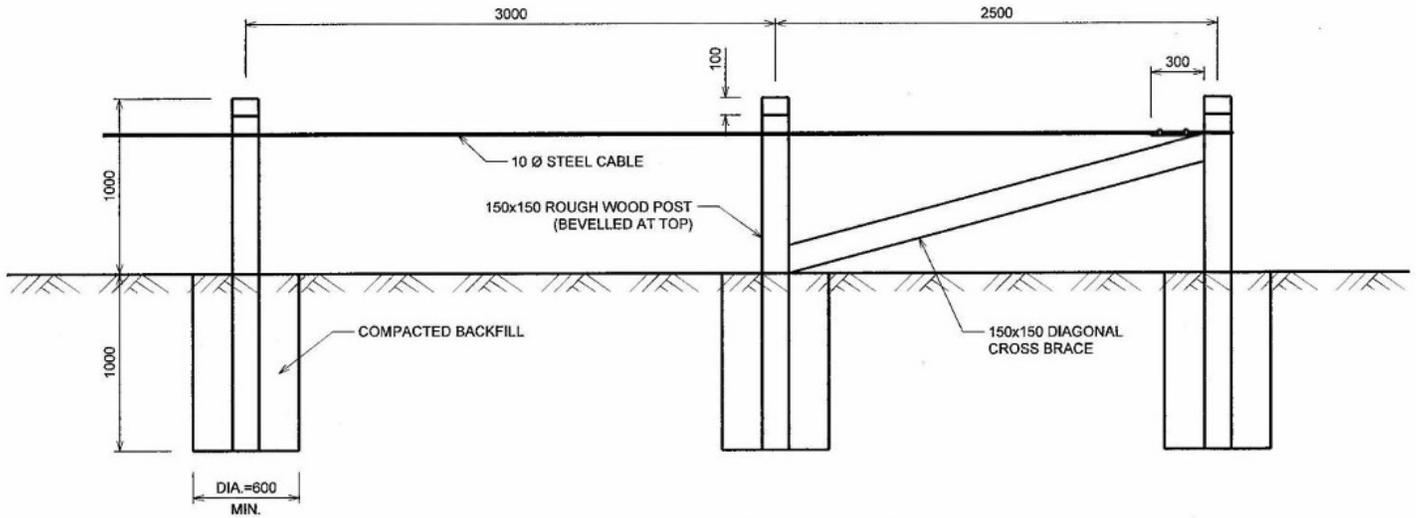
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 Jun 15 PERMIT NUMBER: P4429 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 2015/05/01		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541001\U5TN4541001004_v8.dwg 05-JAN-2015 13:15 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		Figure 59 File Number 454.1001.004	

Figure 60: CHAIN LINK FENCE GATE (454.1001.024)

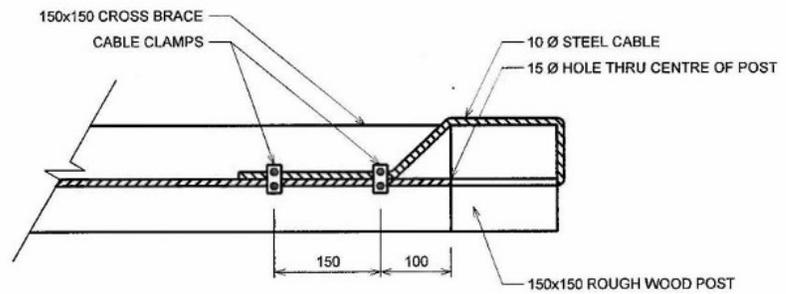
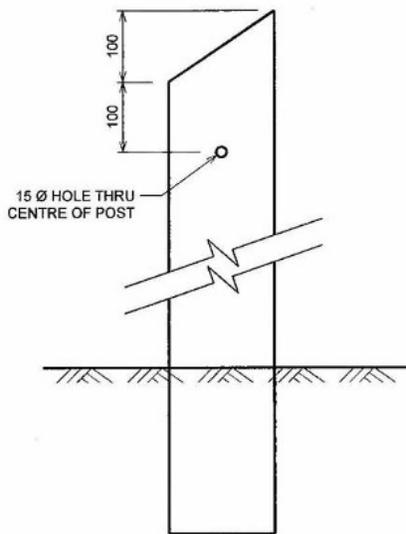


NOTE:
PILES AND POST SIZES PER STANDARD DRAWING 454.1001.004.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd							
<table border="1" style="width: 100%;"> <tr> <td style="width: 15%;"> PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-12-28-16 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta </td> <td style="width: 15%; text-align: center;">  2015/03/01 </td> <td style="width: 20%; text-align: center;">  THE CITY OF CALGARY ROADS </td> <td style="width: 15%; text-align: center;"> DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC </td> <td style="width: 15%;"> Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS </td> <td style="width: 20%; text-align: center;"> CHAIN LINK FENCE GATE </td> <td style="width: 10%; text-align: center;"> Figure 60 File Number 454.1001.024 </td> </tr> </table>												PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-12-28-16 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta	 2015/03/01	 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	CHAIN LINK FENCE GATE	Figure 60 File Number 454.1001.024
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-12-28-16 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta	 2015/03/01	 THE CITY OF CALGARY ROADS	DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	CHAIN LINK FENCE GATE	Figure 60 File Number 454.1001.024												
<small>Z:\permanent\SisRoadSpecs_2014\Drawing Files\4541001\USTN\4541001024_v8.dgn 03-MAR-2015 13:51 ISC: UNRESTRICTED</small>																		



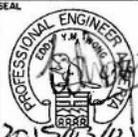
ELEVATION

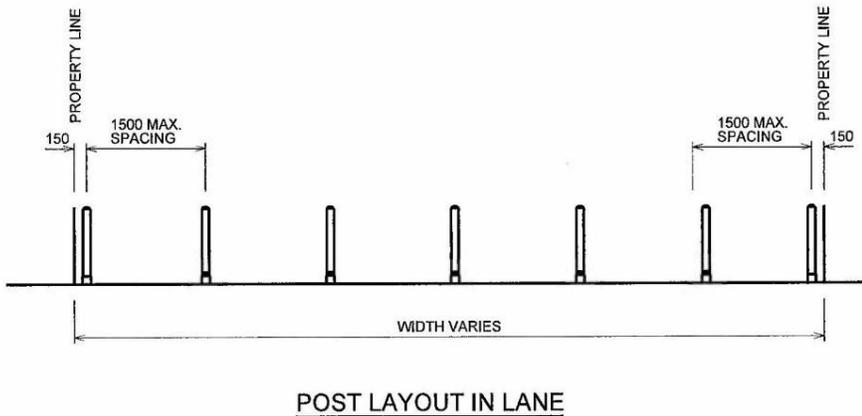
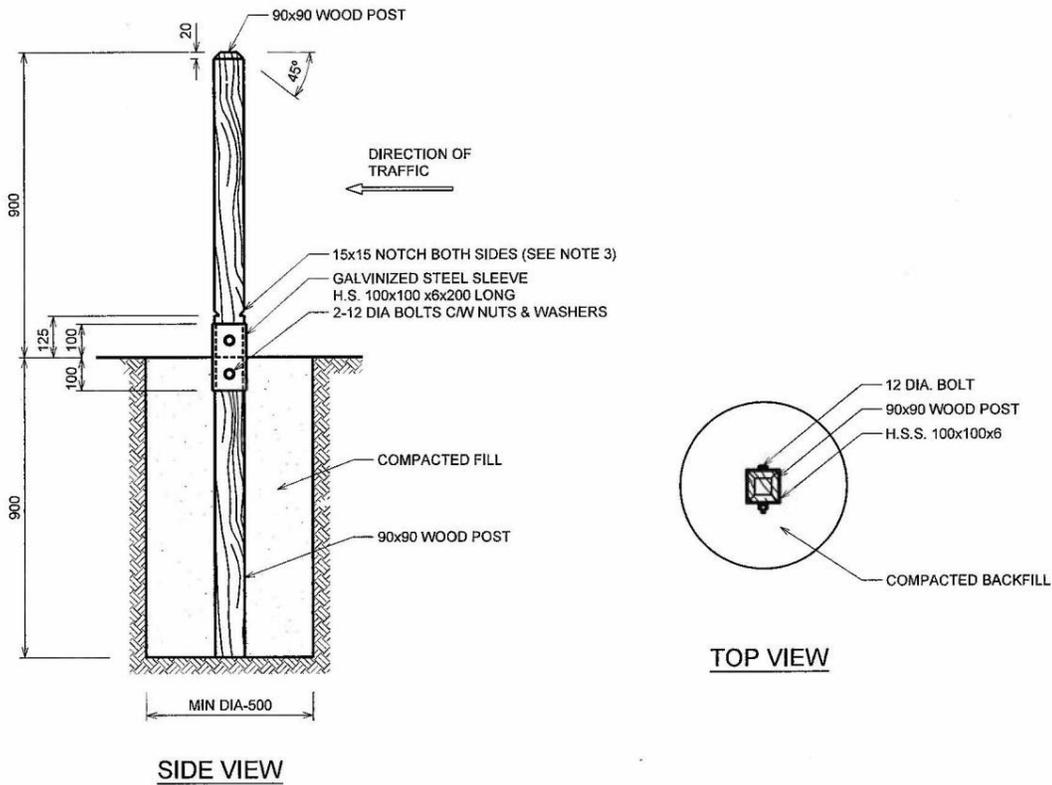


PLAN VIEW AT END POST

NOTES:

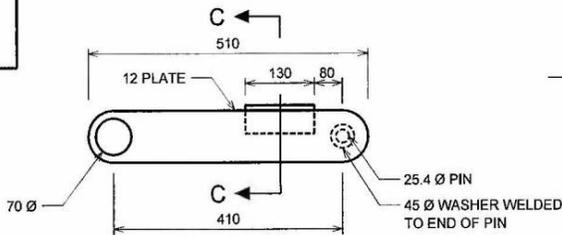
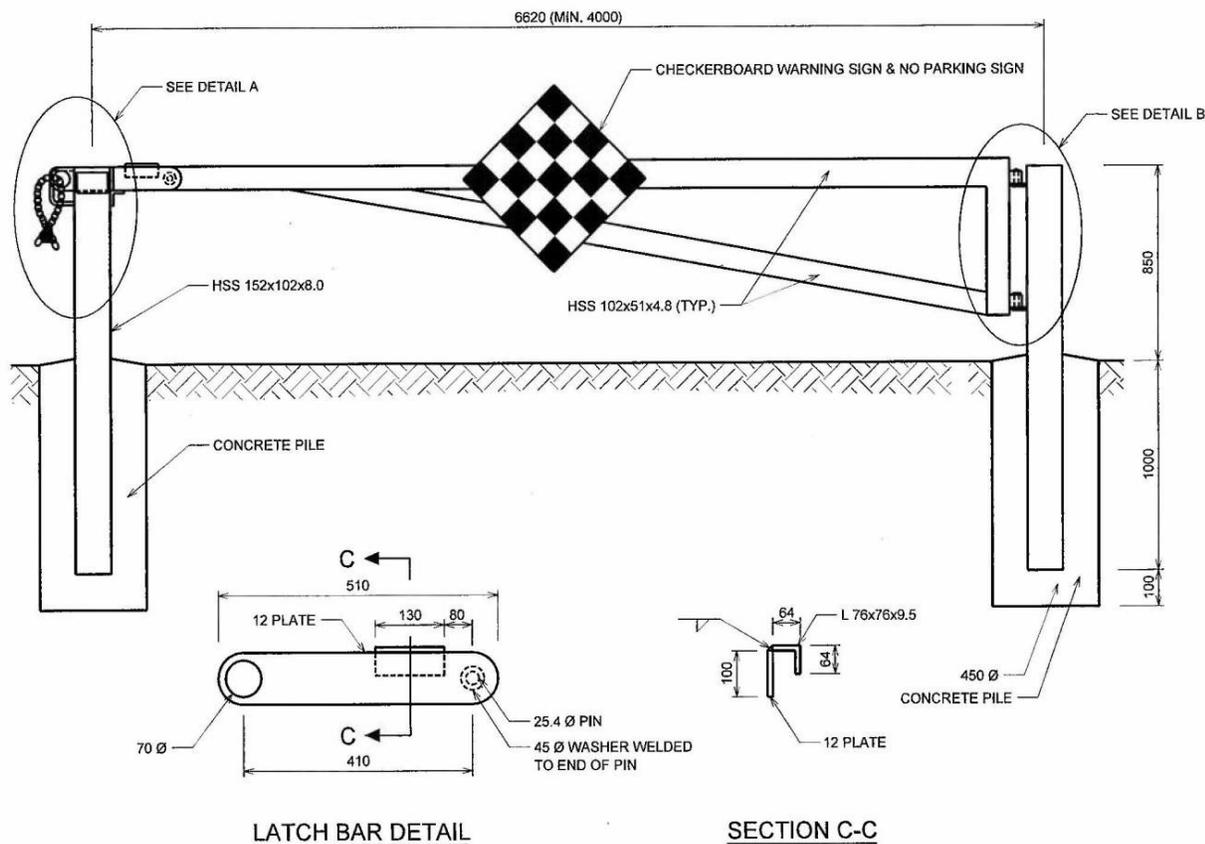
1. ALL LUMBER SHALL BE ROUGH CUT, No. 2 CONSTRUCTION GRADE, KILN DRIED AND PRESSURE TREATED TO C.S.A. 080 WITH ALKALINE COPPER QUAT (A.C.Q.).
2. ALL STEEL CABLES AND CLAMPS SHALL BE HOT DIPPED GALVANIZED TO C.S.A. G164 OR AS SPECIFIED. PROVIDE SUFFICIENT TENSION ON STEEL CABLE TO ELIMINATE SAG.
3. TREAT ALL NEW CUTS WITH A.C.Q.
4. COLOR OF REPLACEMENT POSTS SHALL BE CONSISTENT WITH THE REMAINDER OF THE POSTS.
5. PROVIDE MAX. 1.50m POST SPACING WHEN CABLE OR CHAIN IS NOT USED.
6. MIN. 1.50m POST SPACING FOR PEDESTRIAN OPENINGS.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-10-15 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta				 THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\641001\USTN\4541001013_0.dwg 05-JAN-2015 13:10 ISC - UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		Figure 61 File Number 454.1001.013	
POST AND CABLE FENCE											

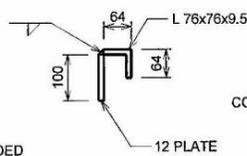


- NOTES:**
- EMERGENCY BREAK-AWAY POST IS COMPOSED OF TWO SEPERATE WOOD POSTS, EACH 900 LONG.
 - ALL WOOD TO BE PRESSURE TREATED.
 - DO NOT NOTCH END POST.
 - INSTALL POSTS AT 1500 O.C. UNLESS OTHERWISE SPECIFIED.
 - USE BREAK-AWAY POSTS FOR EMERGENCY ACCESS/WALKWAY.

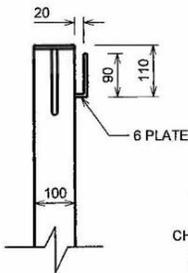
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015.12.15 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		PROFESSIONAL ENGINEER SEAL 2015/03/01	THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\p\m\mnt\StdRoadSpecs_2014\Drawing Files\4541001\USTN\4541001015_v8.dgn 18-NOV-2014 15:13 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	EMERGENCY BREAK AWAY FENCE			Figure: 62 File Number: 454.1001.015



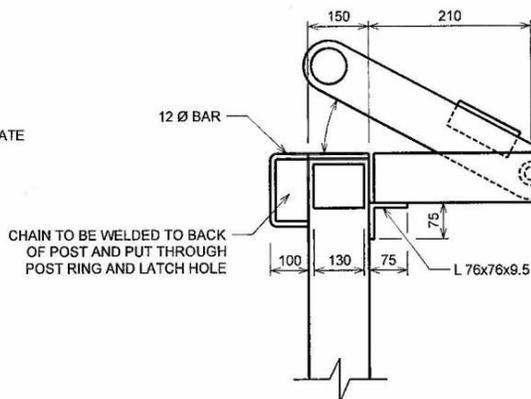
LATCH BAR DETAIL



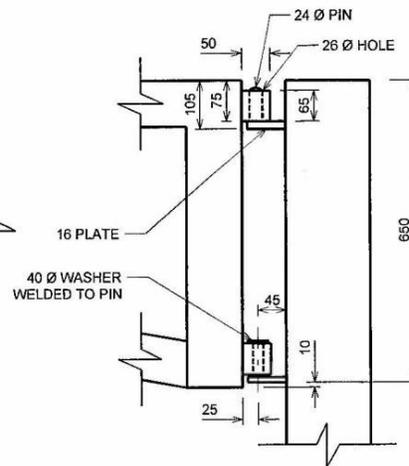
SECTION C-C



ELEVATION END VIEW DETAIL



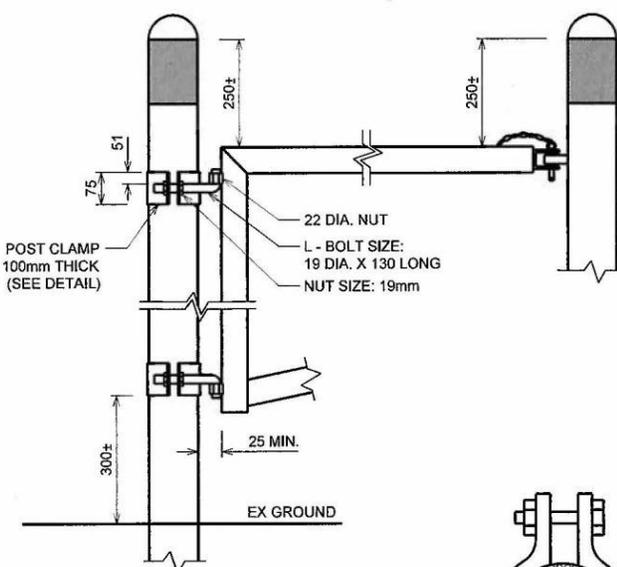
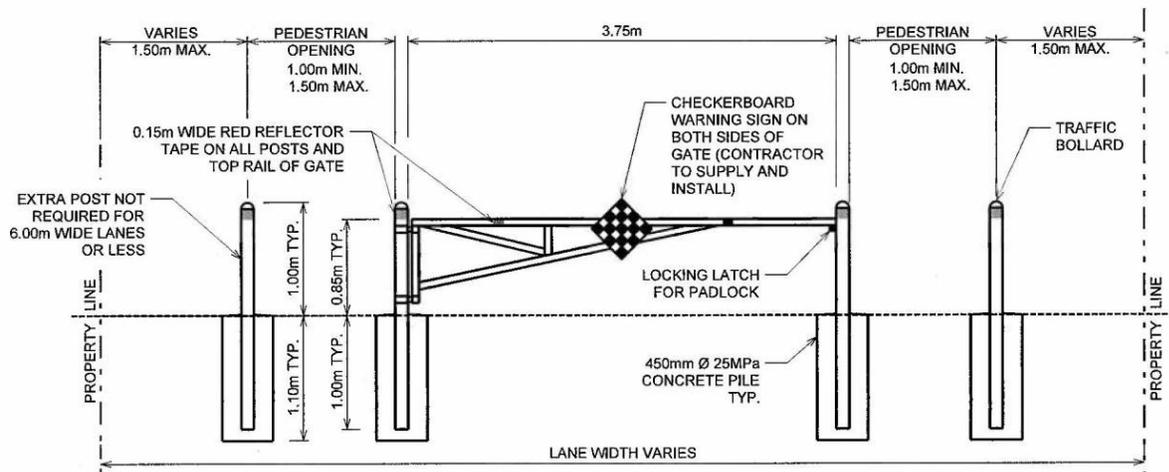
DETAIL A



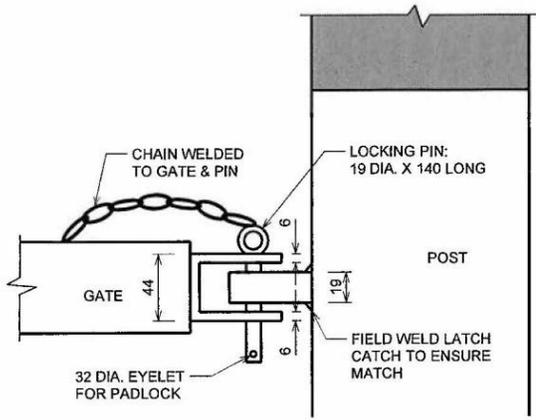
DETAIL B

- NOTES:
- CONCRETE STRENGTH:
 - PILE'S SHALL HAVE A MIN. COMPRESSIVE STRENGTH OF 25 MPa AT 28 DAYS.
 - STEEL:
 - STRUCTURAL STEEL SHALL CONFORM TO C.S.A. SPEC. G 40.21M GRADE 300W
 - HOLLOW STRUCTURAL SECTIONS SHALL CONFORM TO C.S.A. STANDARDS G 40.20M GRADE 350W
 - ALL WELDING SHALL CONFORM TO C.S.A. SPEC. W 59
 - ALL WELDING TO BE GROUND SMOOTH
 - ALL EXPOSED OPEN ENDS TO BE CAPPED
 - POSTS AND GATE SHALL BE GALVANIZED IN ACCORDANCE WITH C.S.A. SPEC. G 164
 - ALL GALVANIZING SHALL BE DONE AFTER FABRICATION
 - ALL STEEL MEMBERS TO BE PAINTED RED & WHITE IN ALTERNATE BANDS 300 WIDE
 - PRIME COAT & FINISH COAT WITH HIGH SOLIDS EPOXY PAINT.
 - FOR LANE CLOSURE PROVIDE MIN. 1.00m OPENING FOR PEDESTRIAN ON THE SIDE.

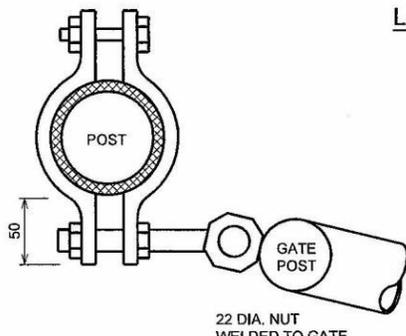
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd			
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-15 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\StdRoadSpecs_2014\Drawing Files\W41001\USTN\4541001027_v6.dgn 05-JAN-2015 12:18 ISC - UNRESTRICTED			Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS			Figure: 63 File Number: 454.1001.027		



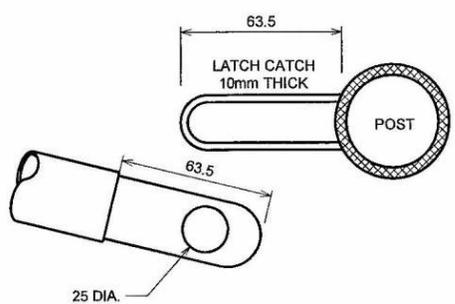
HINGE DETAILS - ELEVATION



LATCH DETAILS - ELEVATION



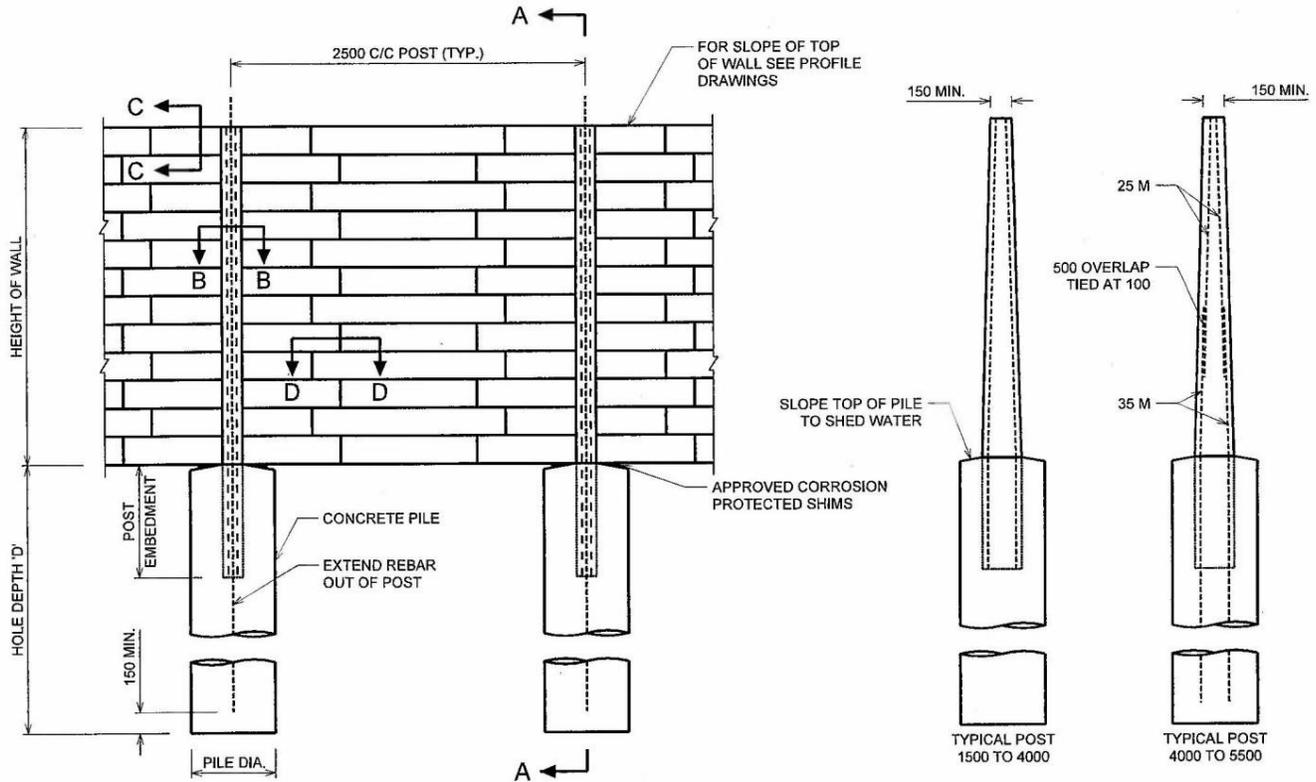
CLAMP DETAILS - PLAN VIEW



LATCH DETAILS - PLAN VIEW

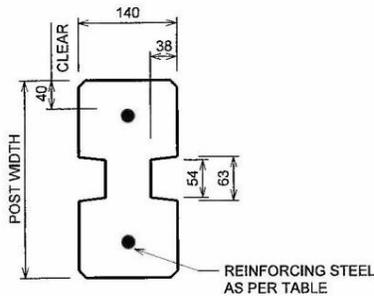
- NOTES:
1. ALL POSTS TO BE DN100 STD (114.3mm DIA.) HOT DIP GALVANIZED.
 2. GATE TO BE DN50 STD (60.3mm DIA.) HOT DIP GALVANIZED AFTER FABRICATION.
 3. ALL WELDING TO BE GROUND SMOOTH.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015 June 10 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL PROFESSIONAL ENGINEER J. M. WOODWARD 2015/103101		THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\SIGRoadSpecs_2014\Drawing Files\4541001\USTN\4541001031_v8.dgn 05-JAN-2015 13:21 ISC: UNRESTRICTED		Drawn JL Date 2014-11 Designed EW Checked EW Scale: NTS		Figure 64 File Number 454.1001.031	
LANE GATE CLOSURE											

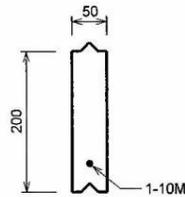


TYPICAL WALL ELEVATION

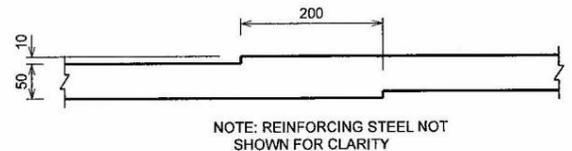
SECTION A - A



SECTION B - B



SECTION C - C



SECTION D - D

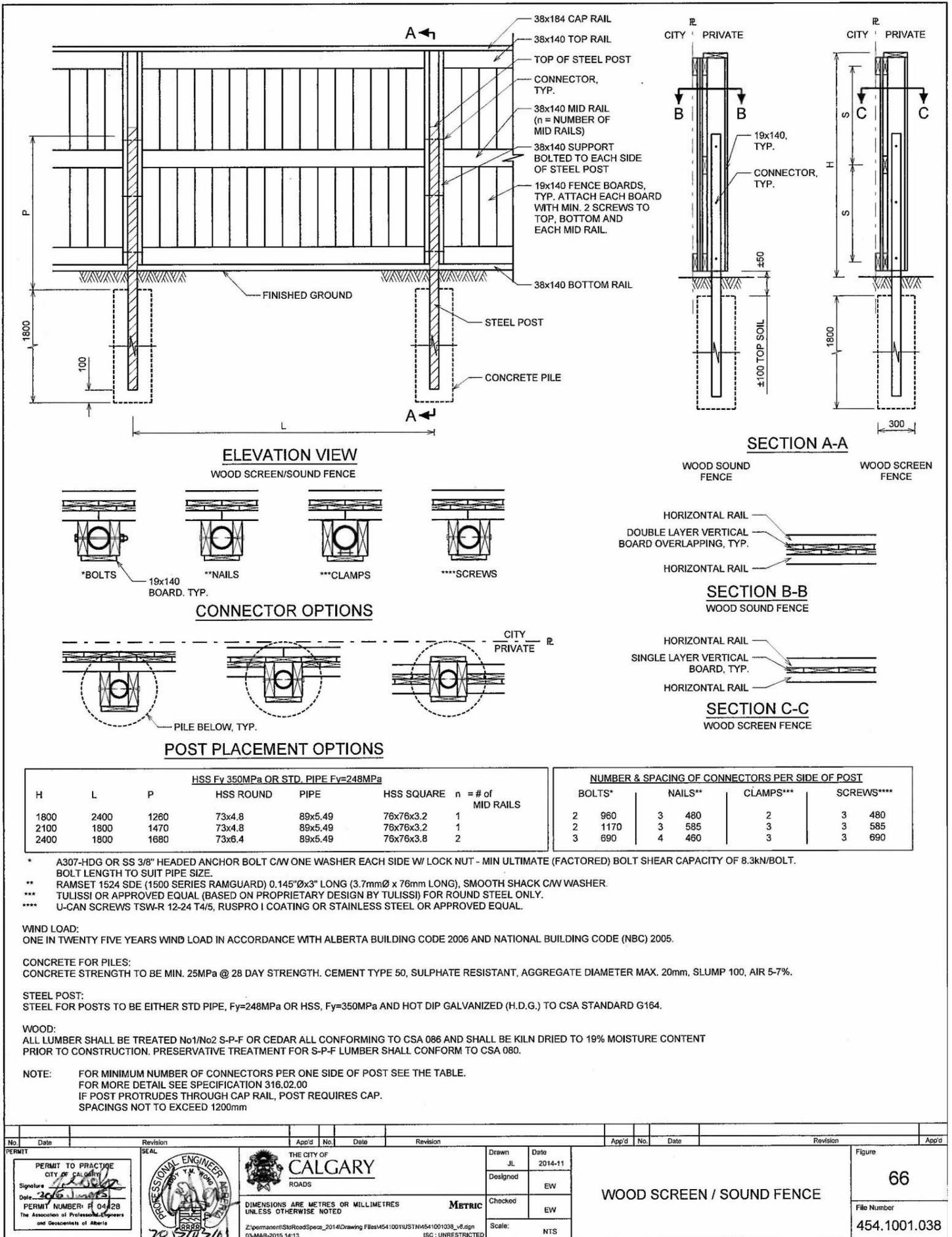
NOISE WALL HEIGHT	HOLE DEPTH 'D'	PILE DIAMETER	POST EMBEDMENT	REINFORCING STEEL (MIN.)	NOMINAL POST WIDTH
1500 - 2000	2500	460	600	2-15M	240
2000 - 2500	2500	460	800	2-20M	250
2500 - 3000	2500	600	800	2-20M	280
3000 - 3500	2700	600	1000	2-25M	305
3500 - 4000	3000	600	1000	2-25M	330
4000 - 4500	3500	600	1200	2-30M	340
4500 - 5000	3500	760	1200	2-35M	355
5000 - 5500	3500	760	1200	2-35M	380

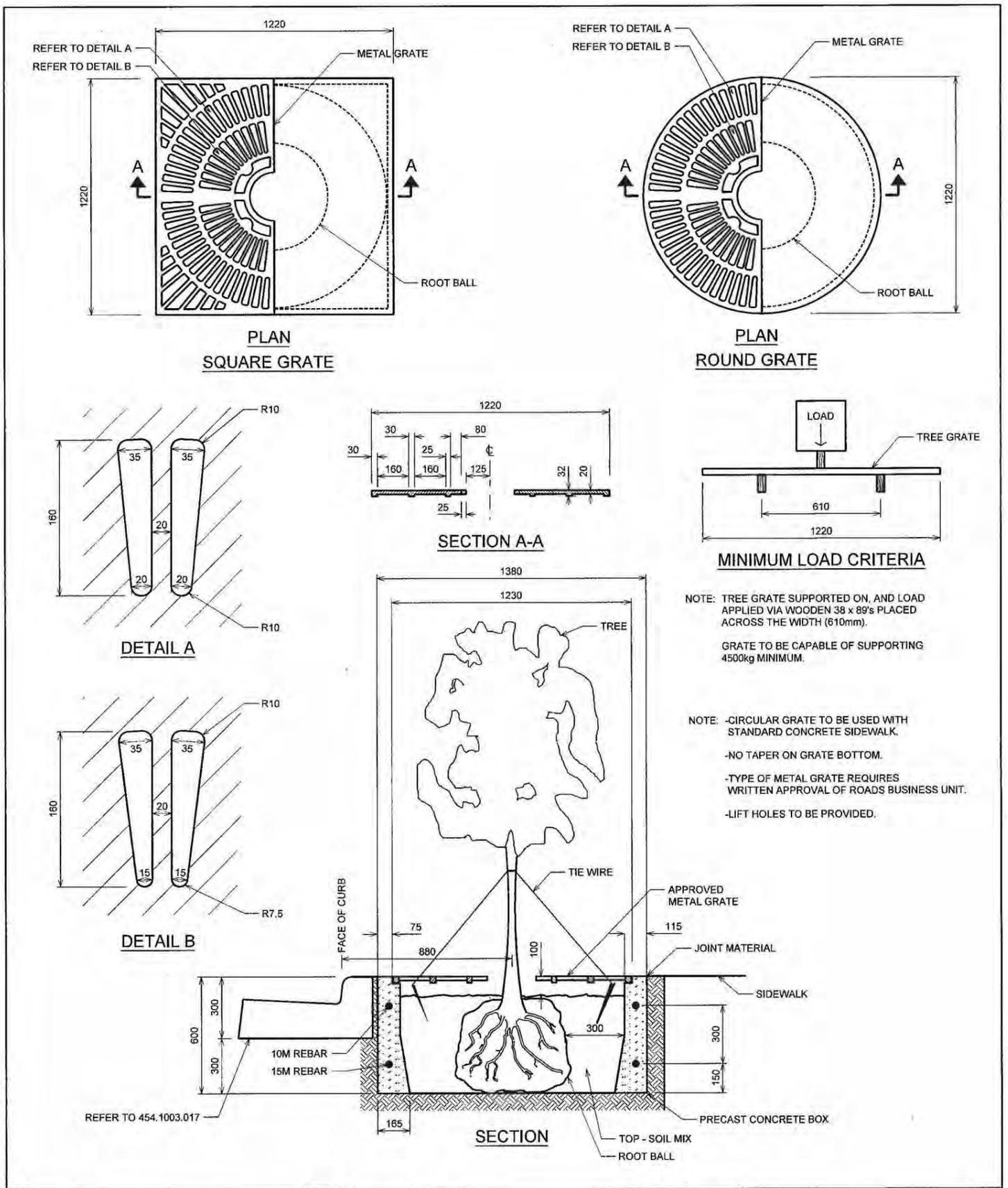
CONCRETE STRENGTHS
 PRECAST POSTS AND PLANKS - 35MPa (MIN.) AT 28 DAYS.
 PILING TYPE 50 CEMENT, 25MPa (MIN.) AT 28 DAYS.

NOTE:
 1. THIS DRAWING TO BE USED FOR GENERAL INFORMATION ONLY.
 DETAILED SHOP DRAWINGS TO BE SUPPLIED BY CONTRACTOR.

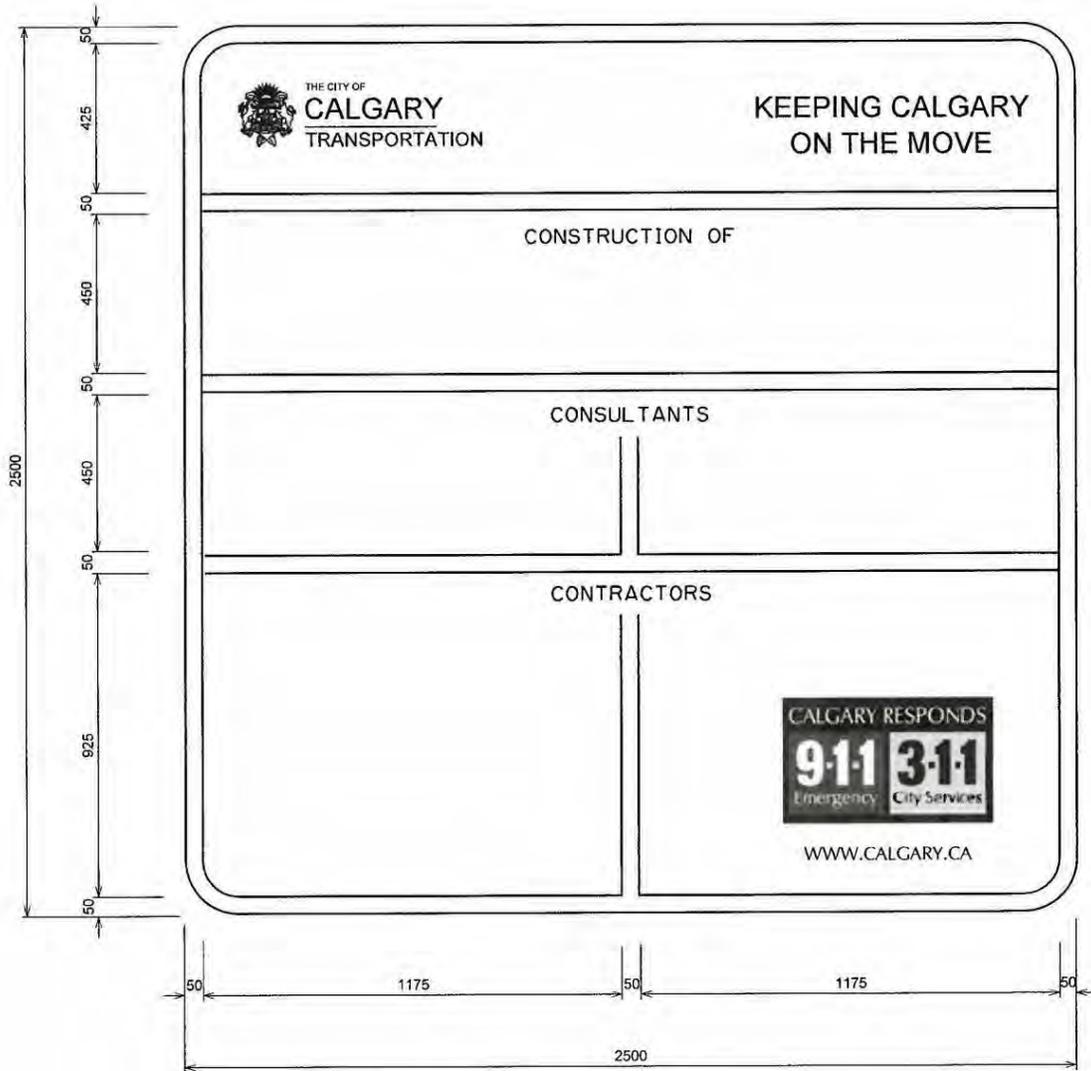
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-16 PERMIT NUMBER: P 0428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL PROFESSIONAL ENGINEER 2015/03/01	THE CITY OF CALGARY ROADS		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	CONCRETE SOUND FENCE			Figure: 65 File Number: 454.1001.021		

Figure 66: WOOD SCREEN/SOUND FENCE (454.1001.038)



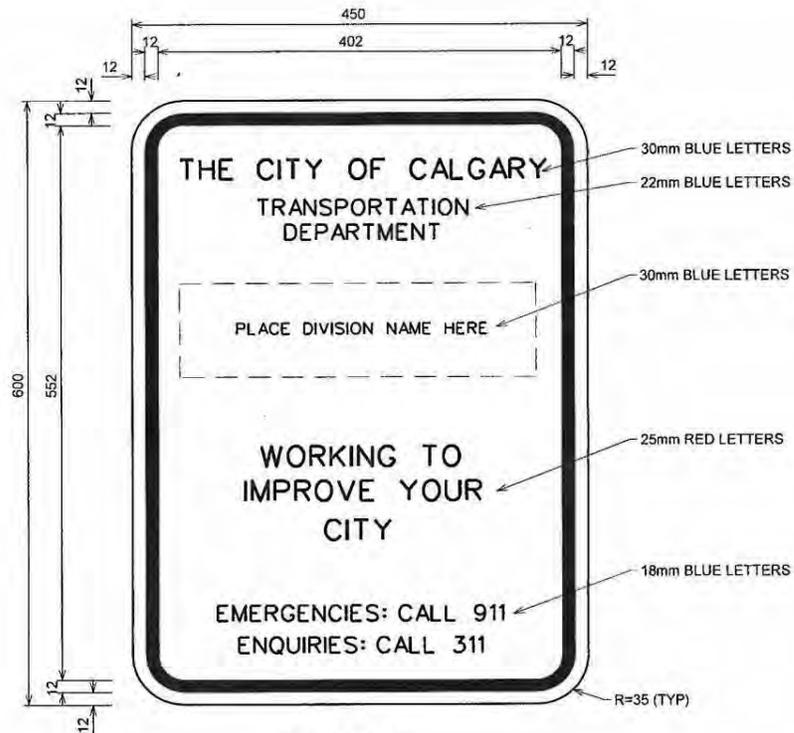


No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																				
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PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: P-4428 The Association of Professional Engineers and Geoscientists of Alberta	SEAL PROFESSIONAL ENGINEER [Stamp] 20150310	THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanen\it\StdRoadSpecs_2014\Drawing Files\4541002\USTN\4541002004_8.dgn 09-DEC-2014 13:35 ISC: UNRESTRICTED	Drawn	Date	PRECAST CONCRETE TREE BOX	Figure 67 File Number 454.1002.004																									
			JL	2014-11																											
			Designed	EW																											
			Checked	EW																											
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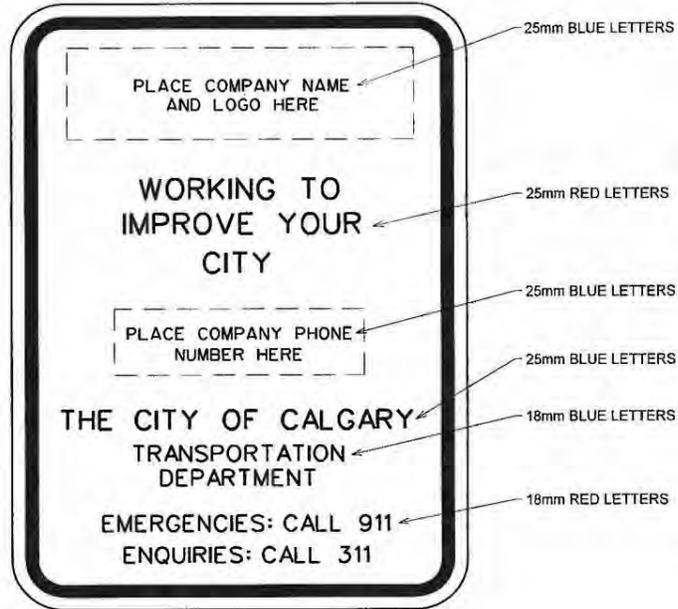


NOTE:
SIZE OF SIGN AND DESIGN MAY VARY AS REQUIRED BY PROJECT ENGINEER.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd			
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>[Date]</i> PERMIT NUMBER: R-4428 The Association of Professional Engineers and Geoscientists of Alberta			SEAL 			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\p\manment\SidRoadSpecs_2014\Drawing Files\4541001\USTN4541001012_v8.dgn 09-DEC-2014 10:55 ISC: UNRESTRICTED			Drawn JL Date 2014-12 Designed EW Checked EW Scale: NTS			Figure 68 File Number 454.1001.012		



CITY SIGN
(FOR USE BY CITY STAFF ONLY)

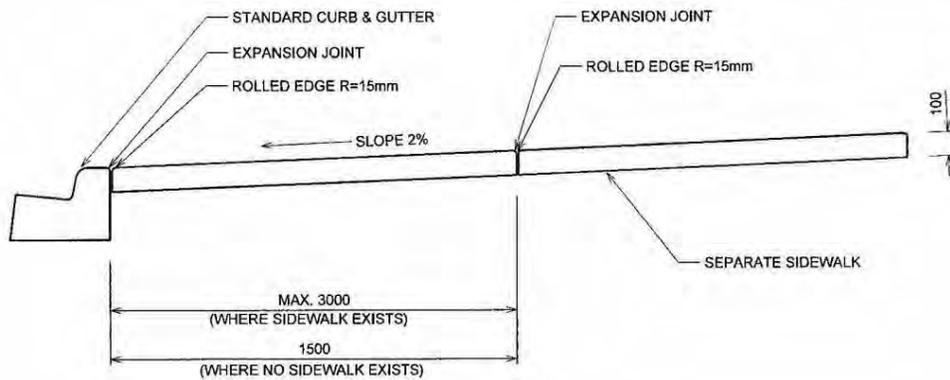
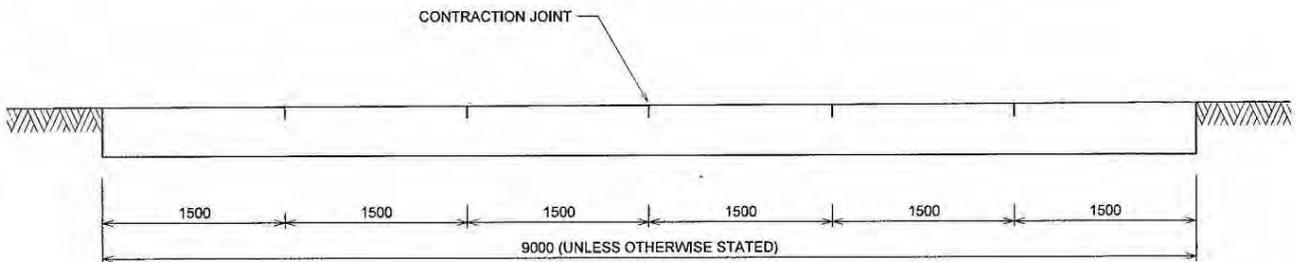
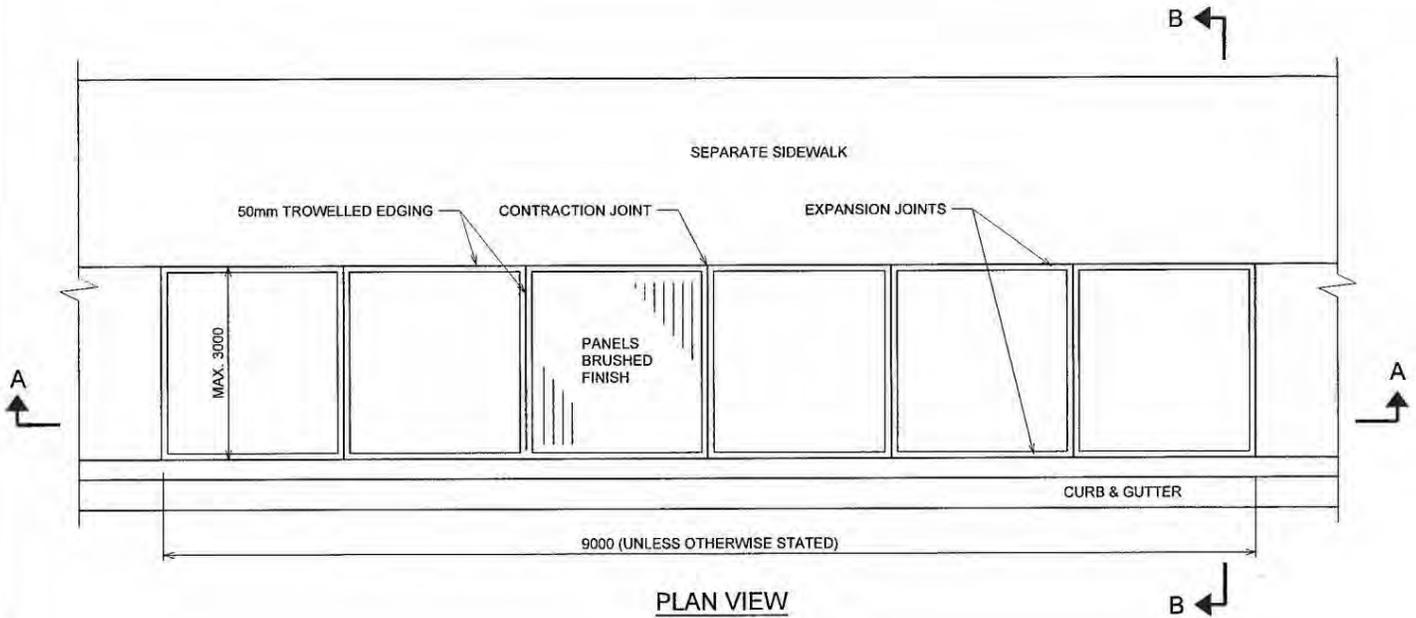


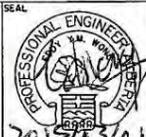
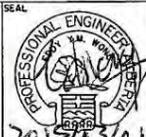
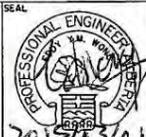
CONTRACTOR SIGN
(FOR USE BY CONTRACTORS ONLY)

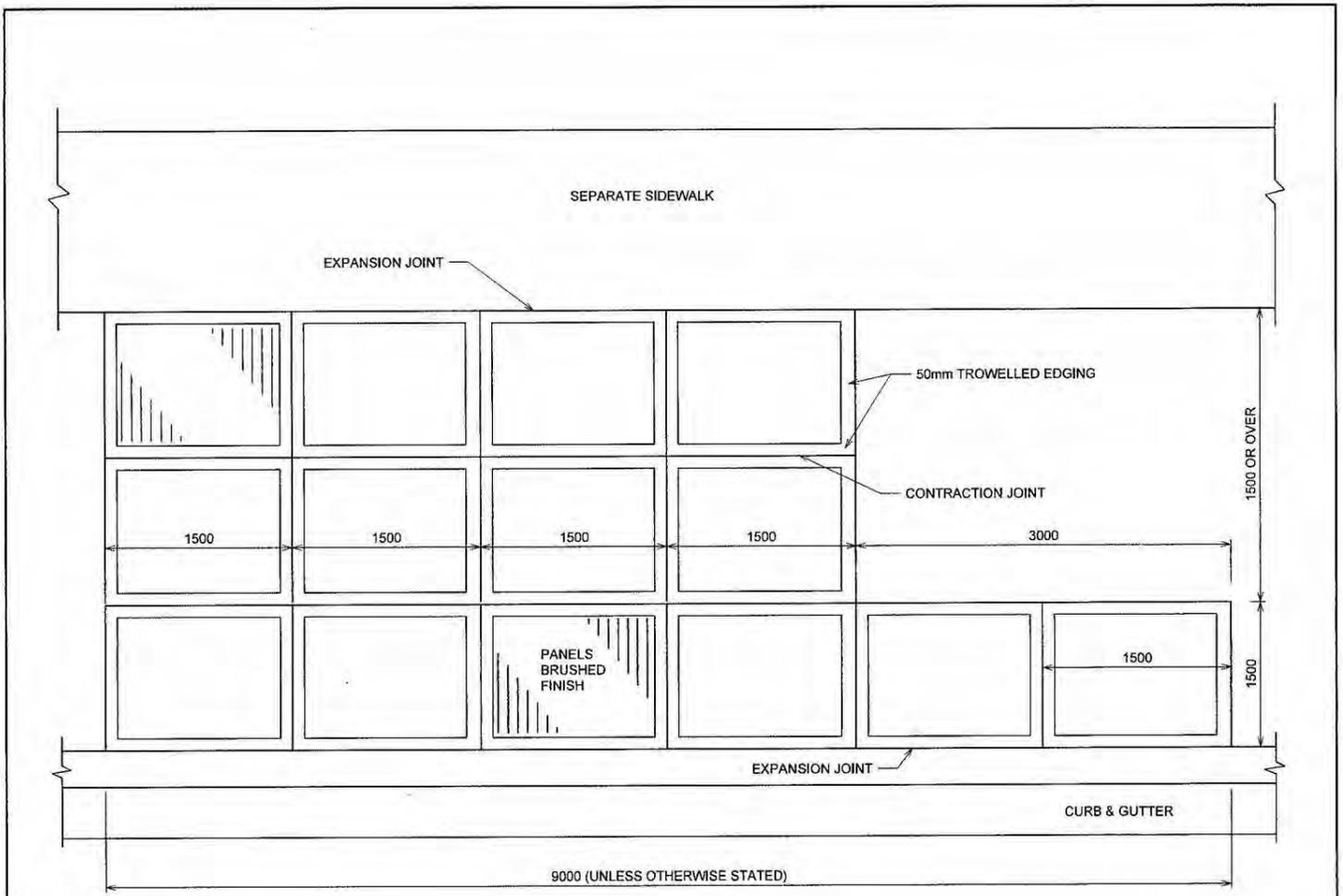
- NOTES:
 1. OVERALL DIMENSIONS APPLY TO BOTH SIGNS.
 2. THE BORDER IS TO BE BLUE.
 3. THE BACKGROUND IS TO BE WHITE.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: 2014-11-11 PERMIT NUMBER: P 04888 The Association of Professional Engineers and Geoscientists of Alberta				THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\p\m\m\541001\USTN\4541001029_v8.dgn 24-NOV-2014 11:06 ISC: UNRESTRICTED		Drawn: JL, Date: 2014-11 Designed: EW Checked: EW Scale: NTS		PORTABLE OR FREE STANDING CONSTRUCTION SIGN			Figure: 69 File Number: 454.1001.029	

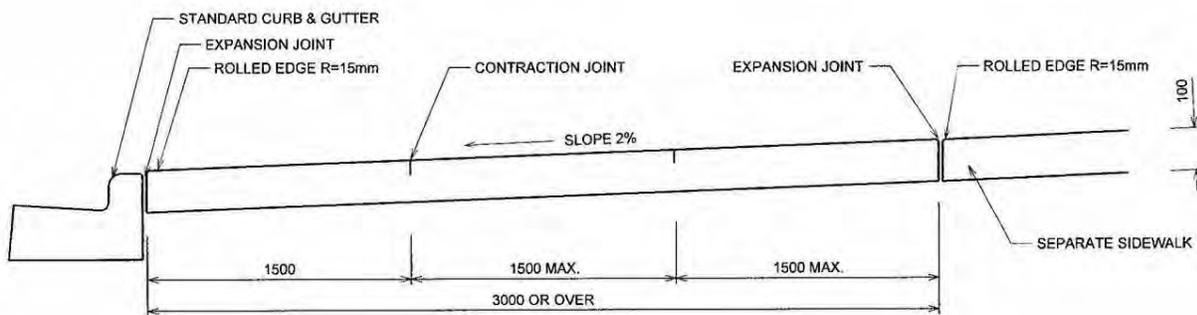
Figure 70: BUS STOP APRON TYPE 'A' (WITH BOULEVARD <3m) (454.1012.001)



No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd						
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2014/11/11 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\p\m\man\StpReacSpocs_2014\Drawing Files\4541012\JUSTIN\4541012001_v6.dgn 25-NOV-2014 15:40 ISC: UNRESTRICTED	Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS	BUS STOP APRON TYPE 'A' (WITH BOULEVARD < 3m)	Figure: 70 File Number: 454.1012.001												



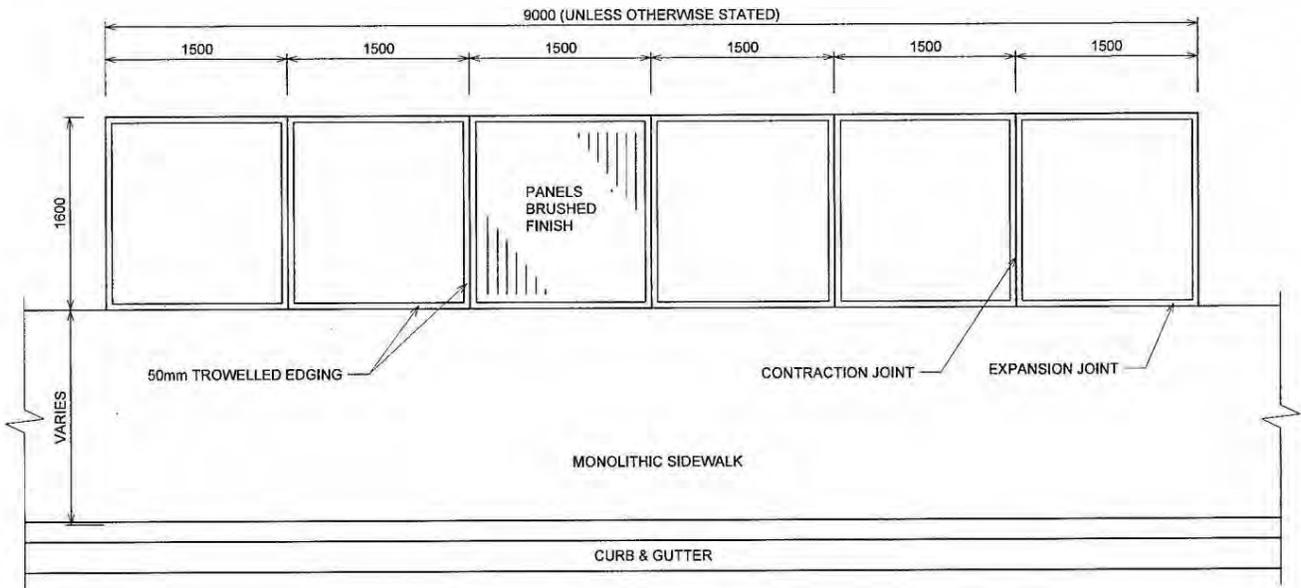
PLAN VIEW



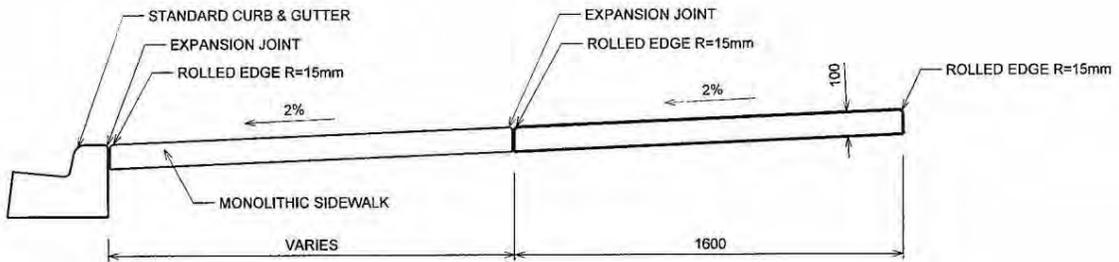
SECTION

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd		
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Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541012\USTM4541012002_v6.dgn 05-JAN-2015 15:10 ISC : UNRESTRICTED													

Figure 72: BUS STOP APRON TYPE 'C' (WITH MONOLITHIC SIDEWALK) (454.1012.003)



PLAN VIEW

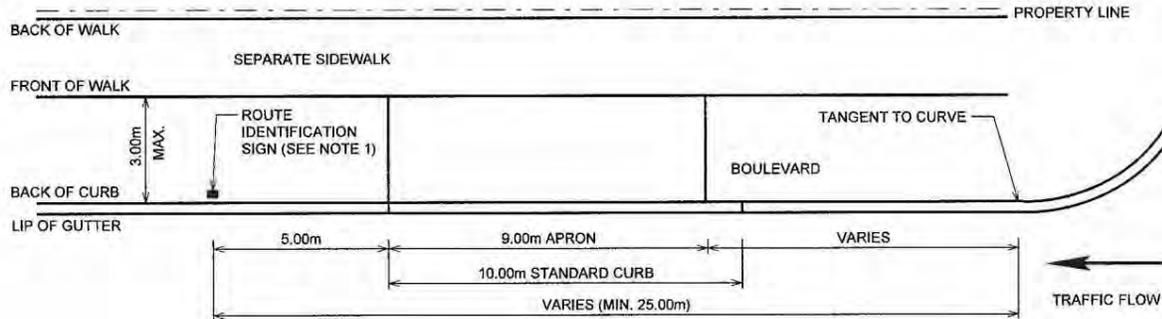


SECTION

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																							
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PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/10 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta		 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permits\GIS\RoadSpecs_2014\Drawing Files\4541012\USTN\4541012003_v4.dwg 27-NOV-2014 08:18 ISC: UNRESTRICTED	Drawn	Date	BUS STOP APRON TYPE 'C' (WITH MONOLITHIC SIDEWALK)	Figure																												
			JL	2014-11		72																												
			Designed	EW		File Number																												
			Checked	EW		454.1012.003																												
Scale:	NTS																																	

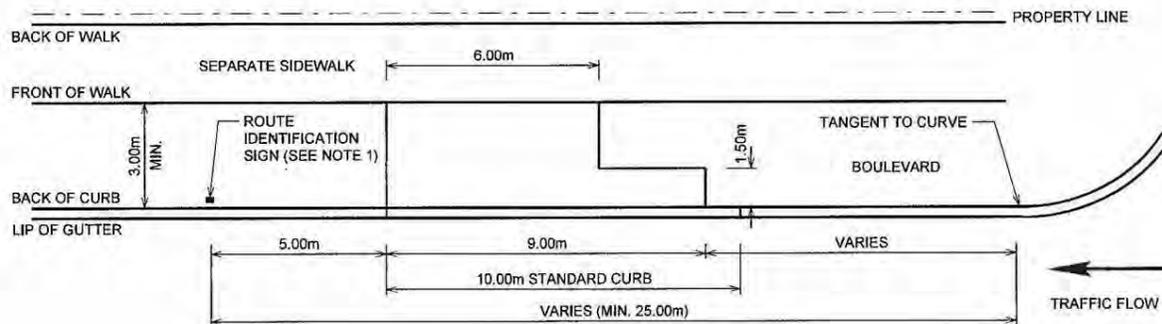
BUS ZONE APRONS

TYPE A,B,C



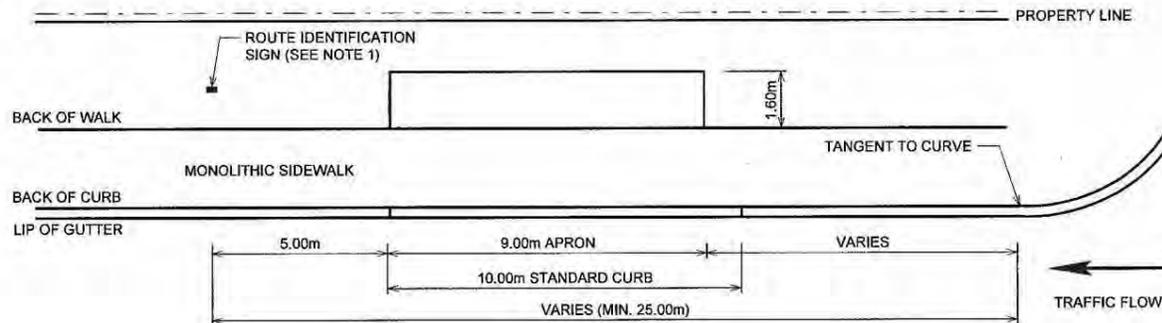
TYPE A

WHERE SIDEWALK IS LESS THAN 3.00m FROM CURB AND WHERE NO SIDEWALK EXISTS
(FOR ARTICULATED BUS ZONE, SEE NOTE 3)



TYPE B

WHERE SIDEWALK IS MORE THAN 3.00m FROM CURB
(FOR ARTICULATED BUS ZONE, SEE NOTE 3)



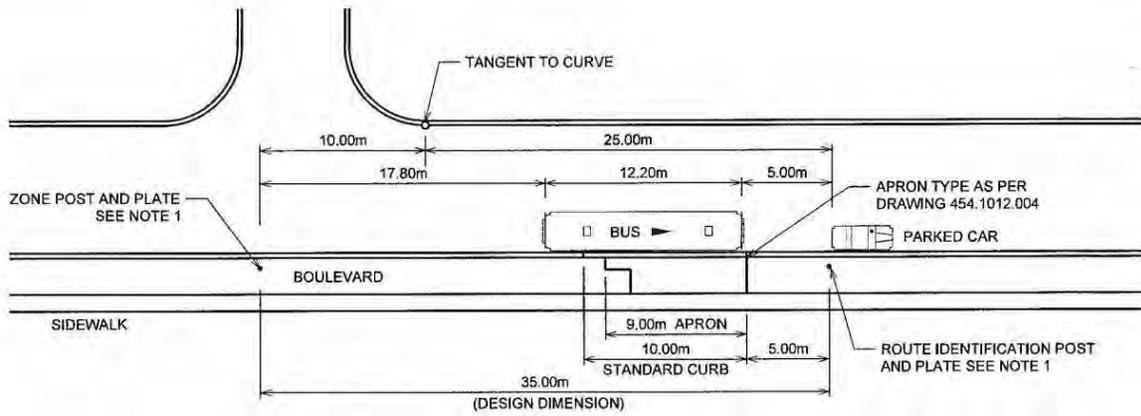
TYPE C

WHERE THERE IS MONOLITHIC CURB AND SIDEWALK
(FOR ARTICULATED BUS ZONE, SEE NOTE 3)

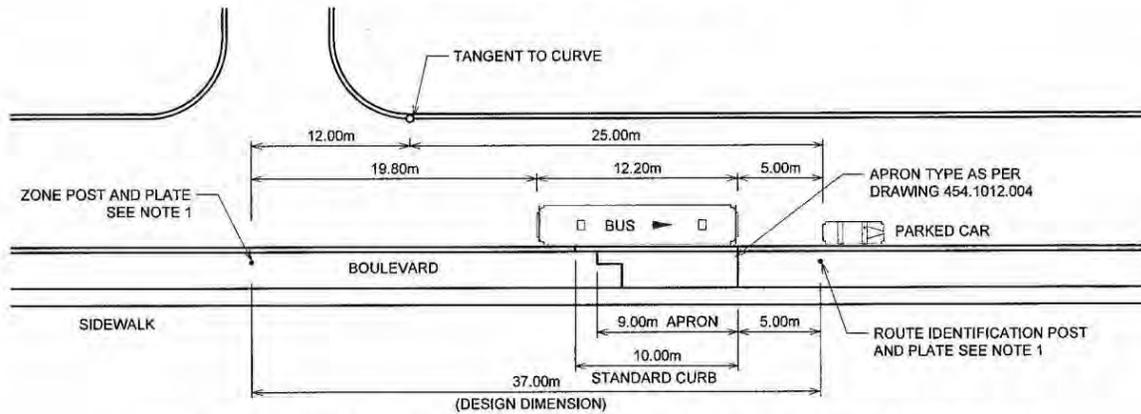
NOTES:

1. POSTS TO BE PLACED AT 0.60m FROM FACE OF CURB FOR SEPARATE SIDEWALK, 0.90m FROM BACK OF WALK FOR MONOLITHIC SIDEWALK.
2. SITE SPECIFIC- PAD REQUIREMENTS TO BE SPECIFIED BY THE TRANSPORTATION DEPARTMENT.
3. FOR ARTICULATED BUS ZONE, PROVIDE 15.00m APRON AND 16.00m STANDARD CURB AND MIN. 32.00m FOR BUS ZONE DIMENSIONS .

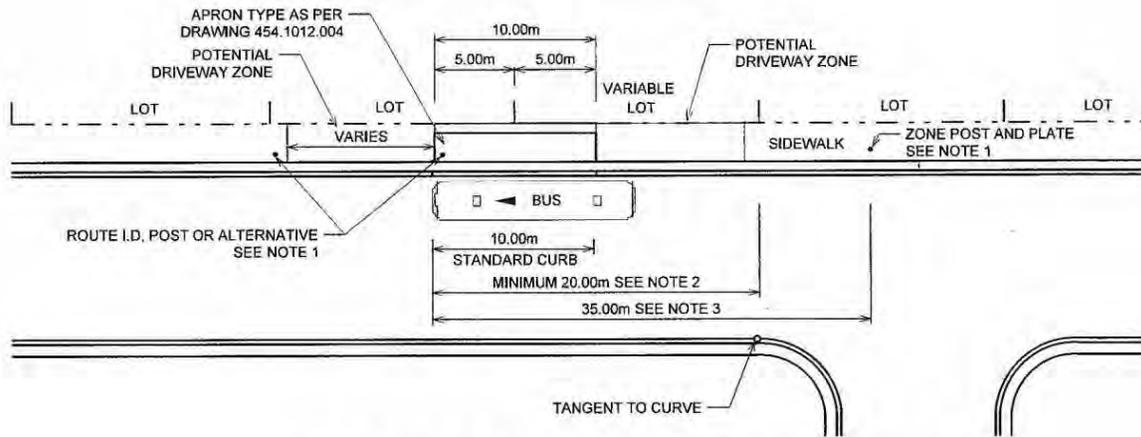
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd		
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanents\StdRoadSpecs_2014\Drawing Files\4541012\USTN\4541012004_V8.dgn 05-JAN-2015 13:49 ISC: UNRESTRICTED			Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS			TYPICAL BUS ZONE APRONS			Figure 73 File Number 454.1012.004	



STANDARD BUS ZONE DIMENSIONS MID - BLOCK ZONE
(FOR ARTICULATED BUS ZONE, SEE NOTES 4 AND 5)



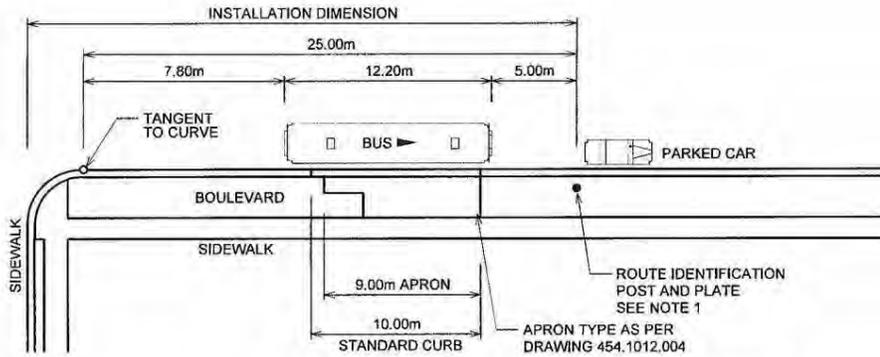
STANDARD BUS ZONE DIMENSIONS MID - BLOCK ZONE (AFTER LEFT TURN)
(FOR ARTICULATED BUS ZONE, SEE NOTES 4 AND 5)



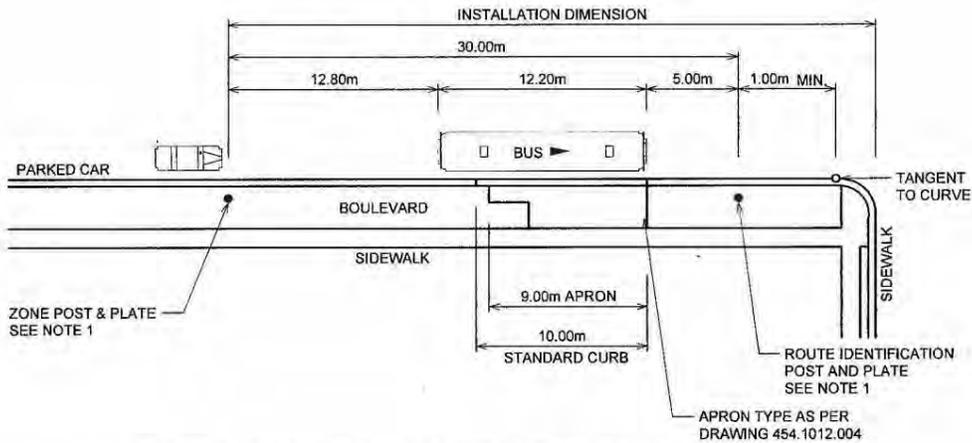
MID - BLOCK BUS ZONE WITH DRIVEWAY ACCESS
(FOR ARTICULATED BUS ZONE, SEE NOTES 4 AND 5)

- NOTES:
1. POSTS TO BE PLACED AT 0.60m FROM FACE OF CURB FOR SEPARATE SIDEWALK 0.90m FROM BACK OF WALK FOR MONOLITHIC SIDEWALK.
 2. IF THIS DIMENSION IS LESS THAN 20.00m CENTER THE STANDARD CURB ON NEXT LOT LINE.
 3. DIMENSION BECOMES 37.00m IF BUS TURNS LEFT INTO ZONE.
 4. FOR ARTICULATED BUS ZONE, PROVIDE 15.00m APRON AND 16.00m STANDARD CURB.
 5. USE 18.80m FOR ARTICULATED BUS AND ADJUST THE BUS ZONE DIMENSIONS ACCORDINGLY.
 6. RESTRICTIVE COVENANT (NO VEHICULAR ACCESS) THROUGH STANDARD CURB.

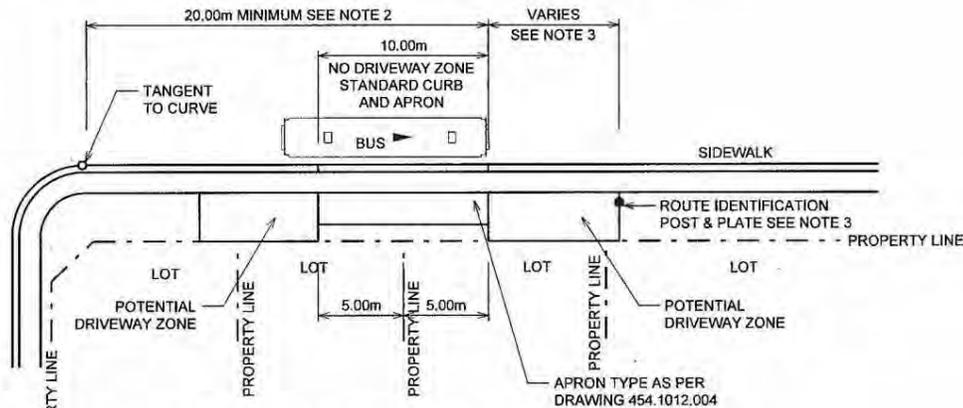
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd									
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015-11-18 PERMIT NUMBER: 04428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS			DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent51012\RoadSpecs_2014\Drawing Files\4541012\USTN4541012006_V8.dgn 27-NOV-2014 09:02 ISC - UNRESTRICTED			Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS			TYPICAL MID-BLOCK BUS ZONES			Figure: 74 File Number: 454.1012.006		



STANDARD BUS ZONE DIMENSIONS FAR - SIDE ZONE
(FOR ARTICULATED BUS ZONE, SEE NOTES 3 AND 4)



STANDARD BUS ZONE DIMENSIONS NEAR - SIDE ZONE
(FOR ARTICULATED BUS ZONE, SEE NOTES 3 AND 4)



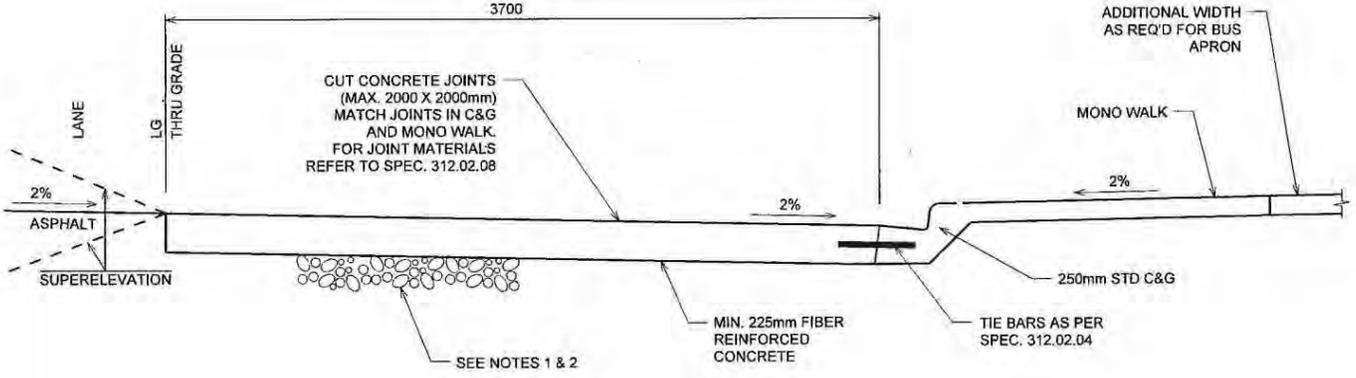
FAR SIDE BUS ZONE WITH DRIVEWAY ACCESS
(FOR ARTICULATED BUS ZONE, SEE NOTES 3 AND 4)

NOTES:

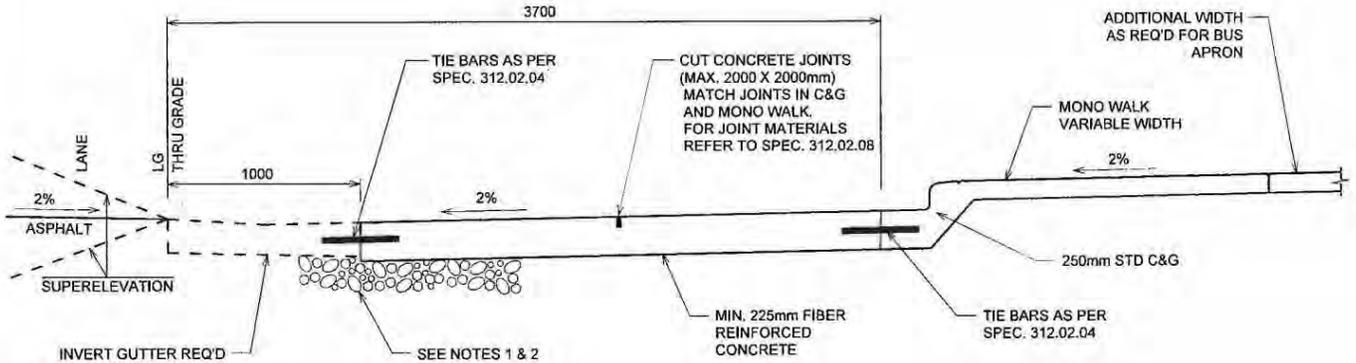
1. POSTS TO BE PLACED AT 0.60m FROM FACE OF CURB FOR SEPERATE SIDEWALK AND 0.90m FROM BACK OF WALK FOR MONOLITHIC SIDEWALK.
2. IF THIS DIMENSION IS LESS THAN 20.00m CENTER THE STANDARD CURB ON NEXT LOT LINE.
3. FOR ARTICULATED BUS ZONE, PROVIDE 15.00m APRON AND 16.00m STANDARD CURB.
4. USE 18.80m FOR ARTICULATED BUS AND ADJUST THE BUS ZONE DIMENSIONS ACCORDINGLY.
5. RESTRICTIVE COVENANT THROUGH STANDARD CURB.

No.		Date		Revision		App'd		No.		Date		Revision		App'd	
PERMIT		SEAL		THE CITY OF CALGARY		ROADS		METRIC		TYPICAL FAR SIDE AND NEAR SIDE BUS ZONES		Figure 75		File Number 454.1012.007	
PERMIT TO PRACTISE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: R 0442B The Association of Professional Engineers and Geoscientists of Alberta		PROFESSIONAL ENGINEER SEAL 2015/02/01		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS									
Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541012\USTN\4541012007_V8.dgn 03-MAR-2015 13:50 ISC: UNRESTRICTED															

Figure 76: CONCRETE BUS BAY (454.1012.008)



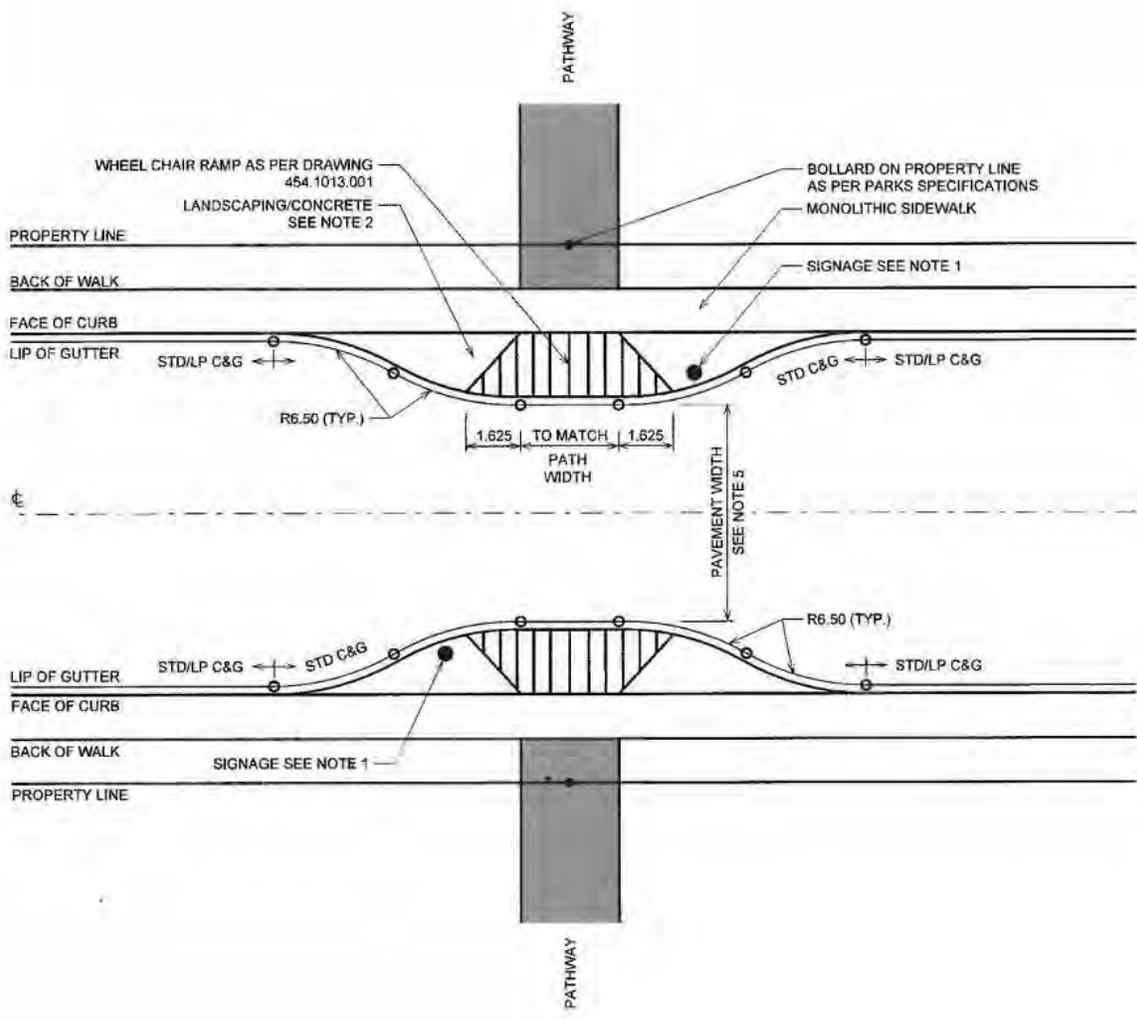
CROSSFALL DESIGN



INVERT DESIGN

- NOTES:
1. SEE SECTION 302.02.02. MIN. 150mm OF GRAVELLED LANE GRAVEL (50mm TOP SIZE).
 2. SPECIFICATIONS ARE TO MINIMUM STANDARDS. CONSIDERATION MUST BE GIVEN TO ADDRESS ACTUAL SOIL CONDITIONS AND ASSESS THE NEED FOR ADDITIONAL GRANULAR BASE, THICKER SLAB, REINFORCEMENT OR SUB-DRAINAGE SYSTEM.
 3. FOR CONCRETE PAVEMENT SPECIFICATIONS REFER TO 312.00.00.
 4. INVERT DESIGN TO BE CONSIDERED ON A SITE BY SITE BASIS. WHEREVER POSSIBLE "CROSSFALL DESIGN" SHALL BE USED.
 5. FOR HORIZONTAL DESIGN REFER TO SPEC. 454.1012.005 IN THE DESIGN GUIDELINES FOR SUBDIVISION SERVICING.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd			
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS			Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS			Figure 76 File Number 454.1012.008		
DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\permanent\StdRoadSpecs_2014\Drawing Files\4541012\UTM4541012008_v8.dgn 13-MAY-2015 15:06 ISC - UNRESTRICTED														

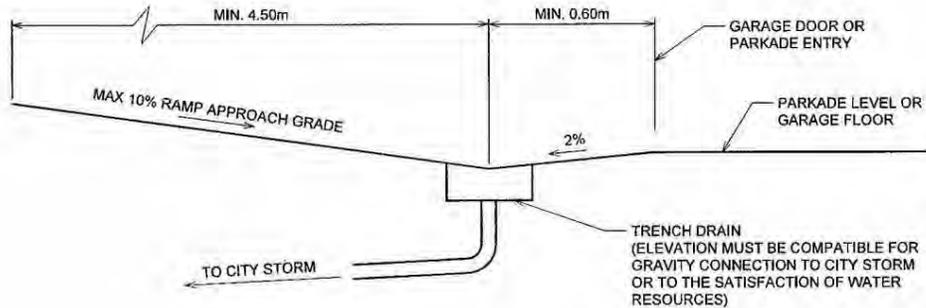
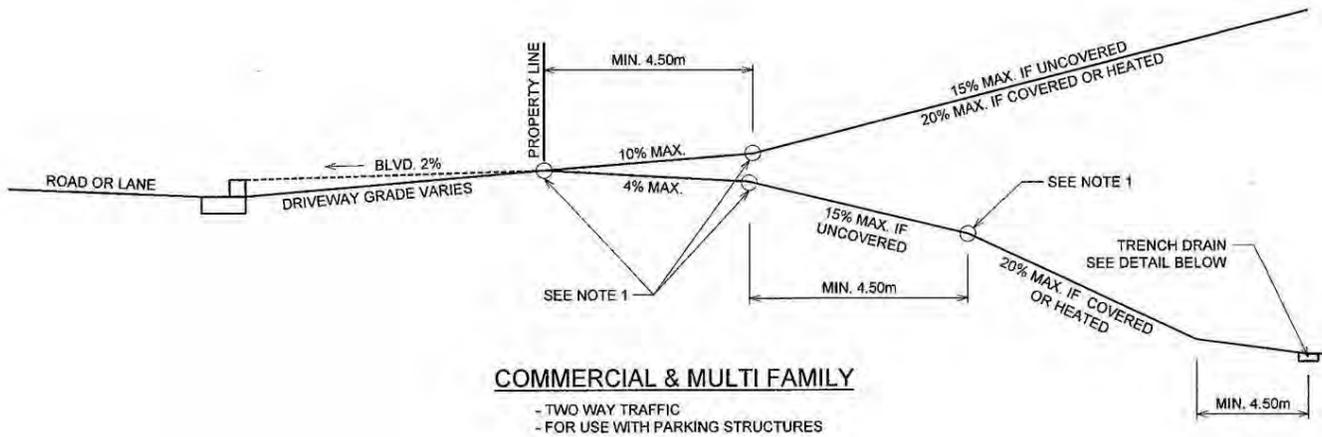
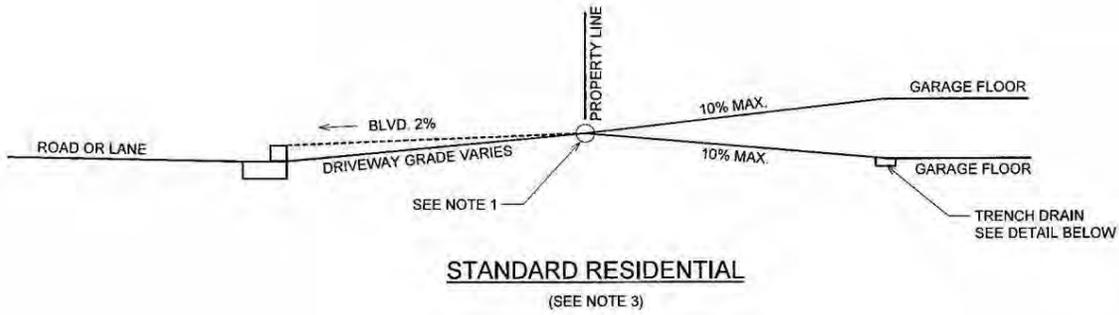


NOTES:

1. SIGNAGE LOCATION TO BE CONFIRMED WITH TRAFFIC DIVISION.
2. CURB EXTENSION TO BE HARD SURFACED FOR MONOLITHIC SIDEWALK AND GRASSED FOR SEPARATE SIDEWALK.
3. CROSSING LOCATION SHALL BE CENTERED ON CURB EXTENSION.
4. WHEN BICYCLE LANES ARE PRESENT, MODIFICATIONS MAY BE REQUIRED TO CURB EXTENSIONS.
5. PAVEMENT WIDTHS:

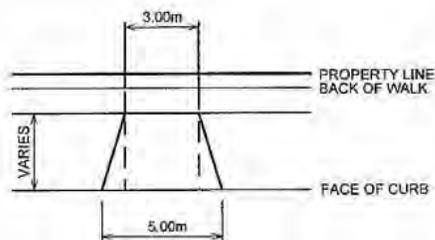
- 2 LANE ROADWAY	8.00m LOG TO LOG
- COLLECTOR STREET < 3000 VPD	7.00m LOG TO LOG
- RESIDENTIAL STREET	7.00m LOG TO LOG
- SINGLE LANE WITH A CENTRE MEDIAN	6.00m FOC TO FOC

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2/16/2014 PERMIT NUMBER: PA 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 201576310		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\permanent\SidRoadSpecs_2014\Drawing Files\4541001\USTN\4541001037_v8.dwg 21-NOV-2014 09:10 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		TYPICAL MID-BLOCK CROSSING			Figure 77 File Number 454.1001.037

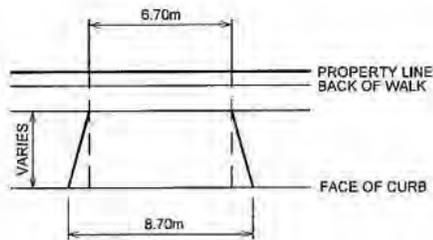


- NOTES:
1. MAXIMUM GRADE CHANGE = 12%.
 2. ANY PROPOSED DRIVEWAY GRADES NOT CONFORMING TO THE ABOVE CRITERIA FOR THE STANDARD RESIDENTIAL PROFILE ARE SUBJECT TO THE REVIEW AND APPROVAL OF THE ROADS BUSINESS UNIT.
 3. MINIMUM 6.00m TO GARAGE FROM BACK OF SIDEWALK OR FROM BACK OF CURB (IF NO SIDEWALK EXISTS).

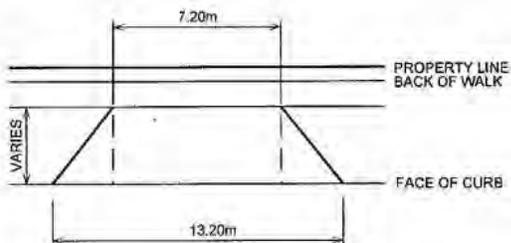
No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
				Drawn: JL, Date: 2014-11 Designed: EW Checked: EW Scale: NTS		DRIVEWAY GRADES				Figure 78 File Number 454.1010.003	
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: P-0442B The Association of Professional Engineers and Geoscientists of Alberta		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\p\ment\StdRoadSpecs_2014\Drawing Files\4541010\USTH\4541010003_v8.dgn 04-MAR-2015 10:11 ISC: UNRESTRICTED									



RESIDENTIAL SINGLE

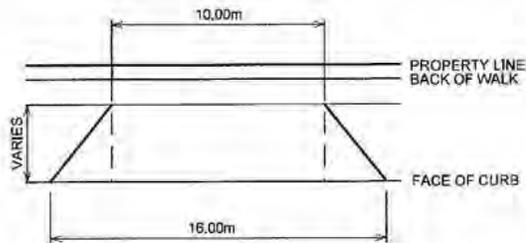


RESIDENTIAL DOUBLE



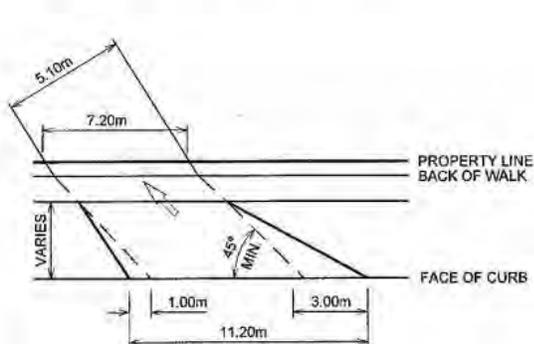
7.20m COMMERCIAL

- FOR USES SUCH AS SMALL PARKING LOTS & STRIP COMMERCIAL
- PRIMARILY PASSENGER VEHICLES
- TWO WAY TRAFFIC



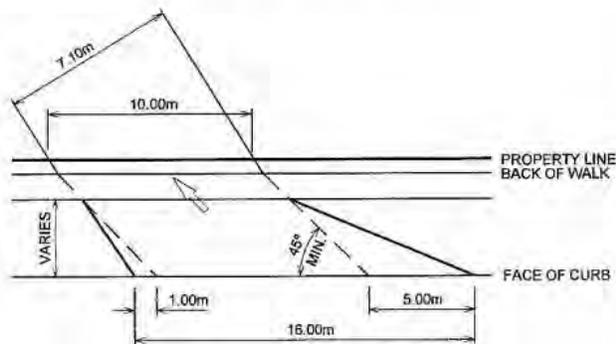
10.00m COMMERCIAL

- FOR USES SUCH AS LARGE DEVELOPMENTS, SHOPPING CENTRES, APARTMENT COMPLEXES ETC.
- FOR TRUCK ACCESS
- TWO WAY TRAFFIC



7.20m ENTRANCE DIRECTIONAL

- ONE WAY INBOUND TRAFFIC ONLY
- FOR USES AS ABOVE



10.00m ENTRANCE DIRECTIONAL

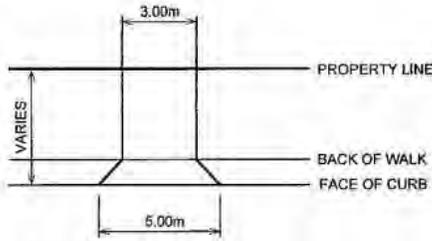
- ONE WAY INBOUND TRAFFIC ONLY
- FOR USES SUCH AS LARGE DEVELOPMENTS, SHOPPING CENTRES, APARTMENT COMPLEXES ETC.

NOTES:

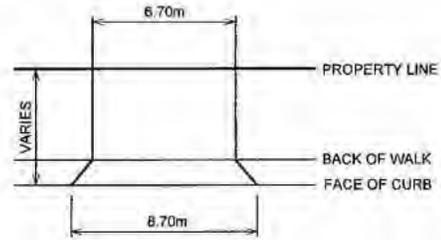
1. ALL SIGNALIZED DRIVEWAYS SHALL HAVE CURB RETURNS.
2. ALL DRIVEWAYS ARE TO TIE TO FRONT OF WALK, IF NO WALK IS REQUIRED THEN THE DRIVEWAY IS TO TIE TO BACK OF CURB. THE ADJACENT DEVELOPMENT IS RESPONSIBLE FOR THE TIE.
3. THE DRIVEWAY FLARE SHALL NOT EXTEND BEYOND THE PROJECTION OF THE COMMON PROPERTY LINE.

4. DRIVEWAY DIMENSIONS INDICATED ARE MINIMUMS.
5. DRIVEWAY FLARE CAN BE INCREASED TO FACILITATE MOVEMENT OF LARGE TRUCKS.
6. EXIT DIRECTION TO BE REVERSE OF 7.20m OR 10.00m ENTRANCE DIRECTIONAL.
7. FOR BACK TO BACK DIRECTIONAL DRIVEWAYS, AN ISLAND IS REQUIRED BETWEEN THE TWO DRIVEWAYS. THE ISLAND SHALL BE CONSTRUCTED WITH STANDARD CURB AND GUTTER WITH CONCRETE FILL.

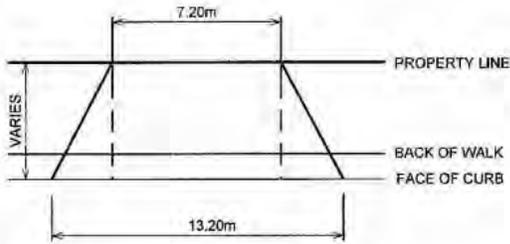
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No. _____ Date _____ PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: _____ Date: _____ PERMIT NUMBER: P 04429 The Association of Professional Engineers and Geoscientists of Alberta	 PROFESSIONAL ENGINEER 9828	 THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC 2:\permits\roadSpecs_2014\0-swng files\4541010\STRN454101004_r.jpg 06-JAN-2015 14:57 ISC : UNRESTRICTED	Drawn: JL Date: 2014-12 Designed: EW Checked: EW Scale: NTS	TYPICAL DRIVEWAY LAYOUTS FOR SEPARATE SIDEWALK	Figure 79 File Number 454.1010.004												



RESIDENTIAL SINGLE

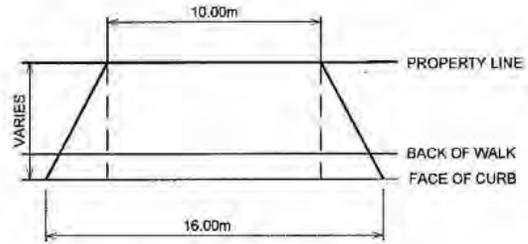


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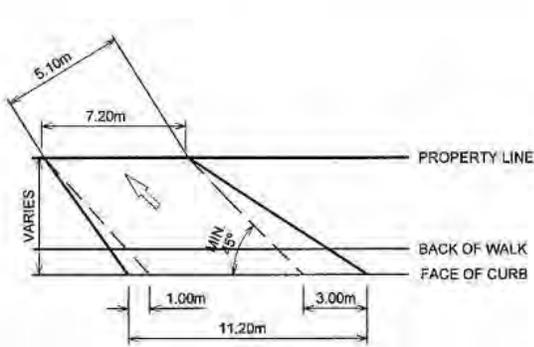
7.20m COMMERCIAL

- FOR USES SUCH AS SMALL PARKING LOTS & STRIP COMMERCIAL
- PRIMARILY PASSENGER VEHICLES
- TWO WAY TRAFFIC



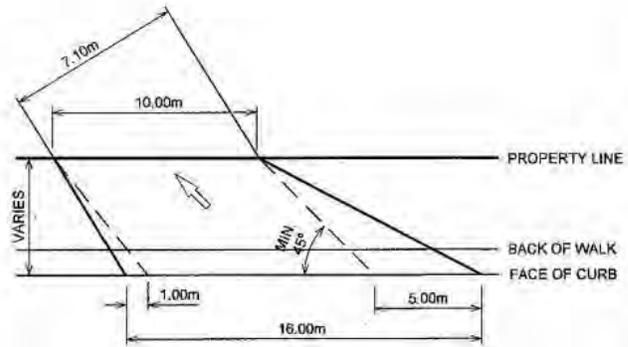
10.00m COMMERCIAL

- FOR USES SUCH AS LARGE DEVELOPMENTS, SHOPPING CENTRES, APARTMENT COMPLEXES ETC.
- FOR TRUCK ACCESS
- TWO WAY TRAFFIC



7.20m ENTRANCE DIRECTIONAL

- ONE WAY INBOUND TRAFFIC ONLY
- FOR USES AS ABOVE



10.00m ENTRANCE DIRECTIONAL

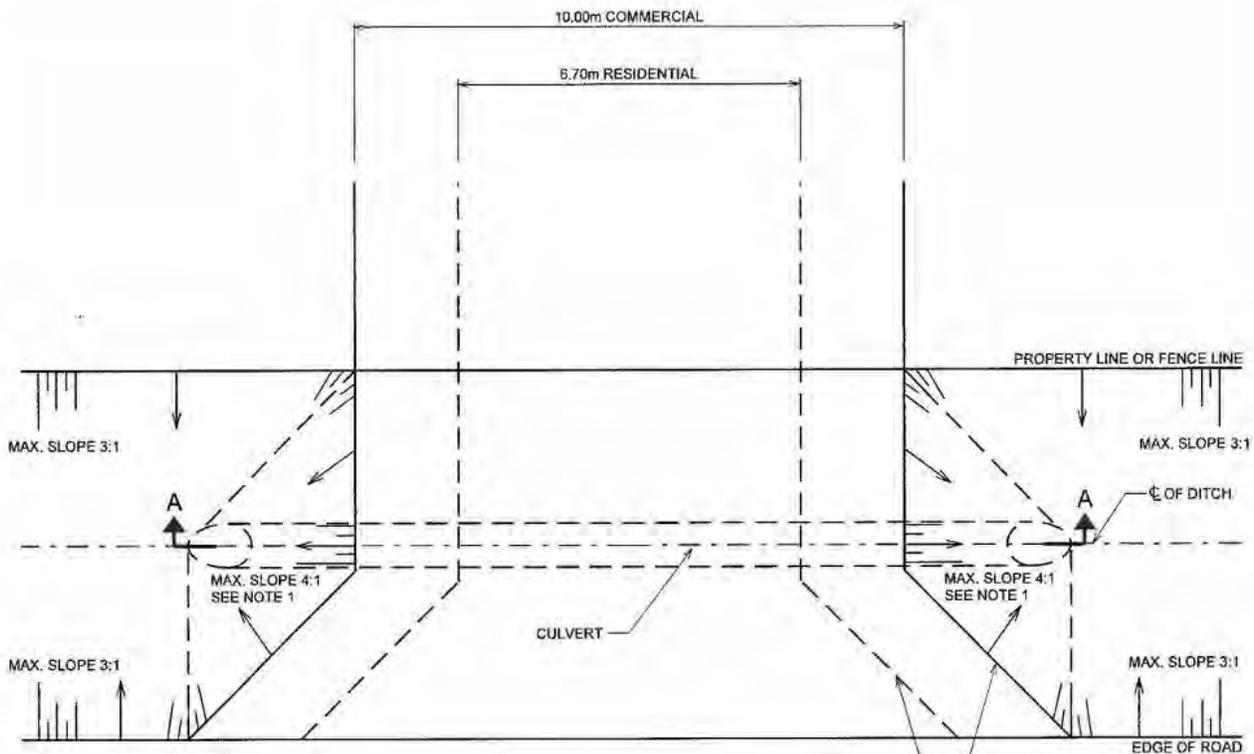
- ONE WAY INBOUND TRAFFIC ONLY
- FOR USES SUCH AS LARGE DEVELOPMENTS, SHOPPING CENTRES, APARTMENT COMPLEXES ETC.

NOTES:

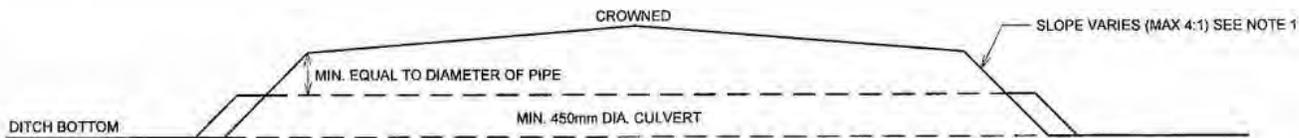
1. ALL SIGNALIZED DRIVEWAYS SHALL HAVE CURB RETURNS.
2. ALL DRIVEWAYS ARE TO TIE TO BACK OF WALK. IF NO WALK IS REQUIRED THEN THE DRIVEWAY IS TO TIE TO BACK OF CURB. THE ADJACENT DEVELOPMENT IS RESPONSIBLE FOR THE TIE.
3. THE DRIVEWAY FLARE SHALL NOT EXTEND BEYOND THE PROJECTION OF THE COMMON PROPERTY LINE.

4. DRIVEWAY DIMENSIONS INDICATED ARE MINIMUMS.
5. DRIVEWAY FLARES CAN BE INCREASED TO FACILITATE MOVEMENT OF LARGE TRUCKS.
6. EXIT DIRECTIONAL TO BE REVERSE OF 7.20m OR 10.00m ENTRANCE DIRECTIONAL.
7. FOR BACK TO BACK DIRECTIONAL DRIVEWAYS, AN ISLAND IS REQUIRED BETWEEN THE TWO DRIVEWAYS. THE ISLAND SHALL BE CONSTRUCTED WITH STANDARD CURB AND GUTTER WITH CONCRETE FILL.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd				
PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> PERMIT NUMBER: F10R428 The Association of Professional Engineers and Geoscientists of Alberta						THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC 2:\permanet\SiteRoadSpecs_2014\Drawings\Fig4541010US1\NAS4101005_-S.091 10DEC-2016 14:06 ISC - UNRESTRICTED			Drawn: JL Date: 2014-12 Designed: EW Checked: EW Scale: NTS			TYPICAL DRIVEWAY LAYOUTS FOR MONOLITHIC SIDEWALK			Figure 80 File Number 454.1010.005



PLAN

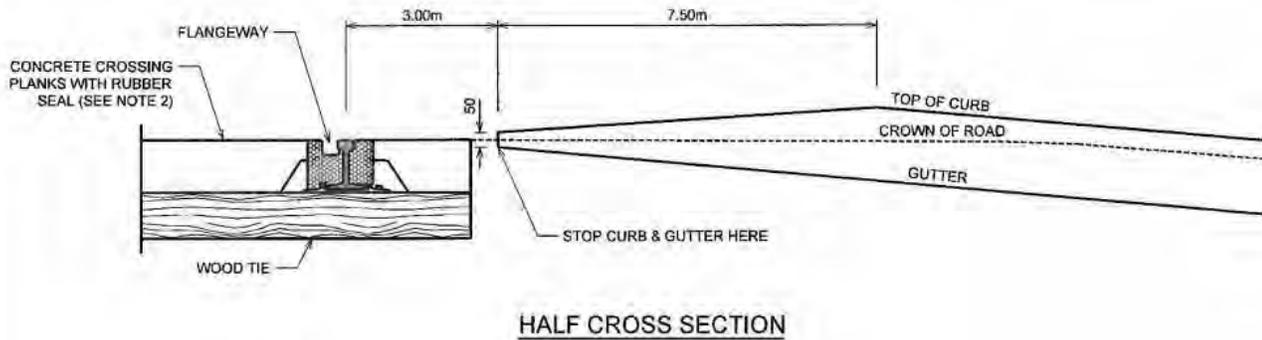
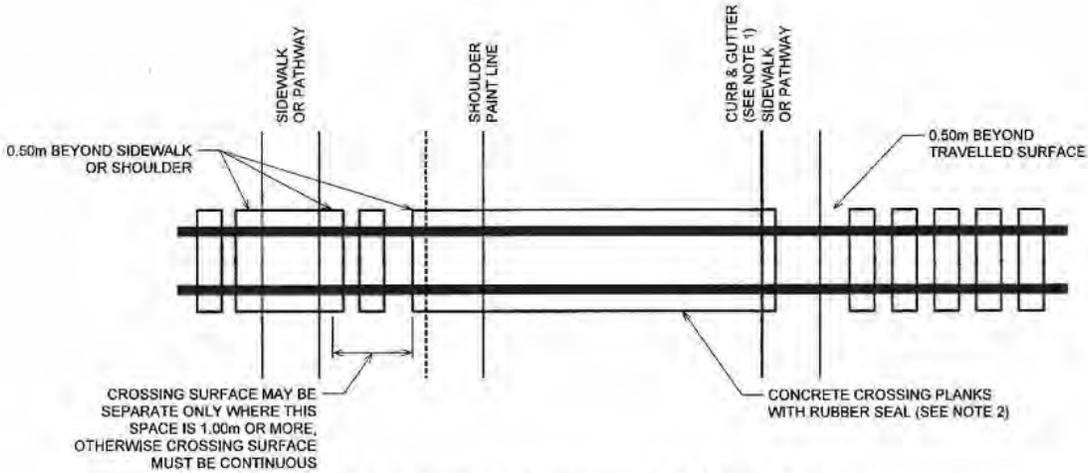
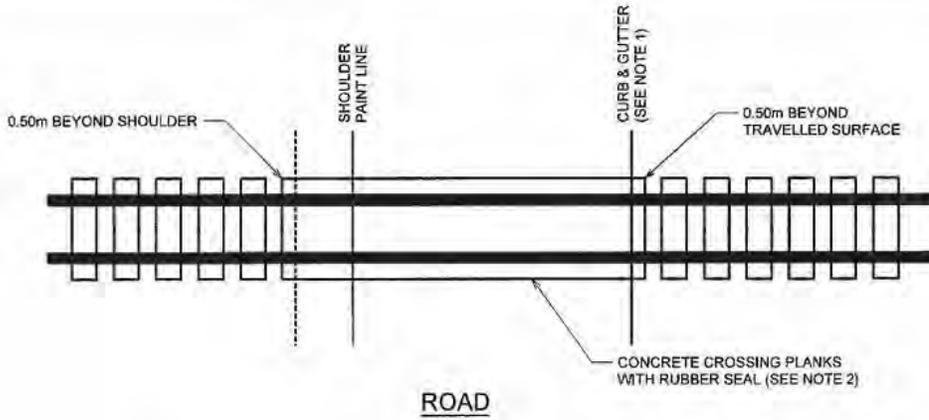


TYPICAL CROSS-SECTION A-A

NOTES:

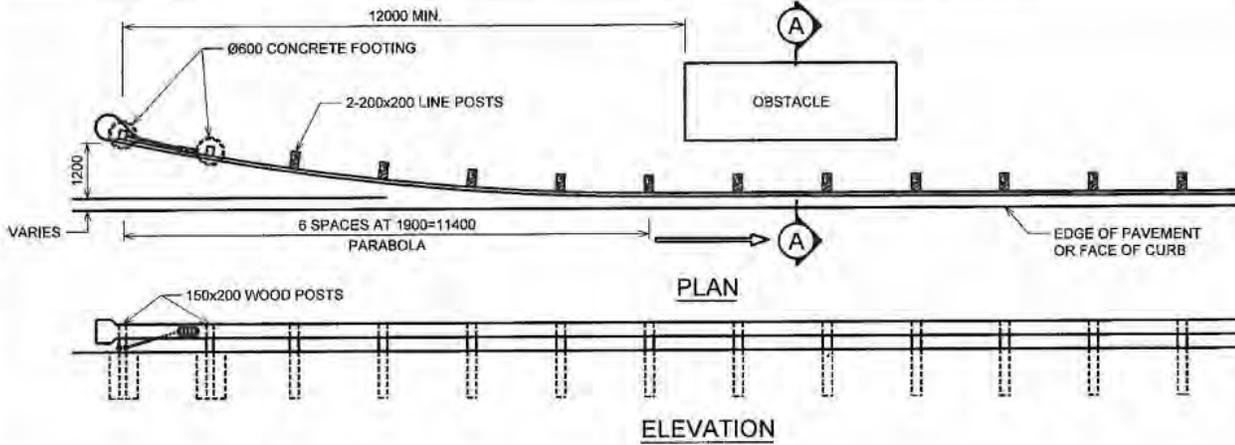
1. DRIVEWAY SIDE SLOPE :
 4:1 FOR LOCAL ROADS
 5:1 FOR COLLECTOR AND/OR ARTERIAL ROADS.
2. DRIVEWAY FLARES CAN BE INCREASED TO FACILITATE MOVEMENT OF LARGE TRUCKS.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd		
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: <i>[Date]</i> PERMIT NUMBER: P 04426 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		 THE CITY OF CALGARY ROADS		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\p\m\m\m\GisRoadSpecs_2014\Drawing Files\4541010\USTN\4541010006_v6.dgn 11-DEC-2014 14:43 ISC: UNRESTRICTED		Drawn JL Date 2014-12 Designed EW Checked EW Scale NTS		TYPICAL AGRICULTURAL DRIVEWAY CROSSING		Figure 81 File Number 454.1010.006	

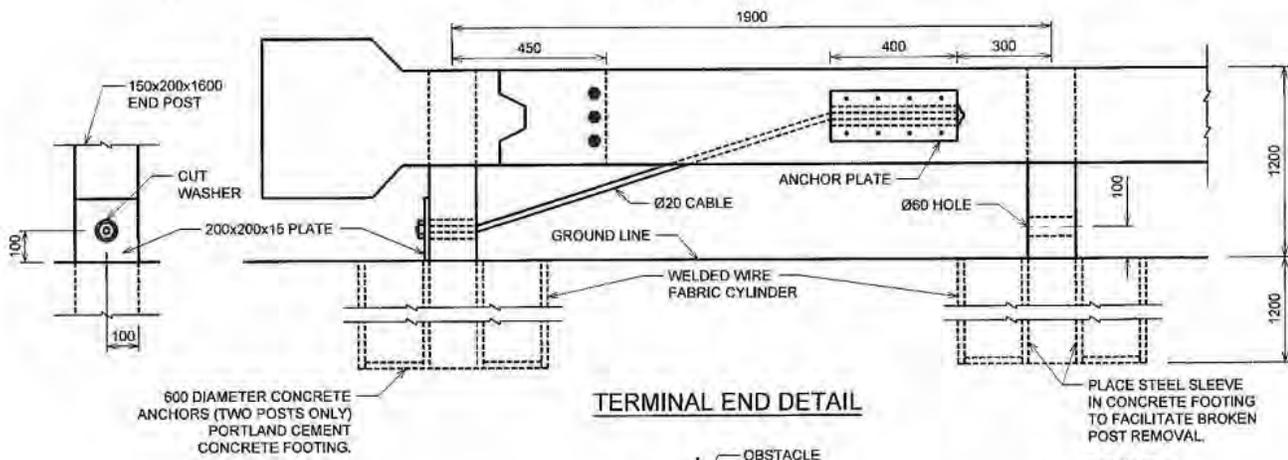
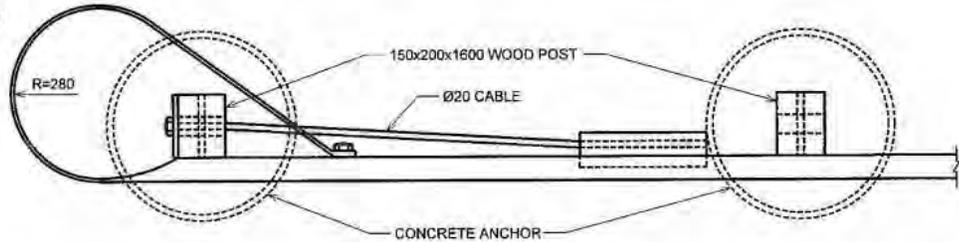


- NOTES:
1. CURB ENDS WHEREVER CURB INTERSECTS RAILWAY CROSSING.
 2. CONCRETE CROSSING PLANKS WITH RUBBER SEAL TO BE IN ACCORDANCE WITH CP/CN RAIL SPECIFICATIONS.
 3. ALL MATERIALS SHALL COMPLY WITH THE CURRENT CITY AND CP/CN RAIL SPECIFICATIONS.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd	
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2015/03/04 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta		SEAL 		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric 2:\pmanant\SisRoadSpecs_2014\Drawing Files\4541007\UST\N4541007014_w.dwg 05-JAN-2015 13:59 ISC - UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		AT-GRADE RAILWAY CROSSING			Figure 82 File Number 454.1007.014	

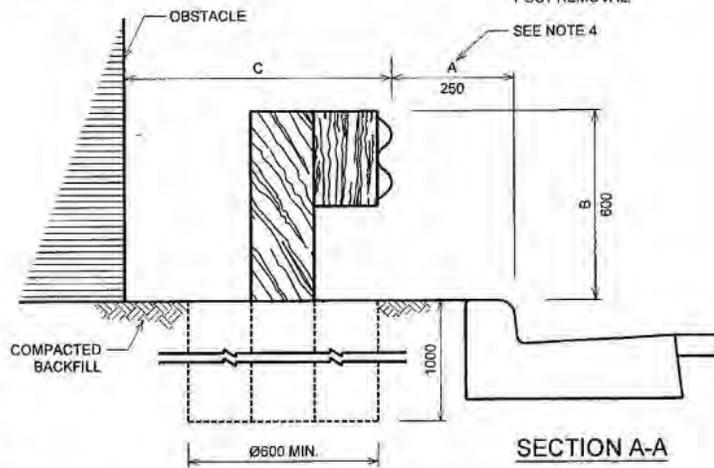


*FOR END TREATMENT DESIGN SEE NOTE 5



TERMINAL END DETAIL

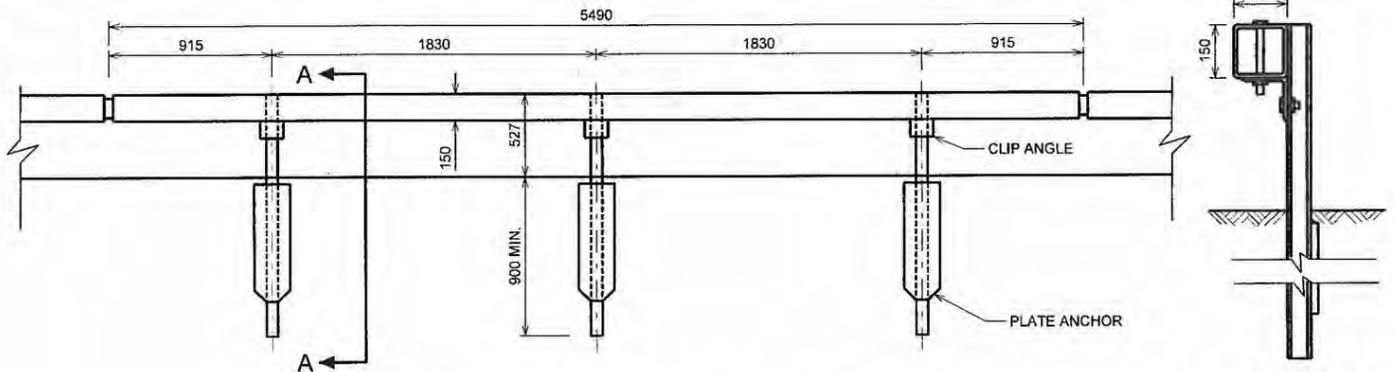
SECTION A-A



NOTES:

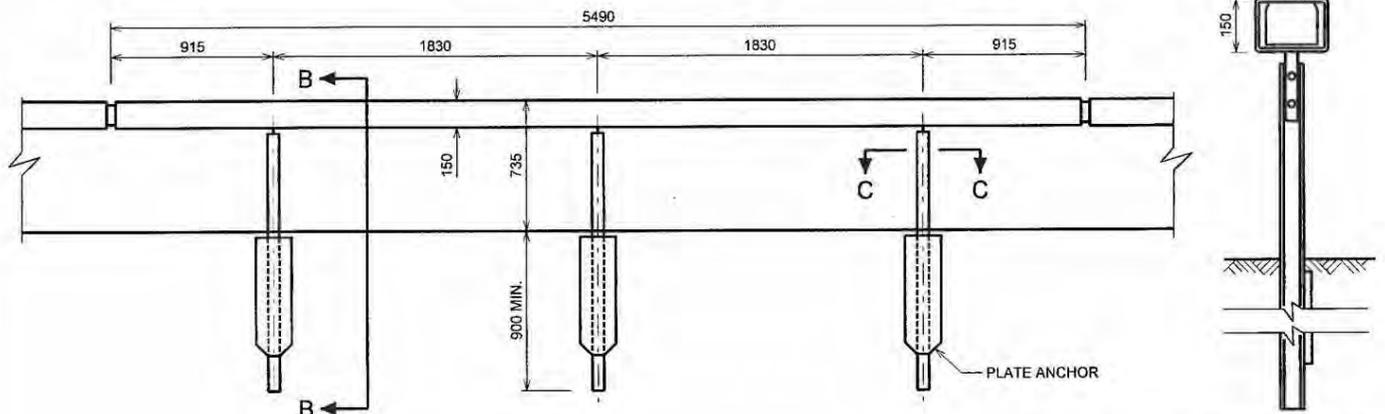
1. WHEN A>250mm, B=685mm.
2. WHEN C>1500, POST SPACING 1905
C<1500, POST SPACING 950
C<850, POST SIZE 250 x 250
3. WHENEVER GUARDRAIL IS INTRODUCED, INITIAL SECTION IS OFFSET 1200 AS SHOWN ABOVE, MINIMUM LENGTH OF TAPER 12.00m.
4. FOR ROADWAYS WITHOUT CURB AND GUTTER, OFFSETS REQUIRED (FROM EDGE OF PAVEMENT) SHALL BE IN ACCORDANCE WITH LATERAL OFFSETS OUTLINED IN ROADSIDE SAFETY SECTION OF 'TAC' MANUAL
5. WHERE APPLICABLE, CRASH ATTENUATING TERMINAL OR ENERGY ABSORBING TERMINAL SYSTEM SHOULD BE USED FOR THE END TREATMENT. REFER TO ALBERTA TRANSPORTATION ROADSIDE DESIGN GUIDE FOR THE DESIGN AND SELECTION OF BARRIER, END TREATMENT AND CRASH CUSHION.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd								
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<p>PERMIT</p> <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>Signature: <i>[Signature]</i></p> <p>Date: <i>[Date]</i></p> <p>PERMIT NUMBER: P 04428</p> <p>The Association of Professional Engineers and Geoscientists of Alberta</p>		<p>THE CITY OF CALGARY ROADS</p>	<p>DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED</p> <p>METRIC</p>	<p>Drawn JL</p> <p>Designed EW</p> <p>Checked EW</p> <p>Scale: NTS</p>	<p>Date 2014-11</p>	<p>W-BEAM BARRIER</p>	<p>Figure 83</p> <p>File Number 454.1001.020</p>												
<p>Z:\work\metr\StdRoadSpecs_2014\Drawing Files\4541001020\4541001020_v6.dgn 22-JAN-2015 09:10 ISC: UNRESTRICTED</p>																			



SHOULDER BARRIER WITH DRIVEN POST

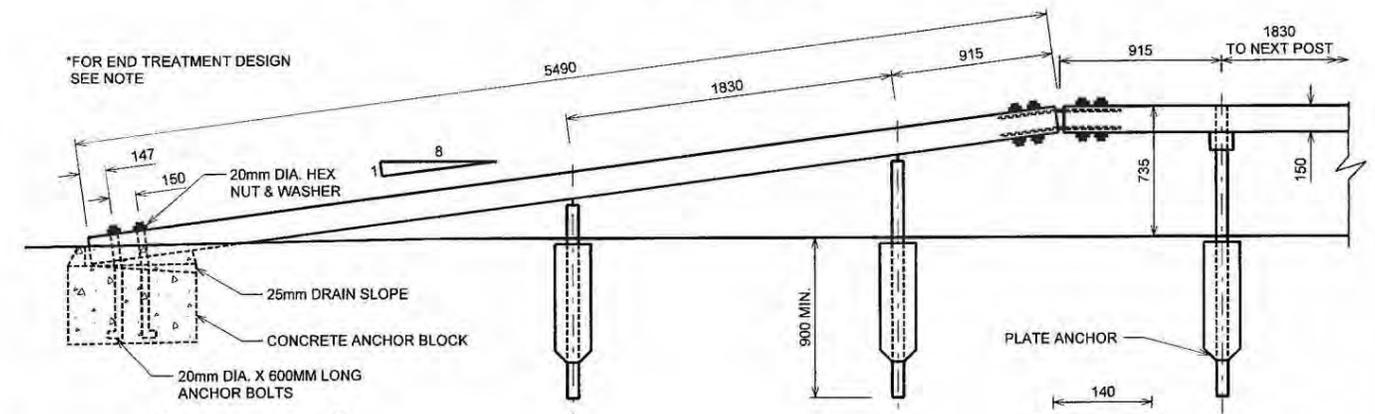
SECTION A-A



MEDIAN BARRIER WITH DRIVEN POST

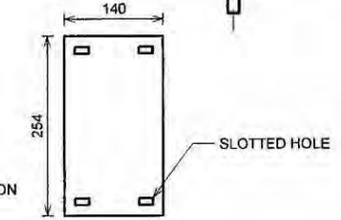
SECTION B-B

*FOR END TREATMENT DESIGN SEE NOTE

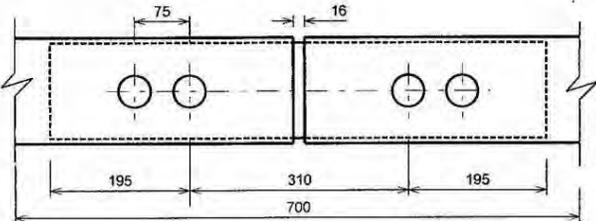


TERMINAL SECTION

NOTE: WHERE APPLICABLE, CRASH ATTENUATING TERMINAL OR ENERGY ABSORBING TERMINAL SYSTEM SHOULD BE USED FOR THE END TREATMENT. REFER TO ALBERTA TRANSPORTATION ROADSIDE DESIGN GUIDE FOR THE DESIGN AND SELECTION OF BARRIER, END TREATMENT AND CRASH CUSHION.

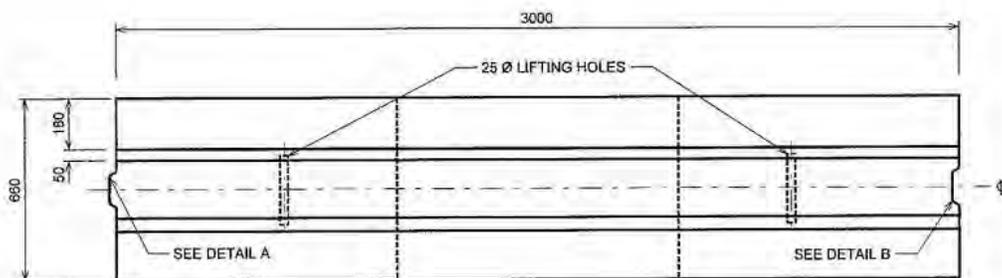


SECTION C-C

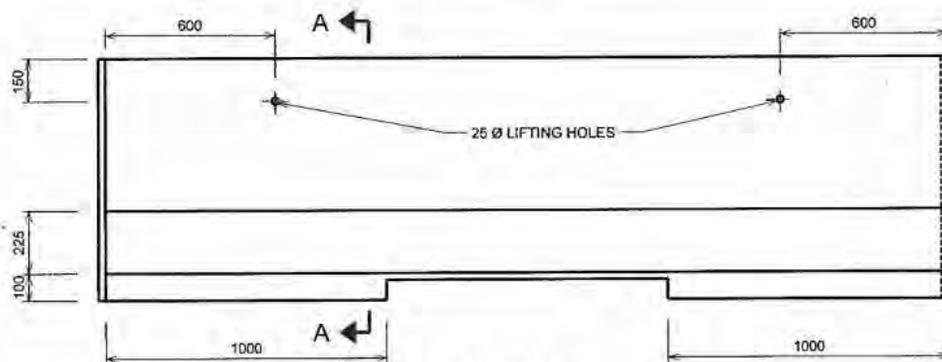


SPLICE DETAIL

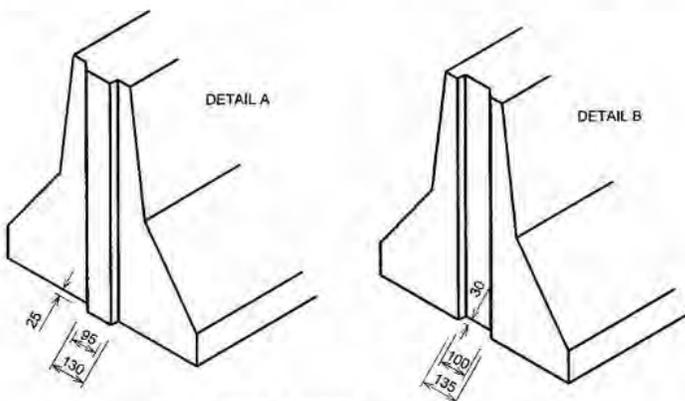
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PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: [Date] PERMIT NUMBER: P-04928 The Association of Professional Engineers and Geoscientists of Alberta		SEAL PROFESSIONAL ENGINEER CIVIL 2015/03/10		THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED M ² TRIC Z:\permanent\NSM\RoadSpecs_2014\Drawing Files\4541001\1\USTN\4541001019_v8.dgn 22-JAN-2015 09:18 ISC: UNRESTRICTED		Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS		BOX-BEAM BARRIER		Figure: 84 File Number: 454.1001.019	



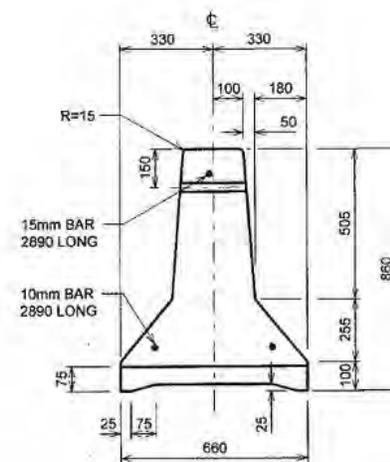
PLAN



ELEVATION



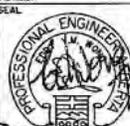
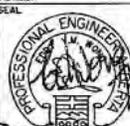
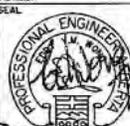
*FOR END TREATMENT DESIGN
SEE NOTE 4

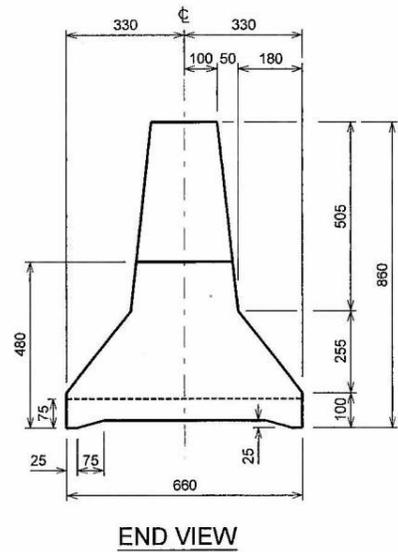
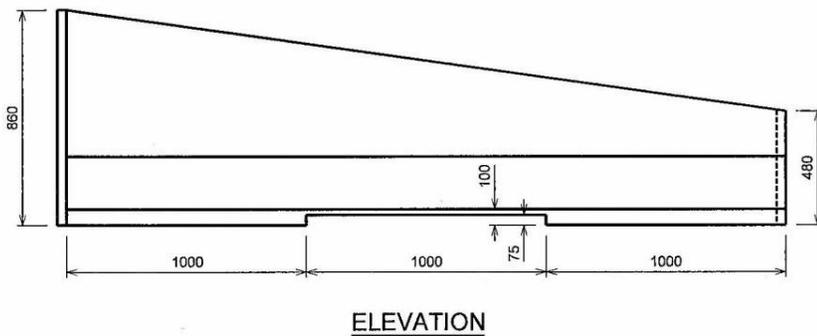
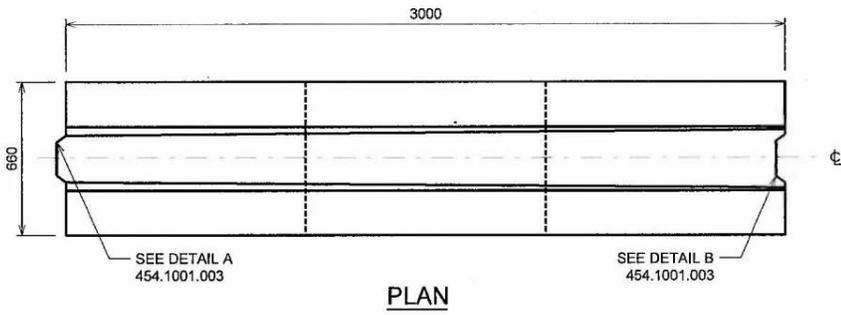
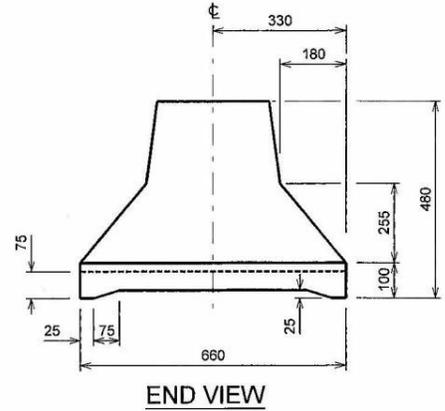
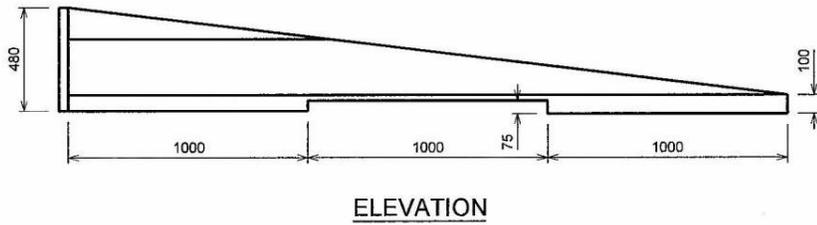
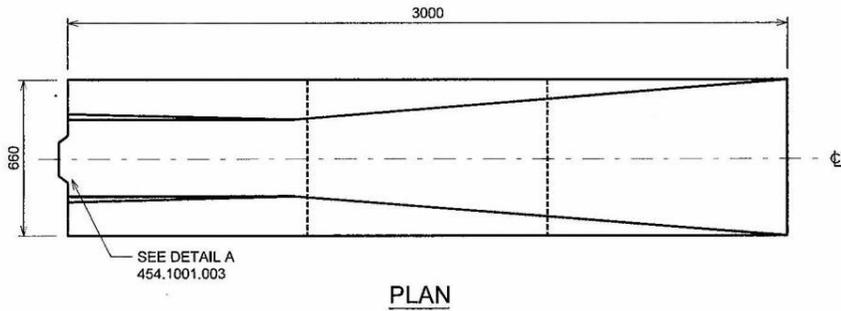


SECTION A-A

NOTES:

1. ALL DETAILING APPLIES TO PRECAST CONCRETE GUARDRAIL.
2. MIN. 150mm OF ASPHALT BEHIND CONCRETE BARRIER AND 0.50m ROUNDING AREA.
3. EXTRUDED CONCRETE GUARDRAIL
 - NO REINFORCING STEEL
 - ELIMINATE LIFT HOLES
 - ELIMINATE BOTTOM 100mm VERTICAL FACE OF BARRIER WHEN LOCALED ON TOP OF CURB
 - SAWING OR DEEP TOOL MARKING OF CONTRACTION JOINTS EVERY 3.00m IS REQUIRED
 - GROSS DRAIN SLOTS AS REQUIRED ARE TO BE FORMED WITH STYROFOAM WHICH WILL BE REMOVED AFTER CONCRETE IS CURED.
4. WHERE APPLICABLE, CRASH ATTENUATING TERMINAL OR ENERGY ABSORBING TERMINAL SYSTEM SHOULD BE USED FOR THE END TREATMENT. REFER TO ALBERTA TRANSPORTATION ROADSIDE DESIGN GUIDE FOR THE DESIGN AND SELECTION OF BARRIER, END TREATMENT AND CRASH CUSHION.

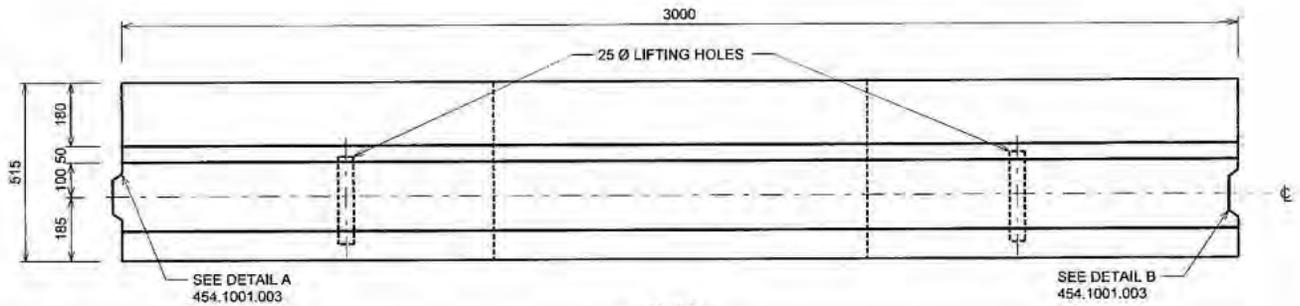
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<p>PERMIT</p> <p>PERMIT TO PRACTICE CITY OF CALGARY</p> <p>Signature: _____</p> <p>Date: _____</p> <p>PERMIT NUMBER: R 04428</p> <p>The Association of Professional Engineers and Geoscientists of Alberta</p>	<p>SEAL</p> 	<p>THE CITY OF CALGARY ROADS</p> <p>DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED</p> <p>METRIC</p> <p>2:\permanent\502Roads\p001_2014\0\sw\rg\F84\4541001\4541001\003_v8.dgn 22-JAN-2011 09:23</p> <p>ISC - UNRESTRICTED</p>	<table border="1" style="width: 100%;"> <tr> <td>Drawn</td> <td>Date</td> </tr> <tr> <td>JL</td> <td>2014-11</td> </tr> <tr> <td>Designed</td> <td>EW</td> </tr> <tr> <td>Checked</td> <td>EW</td> </tr> <tr> <td>Scale:</td> <td>NTS</td> </tr> </table>	Drawn	Date	JL	2014-11	Designed	EW	Checked	EW	Scale:	NTS	<p>CONCRETE BARRIER</p>	<p>Figure</p> <p style="font-size: 24pt; font-weight: bold;">85</p> <p>File Number</p> <p>454.1001.003</p>												
Drawn	Date																										
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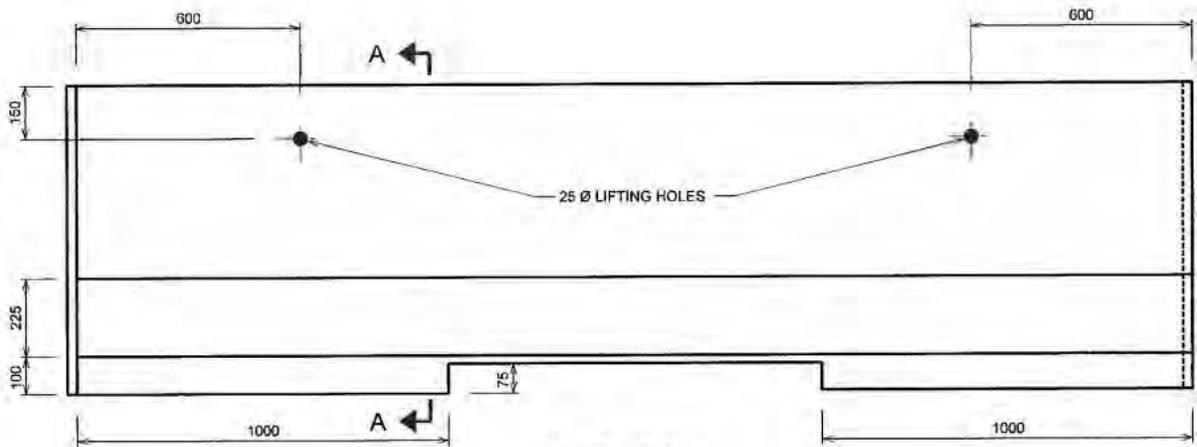
TRANSITION END SECTION

- NOTES:
1. ALL DETAILING APPLIES TO PRECAST CONCRETE GUARDRAIL.
 2. MIN. 150mm OF ASPHALT BEHIND CONCRETE BARRIER AND 0.50m ROUNDING AREA.
 3. EXTRUDED CONCRETE GUARDRAIL
 - NO REINFORCING STEEL
 - ELIMINATE LIFT HOLES
 - ELIMINATE BOTTOM 100mm VERTICAL FACE OF BARRIER WHEN LOCALED ON TOP OF CURB
 - SAWING OR DEEP TOOL MARKING OF CONTRACTION JOINTS EVERY 3.00m IS REQUIRED
 - CROSS DRAIN SLOTS AS REQUIRED ARE TO BE FORMED WITH STYROFOAM WHICH WILL BE REMOVED AFTER CONCRETE IS CURED.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
PERMIT		SEAL	THE CITY OF CALGARY ROADS		Drawn JL	Date 2014-12	CONCRETE BARRIER TRANSITION END SECTION		Figure 86		App'd
PERMIT TO PRACTICE CITY OF CALGARY Signature: [Signature] Date: 2015/03/02 PERMIT NUMBER: P 04428 The Association of Professional Engineers and Geoscientists of Alberta			DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		METRIC	Designed EW	Checked EW	Scale: NTS	File Number 454.1001.011		
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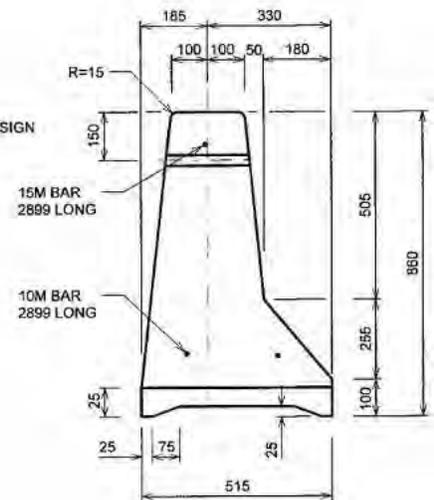


PLAN



ELEVATION

*FOR END TREATMENT DESIGN
SEE NOTE 4



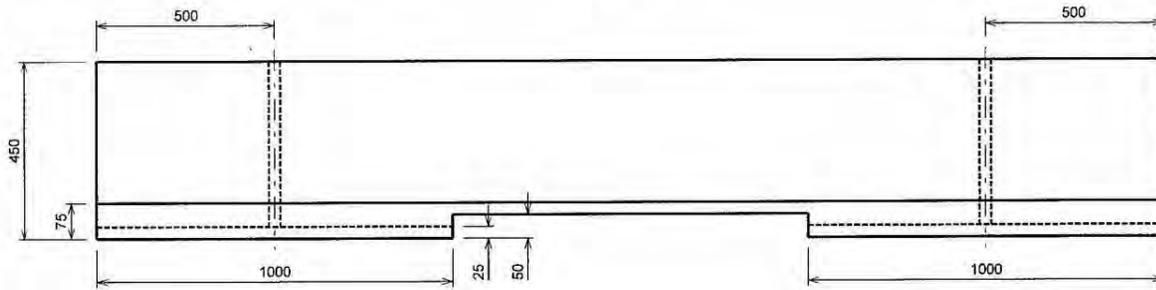
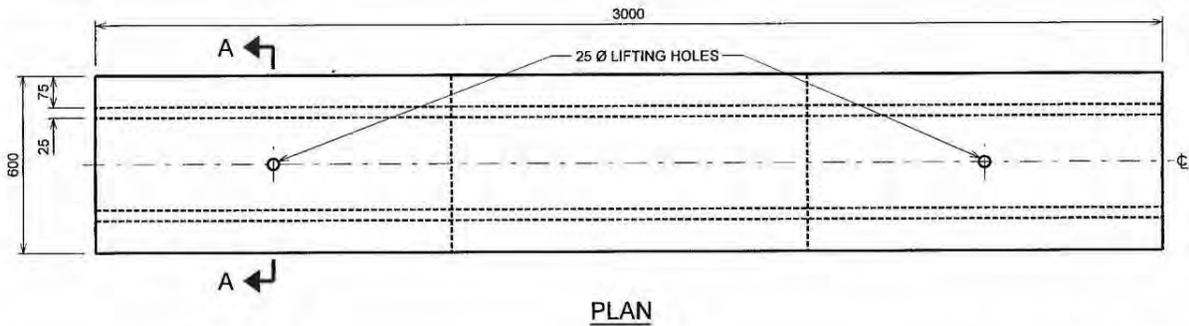
SECTION A-A

NOTES:

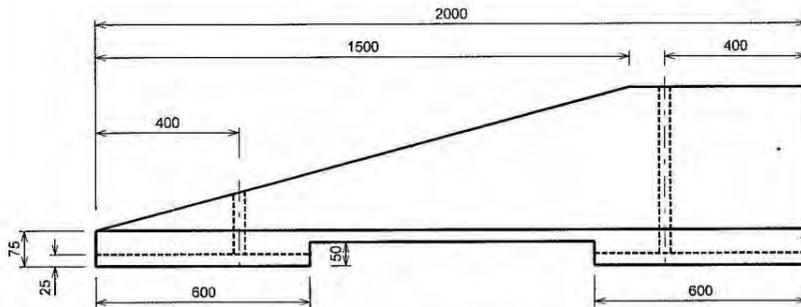
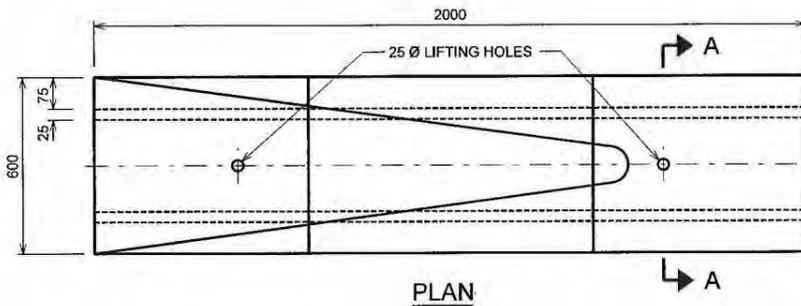
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 - CROSS DRAIN SLOTS AS REQUIRED ARE TO BE FORMED WITH STYROFOAM WHICH WILL BE REMOVED AFTER CONCRETE IS CURED.
4. WHERE APPLICABLE, CRASH ATTENUATING TERMINAL OR ENERGY ABSORBING TERMINAL SYSTEM SHOULD BE USED FOR THE END TREATMENT. REFER TO ALBERTA TRANSPORTATION ROADSIDE DESIGN GUIDE FOR THE DESIGN AND SELECTION OF BARRIER, END TREATMENT AND CRASH CUSHION.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
						Drawn: JL Date: 2014-12		HALF SECTION CONCRETE BARRIER		Figure 87	
Signature: [Signature] Date: [Date]		PERMIT NUMBER: P-4428 The Association of Professional Engineers and Geoscientists of Alberta		DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED		Checked: EW Date: [Date]				File Number 454.1001.025	
Zip: [Address]		2015/03/11		Z:\p\enr\PSR\RoadSpecs_2014\Drawing Files\454.1001.025_v8.dwg		Scale: NTS					
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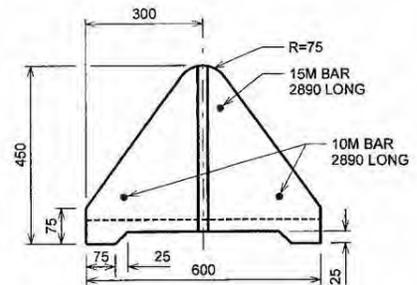
Figure 88: LOW PROFILE CONCRETE BARRIER (454.1001.018)



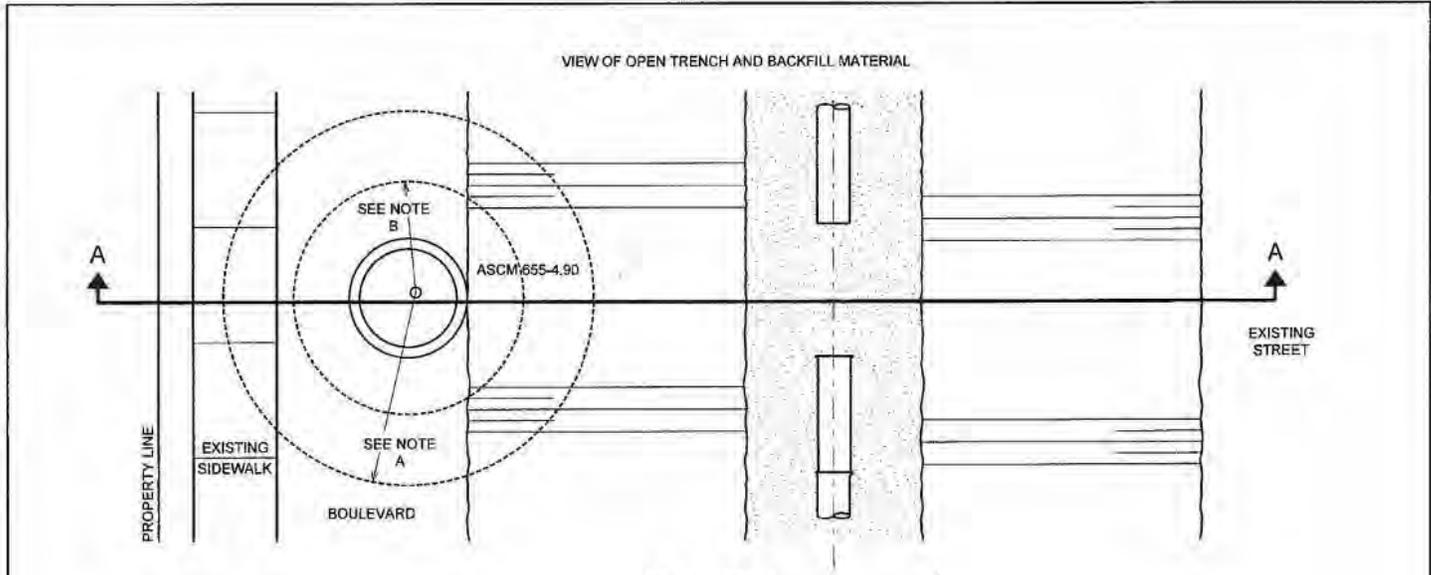
ELEVATION - TANGENT SECTION



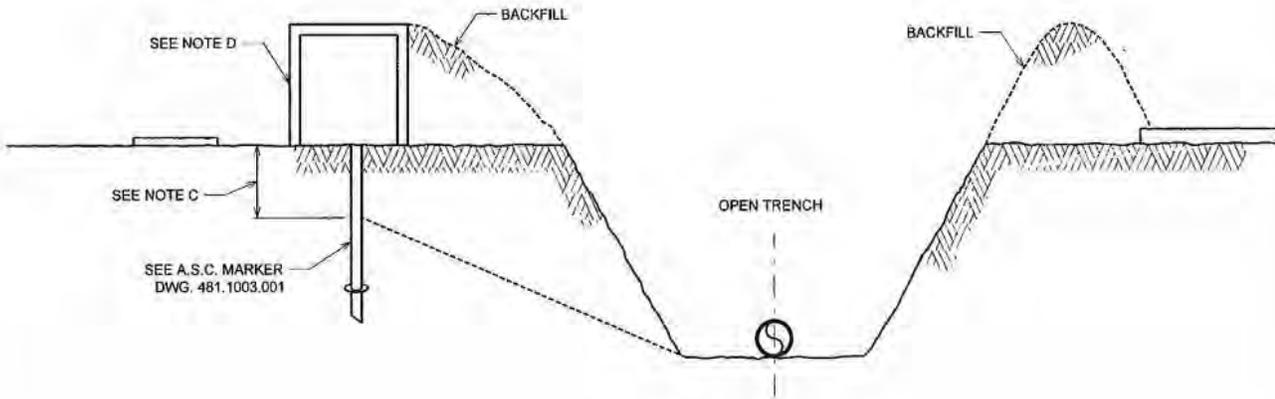
ELEVATION - TAPERED END SECTION



No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd																												
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No. 1 Date: 2015-11-30 Signature: [Signature] Date: 2015-11-30 PERMIT NUMBER: P 01426 The Association of Professional Engineers and Geoscientists of Alberta	SEAL  2015-11-30	THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\pennant\roads\RoadSpecs_2014\Drawing Files\4541001\UST\N4541031018_v8.dgn 09-JAN-2015 14:12 ISC: UNRESTRICTED	Drawn	JL	Date	2014-11	LOW PROFILE CONCRETE BARRIER	Figure	88																														
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PLAN VIEW

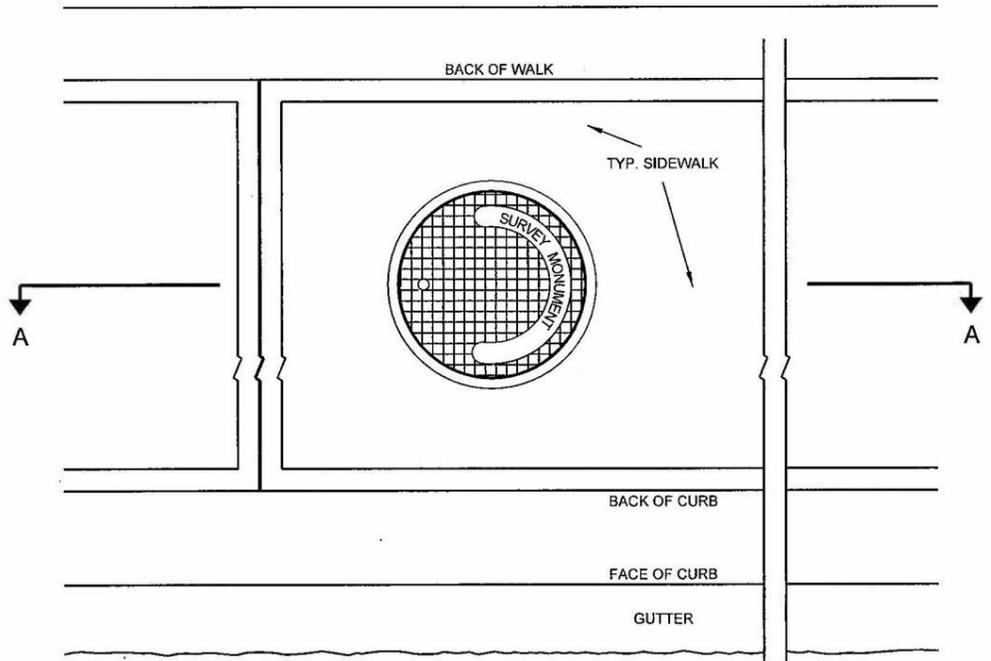


SECTION A-A

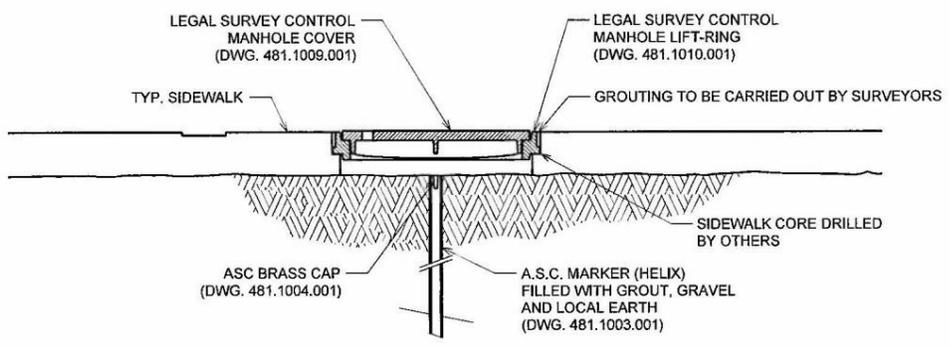
NOTES:

- A. ANY CONSTRUCTION INVOLVED WITHIN 3.00m OF SURVEY MONUMENTATION WHICH MIGHT ENDANGER THAT MONUMENTATION, SHOULD CONTACT THE LEGAL SURVEY SECTION, FIVE (5) WORKING DAYS IN ADVANCE FOR LOCATION, AND AFTER THE WORK IS COMPLETED FOR POSSIBLE MOVEMENT.
- B. IF TRENCH WORK IS GOING TO BE CLOSER THAN 1.50m, REMOVAL AND BACKFILLING, MUST BE CARRIED OUT MANUALLY.
- C. NOT MORE THAN 0.30m OF A SURVEY CONTROL MONUMENT IS TO BE EXPOSED, IF SO REFER TO NOTE 'A' ABOVE.
- D. IF THE SURVEY CONTROL MONUMENT IS GOING TO BE TEMPORARILY COVERED WITH FILL OR ANY OTHER MATERIAL, A SEWER TYPE 'L' BARREL & LID OR COVER (SEE DWG. 452.1001.004 STANDARD SPECIFICATIONS SEWER CONSTRUCTION) SHOULD BE PLACED TO PROTECT MONUMENT.
- E. IF ANY HEAVY EQUIPMENT WORKING WITHIN 10.00m OF A SURVEY CONTROL MONUMENT, THE JOB FOREMAN IS REQUIRED TO LOCATE A GUARD POST AND A SEWER TYPE 'L' BARREL (SEE NOTE 'D'), TO PROTECT THE SURVEY CONTROL MONUMENT DURING CONSTRUCTION.

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd						
PERMIT PERMIT TO PRACTICE CITY OF CALGARY Signature: <i>[Signature]</i> Date: 2014-11-20 PERMIT NUMBER: P-04428 The Association of Professional Engineers and Geoscientists of Alberta			SEAL  PROFESSIONAL ENGINEER 2015/01/14			THE CITY OF CALGARY ROADS DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED Metric Z:\p\manant\StdRoadSpecs_2014\Drawing Files\4811002USTN4811002D01_v8.dgn 05-JAN-2015 14:16 ISC: UNRESTRICTED			Drawn: JL Date: 2014-11 Designed: EW Checked: EW Scale: NTS			ALBERTA SURVEY CONTROL MONUMENT PROTECTION			Figure: 89 File Number: 481.1002.001		

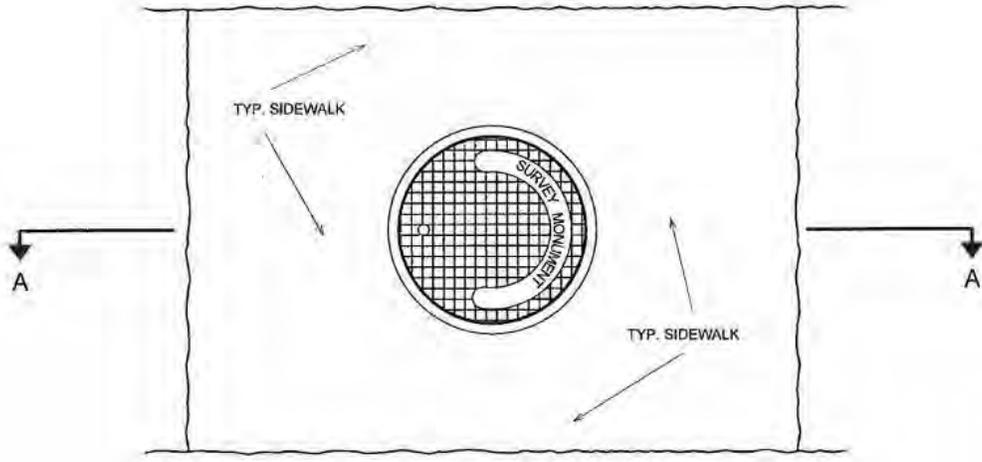


**MANHOLE INSTALLATION
PLAN VIEW**

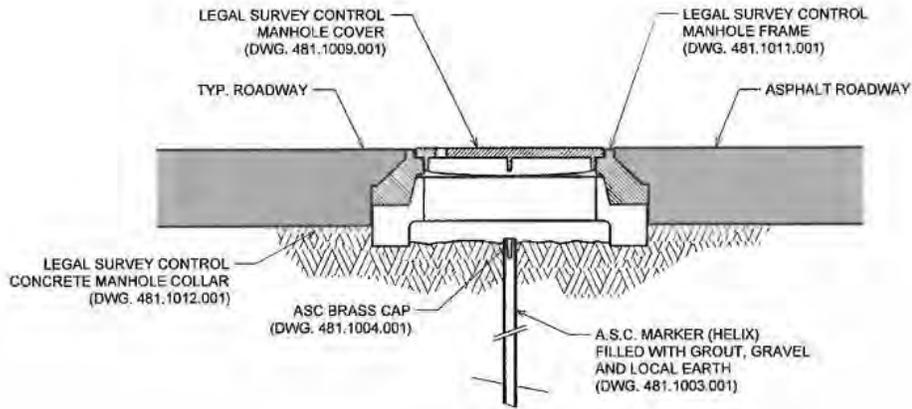


SECTION A-A

No.	Date	Revision	App'd	No.	Date	Revision	App'd	No.	Date	Revision	App'd
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DIMENSIONS ARE METRES OR MILLIMETRES UNLESS OTHERWISE NOTED METRIC Z:\permanent\SiteRoadSpecs_2014\Drawing Files\4811007\USTN\4811007001_v8.dgn 05-JAN-2015 14:21 ISC: UNRESTRICTED											



MANHOLE INSTALLATION
PLAN VIEW



SECTION A-A

No.	Date	Revision	App'd No.	Date	Revision	App'd No.	Date	Revision	App'd	
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