

SCHEDULE 18
Technical Requirements

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100.0 GENERAL

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100.0 GENERAL

100.1 INTRODUCTION

References to section numbers in this Schedule are to section numbers of the Technical Requirements unless expressed otherwise.

This Section covers the general technical requirements applicable to all design, construction and operations of the Infrastructure.

The information in the Technical Requirements is organized as follows:

- Section 100 – General;
- Section 200 – Project Specifics;
- Section 300 – Design and Construction - New Infrastructure;
- Section 400 – Operations - New Infrastructure and Existing Infrastructure;
- Section 500 – Handback Requirements;
- Appendix A – Drawings;
- Appendix B – Select Department Standard Drawings and Reference Tables;
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- Appendix D - *Historical Resources Act* (Alberta) Clearance;
- Appendix E – Guide Signing for New Infrastructure;
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- Appendix H – Automatic Traffic Recorder (“**ATR**”) Specifications;
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- Appendix J – Traffic Modeling and Traffic Signal Guidelines (Packages A-F); and
- Appendix K – Burial Site Protocol.

In the event of any conflict or inconsistency between the Sections/Appendices, such conflict or inconsistency shall be resolved on the basis of the wording in the higher up in the following list:

- Sections 100.1 and 200, including Appendices A, B, D, E, F, G, H, I, J and K;
- Sections 300, 400 and 500; and
- Section 100.2.

References to any standards, publications, policies, guidelines or other requirements in the Technical Requirements (the “**Standards**”), are to the Standards that existed as of the deadline for the submission of SR Package 2 (as set out in the Request for Proposals issued by the Department for the DBFO Agreement), unless otherwise specified.

Any Standards written by the Department, including without limitation Department Standard Drawings, can be found (or the location of where they can be found) on the Department’s website and/or the Electronic Data Room (as defined in the RFP). Subject to the foregoing paragraph, the Contractor shall use the latest revision for the Standard Drawings referred to in

this Schedule 18. Standard Drawings referenced in the text of this Schedule 18 are listed in Part 1 of Appendix B.

100.1.1 DEFINITIONS

In this Schedule 18 (Technical Requirements), capitalized terms shall have the corresponding meaning as set out in section 1.1 of the DBFO Agreement (as defined below) and the following expressions shall have the following meanings (and where applicable their plurals have corresponding meanings):

“511 Alberta” means the traveller information service operated by the Department that provides information on highway conditions, roadwork, network incidents, weather alerts, etc;

“As-Built Construction Reports” has the meaning as set out in Section 300.3.3;

“Alberta Environment” means Alberta Environment and Parks or the applicable successor department by the then applicable name;

“Approved Product” means the products designated as “Approved Products” in the “Products List” posted to the Department’s website;

“Bare Pavement” means the travel lanes, and walkway/pathways being free of snow, packed snow, frost and ice;

“Bridge Design Code” has the meaning as set out in Section 300.5.1.1;

“bridge structures” include bridges, bridge size culverts (1.5 metre diameter or larger), retaining walls, tunnels, and overhead and cantilevered sign structures that form the Infrastructure;

“Bridge Welding Code” has the meaning as set out in Section 300.5.1.1;

“C-D” means collector-distributor;

“Check Engineer” has the meaning as set out in Section 100.2.1.1;

“Construction Quality Manager” has the meaning as set out in Section 100.2.1;

“Contractor’s Engineer” means a Professional Engineer or engineers that are employed by or retained by the Contractor for the carrying out of the Project and the O&M;

“County” means Rocky View County;

“CPR” means Canadian Pacific Railway Company;

“DBFO Agreement” means the Agreement to Design, Build, Finance and Operate Southwest Calgary Ring Road between Her Majesty the Queen in right of Alberta and the Contractor, as defined therein, to which agreement this Schedule 18 (Technical Requirements) is attached;

“Department” means the Province, as represented by the Minister of Transportation, or its expressly authorized representatives or agents;

“Department of Infrastructure” means the Province, as represented by the Minister of Infrastructure;

“Detailed Designs” means the plans, specifications and drawings that the Contractor is required to provide pursuant to section 5.9 of the DBFO Agreement;

“Design Engineer” has the meaning as set out in Section 100.2.1.1;

“Design Guidelines for Bridge Culverts” has the meaning as set out in Section 300.5.1.1;

“Drafting Guidelines” has the meaning as set out in Section 300.5.1.1;

“EB” means eastbound;

“ECO Plan” has the meaning as set out in the third paragraph of Section 100.2.2;

“Elevated Directional Ramps” means the Systems Ramps at Systems Interchanges which will result in a third vertical level of traffic movement were the Systems Ramp placed at the centre of an interchange. The limits of a particular Elevated Directional Ramp are considered to be from the exit gore from one intersecting roadway mainline to the entrance gore of another intersecting roadway mainline;

“Existing O&M Payment” has the meaning as set out in section 2 of Schedule 14 (Payment Schedule) to the DBFO Agreement;

“Field Review Engineer” has the meaning as set out in Section 100.2.1.2;

“Functional Plan” means the Southwest Calgary Ring Road (Highway 201), Functional Planning Study – Glenmore Trail/Stoney Trail Interchange to Highway 22X/Sarcee Trail Interchange – Final Report dated August 2008 prepared by Focus Corporation; West Calgary Ring Road, Functional Planning Study – Stoney Trail – 69 Street SW to Highway 1 (Trans-Canada Highway) Final Report dated June 2010 prepared by Focus Corporation; and the South Calgary Ring Road, Functional Planning Study – Macleod Trail SE to 85 Street SW dated August 2011 prepared by Focus Corporation;

“Highway Geometric Design Guide” has the meaning as set out in Section 200.2.2;

“Infrastructure” means the New Infrastructure and the Existing Infrastructure;

“In-Service Roads” has the meaning as set out in Section 200.3.10 (Operation and Maintenance of In-Service Roads During Construction Period);

“Local Authority” means Local Authority (as defined in the DBFO Agreement) or the TTN, as applicable;

“Mainline” means both Calgary Ring Road and Highway 22X within the Project Limits;

“MASH” means *AASHTO Manual for Assessing Safety Hardware (2009)*;

“MD” means the Municipal District of Foothills No. 31;

“Ministerial Consent” the written consent of the Department of Infrastructure pursuant to section 5(2) of *Calgary Restricted Development Area Regulations (AR 212/76, as amended)*;

“NB” means northbound;

“NE” means northeast;

“New O&M Payment” has the meaning as set out in section 2 of Schedule 14 (Payment Schedule) to the DBFO Agreement;

“NW” means northwest;

“Outer Ring Road” means the future carriage ways to be within the median of the Calgary Ring Road, as shown on Drawings 18-A-03.01SW to 18-A-03.11SW in Appendix A;

“P-Drawings” has the meaning set out in Section 300.5.2.21(c);

“Professional Engineer” means an individual who holds a certificate of registration to engage in the practice of engineering under the *Engineering and Geoscience Professions Act, R.S.A. 2000, c. E-11*, or any replacement legislation;

“Project Limits” means the limits of the Project as identified in Drawings 18-A-02.01SW to 18-A-02.11SW in Appendix A, to the extent allowable by the directional arrows set out in such Drawings;

“Project Quality Manager” has the meaning as set out in Section 100.2.1;

“Province” means Her Majesty the Queen in right of Alberta;

“Quality Field Staff” has the meaning as set out in Section 100.2.1;

“Reclamation Certificate” means a reclamation certificate for disturbed lands as required by the *Environmental Protection and Enhancement Act* (Alberta), R.S.A. 2000, c. E-12, or any replacement legislation;

“Record Drawings” has the meaning as set out in Section 300.3.3.6;

“Roadside Design Guide” has the meaning as set out in Section 200.2.2;

“roadways” include all Mainline lanes and shoulders, interchange ramps, crossroads and other roads that form the Infrastructure, as well as the associated drainage systems, lighting, signage, signals, markings, landscaping, fencing and other appurtenances, excluding bridge structures;

“SB” means southbound;

“Schedule of Lane Closures” has the meaning as set out in Section 400.1.6;

“SE” means southeast;

“Service Roads” has the meaning provided in Section 200.2.3.18;

“Severe Storm Event” has the meaning as set out in Section 400.3.1;

“Stage 1” means the initial configuration of the New Infrastructure as described in the Functional Plan (year 2035) and as modified and further detailed in the Technical Requirements;

“Standard Drawing” means one of the standard design drawings developed by the Department and made known (in part via posting on the Department’s website and/or the Electronic Data Room (as defined in the RFP) to the road design/build/operate industry in Alberta, some of which are listed in Part 1 of Appendix B;

“Storm Event” has the meaning as set out in Section 400.3.1;

“SW” means southwest;

“Systems Interchange” means the Sarcee Trail, Anderson Road, Highway 22X and Macleod Trail interchanges with the Calgary Ring Road;

“Systems Ramps” means the ramps carrying traffic from freeway to freeway and the limits are considered to be from the painted exit gore from one freeway mainline to the painted entrance gore of another freeway mainline;

“TAC Geometric Design Guide” has the meaning as set out in Section 200.2.2;

“Temporary Use Area” has the meaning as set out in the EA (as defined in Section

200.2.13);

“**Third Party Leased Lands**” has the meaning as set out in Section 200.3.4.1;

“**TTN**” means the Tsuut’ina Nation;

“**TUA**” means Temporary Use Area:

“**Ultimate Stage**” means the planned final configuration of the New Infrastructure as described in the Functional Plan and as modified and further detailed in the Technical Requirements;

“**WB**” means westbound; and

“**Witness Point**” means a point of time in the construction process when it would be unreasonably onerous or impossible to confirm conformance to the Technical Requirements of either materials or workmanship once work proceeds past this point.

Appendix F contains a list of acronyms frequently used within the Technical Requirements.

Words and abbreviations which are not defined in the Technical Requirements or the DBFO Agreement and which have well known technical or trade meanings and which are used in the Technical Requirements are used in accordance with such recognized meanings.

Standard units of measurement may be abbreviated in the Technical Requirements.

The City of Calgary includes the quadrant information with street names. For the purpose of this Schedule, any street names without the subsequent quadrant information (e.g. “SW”) are referring to the associated cross street within the Project Limits.

100.2 MANAGEMENT SYSTEMS AND PLANS

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Contractor’s Construction Schedule and the Contractor’s Management Systems and Plans to comply with the Technical Requirements.

100.2.1 QUALITY MANAGEMENT SYSTEM

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Quality Management System (the “**QMS**”), as attached in Schedule 4 (Contractor’s Management Systems and Plans) to the DBFO Agreement.

The QMS shall be consistent with all of the requirements of the *ISO 9001:2015* and shall cover all activities, products and services related to the Project and the O&M, prior to the execution of

these activities, products and services. The Contractor shall make all QMS records available to the Department for inspection and review. The Contractor shall provide the Department with a copy of any or all quality records when requested within 48 hours of the request. The QMS shall address all stages of the Project and the O&M, specifically:

- Design;
- Construction; and
- Operations, including maintenance and rehabilitation.

The QMS shall stipulate how compliance with the Technical Requirements and the Contractor's Management Systems and Plans is ensured. During all stages of the Project and the O&M, work shall not be started on any work items until after the QMS has been completed and submitted to the Department in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure) for that component of the work. All records from the QMS for design, construction, operation, and maintenance, including all audits, shall be maintained and retained by the Contractor until the expiry of two years after the end of the Term or until otherwise agreed to in writing by the Department.

The Contractor's QMS shall include without limitation the following work items:

- Grading;
- Base course;
- Pavement;
- Drainage;
- MSE walls and retaining walls;
- Foundation/Piles;
- Concrete reinforcement;
- Cast-in-place concrete;
- Steel girders;
- Precast girders;
- Bridge bearings;
- Bridge deck construction;
- Girder post tensioning;
- Bridge deck joints;
- Bridgerail;
- Culverts;
- Signs and sign structures; and
- Lighting/signals.

Quality managers for each of the overall project, design, and construction components shall be named in the QMS. Substitutions for the quality managers named in the QMS shall be subject to the Department's review and approval. The QMS shall require that all quality managers possess certification as quality professionals from appropriate certifying bodies, or have successfully completed training courses in the quality discipline. As a minimum, these courses shall include a two day introductory course to *ISO 9001:2015*, and a one week External or Lead Auditor course

based on *ISO 9001:2015*. In addition, the QMS shall require that the quality manager for the design component (“**Design Quality Manager**”) shall be a Professional Engineer with at least five years of experience within the past 10 years overseeing the design of major urban freeways, and that the quality manager for the overall project (“**Project Quality Manager**”) and the quality manager for construction (“**Construction Quality Manager**”) each have at least five years of experience within the past 10 years as quality managers on major highway and bridge construction projects.

The QMS shall require that the Design Quality Manager and Construction Quality Manager shall report directly to the Project Quality Manager, who shall be independent of the construction process and shall report to a member of the executive management team of the Contractor and cannot report to an executive management member that represents a subcontractor of the Contractor.

The QMS shall require that the Construction Quality Manager have a minimum of ten qualified and experienced field staff individuals (the “**Quality Field Staff**”), who are independent of the production process, and who report directly to the Construction Quality Manager. Materials testing personnel, laboratory testing personnel, and quality control staff dedicated to precast girder fabrication, are not considered within this minimum number of Quality Field Staff. The Quality Field Staff shall be certified in Alberta as either a Professional Engineer or a certified engineering technologist and have a minimum of three years of direct construction inspection experience on major highway and bridge construction projects, specific to the work items for which they are responsible. A minimum of three of the Quality Field Staff shall meet the qualifications of Bridge Construction Inspection as defined in Appendix J3 of Volume 1 of the Department’s “*Engineering Consulting Guidelines for Highway, Bridge, and Water Projects*”. Additionally, all Quality Field Staff responsible for inspecting cast-in-place concrete shall be certified as a Concrete Field Testing Technician – Grade 1, and shall have a minimum of three years of direct experience in concrete construction and concrete quality control inspection, including cold weather, materials, placement, and curing experience.

Within 30 days of signing of the DBFO Agreement, or at a date mutually agreed between the Contractor and the Department, the Contractor shall convene a meeting to discuss and agree on document management procedures to be implemented on the Project. Within six months of the first meeting, the Contractor shall convene a second meeting with the Department to review the effectiveness of the document management measures based on feedback from all parties, and to implement any agreed upon procedural changes.

Within 60 days of signing of the DBFO Agreement, or at a date mutually agreed between the Contractor and the Department, the Contractor shall convene a meeting to discuss and confirm the Department’s layout requirements for roadway and bridge design drawings and to confirm shop drawing submission requirements.

The QMS shall include, but not be limited to:

100.2.1.1 Design

The QMS shall require all designs, drawings, specifications and similar documents, for all aspects of the Project and the O&M, to be stamped and signed by Professional Engineers (the “**Design Engineer**”) in accordance with *Association of Professional Engineers, and Geoscientists of Alberta (APEGA) Practice Standard for Authenticating Professional Documents V3.1*.

The QMS shall require two levels of design checks as listed below:

- (a) The QMS shall require all design work, including supplier designs, to be checked by a qualified Professional Engineer (the “**Check Engineer**”). The Check Engineer may be employed by the same legal entity doing the design work, provided the Check Engineer was not involved in that component of the design work. The Check Engineer shall stamp and sign all applicable design reports, drawings and specifications.
- (b) The QMS shall require all bridge structure design work, including supplier designs (e.g. bearings, expansion joints, MSE walls, cover plates, etc.), to be reviewed by a qualified, independent Professional Engineer (the “**Review Engineer**”) selected by the Contractor but approved by the Department, acting reasonably, within 30 days of signing of the DBFO Agreement. The Review Engineer shall be employed by a legal entity that is not carrying out any design work for the Project, and that is at arm’s length from and completely independent of the Contractor and any entity carrying out any design or design checking work for the Project. The design review for bridge structures done by the Review Engineer shall include, but not be limited to, the following:
 - Complete review of the design data drawings and re-analysis of all aspects of the original design including hydrotechnical, geotechnical, geometric and operational safety components;
 - Complete review and re-analysis of all aspects of the original structural design, preferably (but not essentially) by a methodology other than that used in the original design to ensure that the design parameters are relevant, the structural system is sound and the structural members are appropriately sized and detailed;
 - Ensuring that the engineering drawings and construction specifications accurately convey the requirements of the original design; and
 - Ensuring the completeness, integrity and accuracy of all aspects of the engineering drawings and construction specifications.

Without limitation, all engineering designs shall have received the design checks required by this Section 100.2.1.1, prior to submission for the Department’s review. In addition to the relevant design, and at the same time the Contractor submits the engineering designs to the Department for review, the Contractor shall provide to the Province a certificate signed by the Design Engineer, the Check Engineer or the Review Engineer certifying that the design was prepared in accordance with the Technical Requirements.

If a non-conformance in the design is determined at any time, including after construction, the

Contractor shall undertake the necessary modifications to ensure the as-built New Infrastructure is in accordance with the Project Requirements.

100.2.1.2 Construction

The QMS shall provide for ensuring that the as-built New Infrastructure is in conformance with the requirements of the Detailed Design and construction specifications developed for the New Infrastructure. The Contractor shall implement a methodology to verify compliance of the construction with the design requirements. Changes made to the design during construction shall be verified by the Field Review Engineer (as defined in the paragraph below) and stamped and signed by the Design Engineer.

The QMS shall require that a qualified Professional Engineer be designated to each component of construction (the “**Field Review Engineer**”), to assure that the construction of their respective component substantially conforms to the Detailed Designs and to the Technical Requirements, and that each Field Review Engineer stamps a certificate stating that the construction component for which they have been designated responsibility has been built substantially according to the Detailed Designs and the Technical Requirements. Field Review Engineers shall be Professional Engineers with a minimum of five years’ experience directly related to their assigned components of construction. Field Review Engineers shall report directly to the Project Quality Manager and be independent of the production process. Field Review Engineers and their designated Quality Field Staff shall be physically present at the site of construction activities for a sufficient duration to thoroughly review all aspects of the work. The Project Quality Manager shall provide and make changes to the Quality Field Staff resources as may be required by the Field Review Engineers to ensure that sufficient and qualified resources are allocated.

At a minimum, the Field Review Engineer shall produce a stamped certificate at the following junctures:

- Roadway subgrade – at completion of each section;
- Roadway base – at completion of each section;
- Roadway surfacing – at the completion of each section;
- Driven foundation piles – at completion of driving and before cut-off for each substructure;
- MSE walls – after completion of each foundation base preparation and before construction;
- MSE walls – prior to each substructure concrete placement;
- Substructure concrete – prior to installation of bearings for each substructure;
- Bridge bearings – prior to girder erection for each bridge;
- Bridge deck formwork – prior to deck reinforcing steel placement for each bridge;
- Deck reinforcing steel – prior to deck concrete placement for each bridge;
- Deck concrete placement – prior to placing barriers, deck joints, or waterproofing for each bridge;
- Bridgerail – at completion of each bridge;
- Bridge deck joints – at completion of each bridge;

- Sign structures – at completion of fabrication and prior to shipping of each structure;
- Sign structures – at completion of installation of each structure;
- Waterproofing – prior to placing ACP for each bridge;
- Bridge deck asphalt paving – at completion of each bridge;
- Bridge-sized culverts – at completion of each culvert;
- Tunnels – at the completion of foundation work;
- Tunnels – at completion of the tunnel prior to backfilling; and
- Roadway lighting – at completion of each section.

The Project Quality Manager shall have a minimum of five full-time Field Review Engineers. Individual components of construction shall include but are not limited to:

- Structures;
- Structural Fabrication;
- MSE wall;
- Roadwork; and
- Lighting and Signals.

Specifically for MSE walls, the QMS shall require that each supplier have full time representation on site during MSE wall construction and during any ground improvement measures below the wall, and that the MSE wall designer be given the responsibility of Field Review Engineer for all MSE walls, including all associated surface and subsurface drainage measures.

Field Review Engineers for each component of the Project shall be named in the QMS. Substitutions for the Field Review Engineers named in the QMS shall be subject to the Department's review and approval. Each Field Review Engineer shall not be responsible for more than one of the components of construction.

Witness Points shall be identified in the QMS and require acceptance by the Department. The Department shall be given sufficient notice of all upcoming Witness Points to allow auditing of the work. The QMS shall require confirmation of inspection of Witness Points by Quality Field Staff prior to proceeding with the work. The Quality Field Staff shall complete a comprehensive checklist at each Witness Point and the checklist shall be accepted by the Construction Quality Manager before construction proceeds further. The Construction Quality Manager shall be responsible for the accuracy and completeness of the checklist.

The QMS shall require that notice for concrete pours for the following Business Day be provided by email to the Department before noon of the previous Business Day, and shall identify the estimated time, location and element to be poured. The QMS shall further require that on the day of the pour, not less than four hours' notice be given to the Department by email indicating the actual pour time, and notice be given to the Department by email as soon as practicable after the pour confirming that all work is complete.

The QMS shall require that a completed checklist be signed off by the Contractor's Quality Field Staff, and that this checklist be on site and available to the Department not less than four hours

prior to the planned delivery of concrete. At least one member of the Quality Field Staff shall be on site for the full duration of every concrete pour. The Quality Field Staff shall be responsible for inspecting all aspects of the concrete operations in accordance with the QMS developed to meet the Technical Requirements.

The QMS shall require that a superintendent be identified as responsible for each bridge site, and that the superintendent or his/her designate shall maintain a daily journal that includes details of quality control measurements and observations made during the execution of all components of the work. The QMS shall require that a printed set of “Issued for Construction” drawings be maintained at the field location of each bridge site. These drawings shall be redmarked in the field so that changes to design details are accurately recorded immediately after the work is performed. These drawings shall be available for review at all times by the Department.

For all construction materials and products, and for all components, the QMS shall detail the testing and acceptance program, including, but not limited to, the following:

- Material property or characteristics to be measured or inspected;
- Test methods and reference standards;
- Testing frequency;
- Independent quality assurance and quality control inspection criteria and frequency;
- Criteria for product acceptance/rejection; and
- Witness Point sign-off by the Quality Field Staff.

The QMS shall require that monthly fabrication schedules be provided to the Department for the fabrication of all steel work and precast concrete work, and that updates to these are provided weekly if and when changes are made to them.

The QMS shall require that pre-construction meetings be held for each bridge structure prior to:

- Fabrication of precast concrete elements;
- Fabrication of structural steel elements, including sign structures and bridgerail;
- Construction of MSE walls;
- Construction of tunnels; and
- Concrete deck pours.

The QMS shall require the Contractor to conduct pre-construction meetings after the relevant shop drawings have been reviewed in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure) to the DBFO Agreement, one week before fabrication commences. The Contractor shall provide notice to the Department by email at least one week prior to the meeting so that the Department may attend. The meeting shall be held at the fabricator’s plant and the Contractor shall ensure that the Field Review Engineer, plant superintendent and plant manager responsible for the work and any manufacturer’s representative directly involved in the work are in attendance.

The QMS shall require that complete testing/inspection reports be prepared for the Project and the O&M, including all test results and inspection activities for all grade, subbase, base and

surfacing materials, bridge structures, curb and gutter, sidewalks, drainage items, lighting, signals, signage, pavement markings, and other appurtenances.

100.2.1.3 Operations

The QMS shall provide for ensuring that the Project and the O&M conform to the Project Requirements and the O&M Requirements respectively, as well as operating consistently with adjoining roadways.

The Contractor shall update annually during the PNI Operating Period and the Operating Period, the plans detailing the inspection, operation, maintenance, and New Infrastructure rehabilitation activities that will be conducted during the upcoming year to ensure that all requirements in the DBFO Agreement are met. The plans shall include information on scheduling, traffic management and communications with stakeholders.

Non-conforming inspection, operation, maintenance and rehabilitation will be considered unacceptable and the Contractor shall undertake the necessary modifications to ensure conformance with the Technical Requirements.

100.2.1.4 Audits

100.2.1.4.1 Internal Audit

The Contractor shall undertake QMS Internal Audits, as per *ISO 9001:2015 Element 8.2.2*, during design, construction and operation, during the Construction Period and the Operating Period. The auditor shall be certified by an accredited auditors' registration body such as International Register for Certificated Auditors (“**IRCA**”), Registrar Accreditation Board (“**RAB**”), National Quality Institute (“**NQI**”), or other equivalent. The auditor shall follow the guidelines for *Auditing Management Systems, ISO 19011:2011*, as amended or substituted from time to time. The audit shall, at a minimum, ensure that all input requirements are adhered to and that the QMS is implemented and in compliance with the requirements of *ISO 9001:2015*, as amended or substituted from time to time, customer requirements and applicable regulatory standards. All components shall be audited at least twice per year, and prior to the start-up of all new components and fabrication activities.

All QMS deficiencies identified by the internal QMS auditor during the audit must be addressed and corrective measures implemented by the Contractor. The Contractor shall communicate the results of all audits to the Department.

100.2.1.4.2 External Audit

In addition to the internal audits, the Contractor shall undertake QMS external audits during the design, construction and operation during the Construction Period and the Operating Period.

These external audits shall be conducted by an independent QMS auditor certified by an accredited auditors' registration body such as International Register for Certificated Auditors,

Registrar Accreditation Board, National Quality Institute, or other equivalent body. The auditor shall also be qualified to audit the scope of the QMS. The audit process shall follow the guidelines for *Auditing Management Systems, ISO 19011:2011*, as amended or substituted from time to time. The audit shall, at a minimum, ensure that all input requirements are adhered to and that the QMS is implemented and in compliance with the requirements of the *ISO 9001:2015* standard, as amended or substituted from time to time, customer requirements and applicable regulatory standards. A full system audit shall be completed within one year of the Execution of the DBFO Agreement and thereafter at least once per year during the Construction Period and the Operating Period.

All QMS deficiencies identified by the external QMS auditor during the audit shall be addressed and corrective measures implemented by the Contractor within 30 days of completion of the audit. The results of the audit shall be documented and shall be submitted by the Contractor to the Department within seven days of audit completion. Evidence of the correction of any deficiencies identified in the audit shall be submitted by the Contractor to the Department within 30 days of completion of the audit.

If an external audit has not been completed within the specified time, Payment Adjustments of \$2,400/week or any partial week, for the first four weeks and \$6,000/week or any partial week, thereafter shall apply until so completed.

If any deficiencies identified by the external QMS auditor have not been corrected within the specified time, Payment Adjustments of \$6,000/week or any partial week, for the first four weeks and \$12,000/week or any partial week, thereafter shall apply until corrected.

100.2.2 ENVIRONMENTAL MANAGEMENT SYSTEM

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Environmental Management System (the “**EMS**”), as attached in Schedule 4 (Contractor’s Management Systems and Plan) to the DBFO Agreement.

The EMS shall be consistent with all of the requirements of *ISO 14001:2015* and shall cover all activities, products and services related to the Project and the O&M prior to the execution of these activities, products and services. The EMS shall address all stages of the Project and the O&M, specifically:

- Design;
- Construction; and
- Operations, including maintenance, post-construction monitoring and rehabilitation.

The Contractor shall develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period, an environmental construction operations plan (the “**ECO Plan**”) in accordance with all requirements of the *Environmental Construction Operations Plan Framework – Alberta Transportation/The City of Calgary/The City Of Edmonton – 2011 Edition* as part of the EMS and subject to section 5.5 (Contractor’s Designs, Plans and

Schedule) of the DBFO Agreement. The ECO Plan shall include written procedures and drawings addressing the environmental mitigation and protection issues relevant to the construction activities being performed by the Contractor within the TUC and the Road Right of Way, and for all water crossings within the Project Limits. Items that shall be incorporated into the ECO Plan include, but are not limited to, the following:

- Compliance with environmental regulatory requirements;
- Topsoil handling including storage and replacement;
- Borrow excavations;
- Dust control;
- Erosion and sediment control during and after construction;
- Vegetation clearing, establishment and management (including weed control);
- Impacts to water bodies and monitoring activities; and
- Spill management plan (one of the requirements of the spill management plan is for the Contractor to report all spills within the Project Limits to the relevant authorities forthwith, and also to the Department within 24 hours of the occurrence).

The Contractor shall develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period a road salt management plan in accordance with all requirements of the *Environment Canada - Code Of Practice For the Environmental Management Of Road Salts* as part of the EMS and subject to section 5.5 (Contractor's Designs, Plans and Schedule) of the DBFO Agreement.

The Contractor shall develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period an animal-vehicle collision ("AVC") monitoring plan that records the locations, dates and type of animal species involved in all AVCs as part of the EMS and subject to section 5.5 (Contractor's Designs, Plans and Schedule) of the DBFO Agreement.

The EMS shall stipulate how compliance with all applicable laws and all the requirements in the DBFO Agreement (including without limiting the generality of the foregoing technical requirements/commitments in the Functional Plan and/or the EA (as defined in Section 200.2.13), is ensured. During all stages of the Project and the O&M, work shall not be started on any component of the work until after the EMS has been completed for that component of the work. The EMS shall be fully implemented to meet all the requirements of *ISO 14001:2015* no later than 365 days after Execution of the DBFO Agreement and shall be verified by an external audit. The EMS shall include, but not necessarily be limited to the following:

100.2.2.1 Monitoring and Inspection Programs

The EMS shall provide for documented environmental monitoring and inspection programs that verify compliance with all the requirements. The documented programs shall include a description of:

- The scoping of the monitoring and/or inspection programs;
- The qualifications of auditors/inspectors;

- Frequency of inspection and/or monitoring events and rationale for frequency;
- Listing of applicable performance requirement criteria (may include legislative requirements);
- Methodologies;
- Reporting; and
- The responsibilities and requirements for conducting inspections, monitoring programs, reporting results and follow-up/corrective actions.

100.2.2.2 Internal Audit

The Contractor shall undertake internal EMS audits, as per *ISO 14001:2015 Element 4.5.5*, on a regular basis and in any event at least once per year during the design, construction and operation, during the Construction Period and the Operating Period. The auditor shall follow the current guidelines for *Auditing Management Systems, ISO 19011:2011*, as amended or substituted from time to time. The audit shall, at a minimum, ensure that all input requirements are adhered to and that the EMS is implemented and in compliance with the requirements of *ISO 14001*, customer requirements and applicable regulatory and other requirements. All elements shall be audited at least once per year.

All internal audit results must be addressed, corrected and implemented by the Contractor. The results of the audit shall be documented and shall be submitted by the Contractor to the Department within seven days of audit completion. Evidence of the correction of any deficiencies identified in the audit shall be submitted by the Contractor to the Department within 30 days of completion of the audit.

100.2.2.3 External Audit

In addition to the internal audits, the Contractor shall undertake EMS external audits during design, construction and operations, during the Construction Period and the Operating Period.

These external audits must be conducted by an independent EMS auditor certified by an accredited auditors' registration body. The auditor must also be qualified to audit the scope of the EMS. The audit process shall follow the current guidelines for *Auditing Management Systems, ISO 19011:2011*, as amended or substituted from time to time. The audit shall, at a minimum, ensure that all the input requirements are adhered to and that the EMS is implemented and in compliance with the requirements of *ISO 14001:2015*, customer requirements and applicable legal and other requirements. A full system audit shall be completed within one year of the Execution of the DBFO Agreement and thereafter at least once per year during the Construction Period and the Operating Period.

The results of the audit shall be documented and shall be submitted by the Contractor to the Department within seven days of audit completion. All EMS deficiencies identified by the external EMS auditor during the audit shall be addressed and corrective measures implemented by the Contractor, to the extent reasonable and practicable as determined by the Department acting reasonably, within 30 days of the completion of the audit. Evidence of the correction of any deficiencies identified in the audit shall be submitted by the Contractor to the Department

within 30 days of completion of the audit.

If an external audit has not been completed within the specified time, Payment Adjustments of \$2,400/week or any partial week, for the first four weeks and \$6,000/week or any partial week, thereafter shall apply until completed.

If any deficiencies identified by the external EMS auditor have not been corrected within the specified time, Payment Adjustments of \$6,000/week or any partial week, for the first four weeks and \$12,000/week or any partial week, thereafter shall apply until corrected.

100.2.3 HANDLING OF QMS/EMS NON-CONFORMANCE

Non-conformance of required outputs may be a deficiency in the characteristics, documentation or procedures that makes the quality of a product, activity or service unacceptable or not meeting the Technical Requirements and any other known acceptance criteria.

The Contractor shall develop a non-conformance report form template, subject to the approval of the Department, which shall be used to record all non-conformances. All non-conformance reports shall at minimum include a comprehensive description of the non-conformance and corrective action(s) and preventative action(s) be adequately stated.

In all instances, the Contractor shall review and sign-off all the non-conformance reports whether the non-conformance is identified by the Department, the Contractor, or otherwise. All remedial work shall be at the Contractor's expense. The Contractor shall notify the Department at least 72 hours in advance of any proposed remedial work. The Contractor shall not start any remedial work until submittal of the non-conformance report under Schedule 5 (Design and Plan Certification Process and Review Procedure).

The Contractor shall maintain an up-to-date register of all non-conformance reports indicating their current status. A copy of all non-conformance reports shall be provided to the Department within one week of occurrence or discovery of occurrence and the Contractor shall update the Department on the status of outstanding non-conformance reports on a weekly basis.

Design or construction works identified as non-conforming by the Department shall be treated as non-conforming works within the Contractor's QMS. The Contractor's remedies to non-conforming works reports generated as a result of the Department's audits shall be proposed to the Department. The Contractor is required to respond to the non-conforming works report with a remedy which requires review and prior written approval by the Department acting reasonably. Failure of the Contractor to respond to non-conformances with a reasonable plan for remedy within 14 calendar days after occurrence or discover of the occurrence shall result in a Payment Adjustment of \$5,000 per occurrence.

Non-conforming construction works will be considered unacceptable and the Contractor shall undertake the necessary modifications to ensure the as-built New Infrastructure conforms to the requirements of the Detailed Designs and the Technical Requirements. Work without documentation to conclusively demonstrate conformance and which cannot be verified by non-

destructive testing will be considered non-conforming. In the event of the foregoing sentence, the Contractor shall be responsible for all costs associated with any removal, replacement and testing that may be required to confirm the Technical Requirements have been met.

Any audits that identify a meaningful discrepancy between the state of the work and its representation on the Contractor's signed-off checklist shall be subject to a Payment Adjustment of \$2,000 per occurrence.

The Field Review Engineer shall not stamp certificates for components where non-conformance reports have not been closed. Non-conformance reports will not be considered by the Department to be closed until the remedial work has been acceptably completed and documented in accordance with the requirements of the non-conformance report.

100.2.4 PROJECT SCHEDULE

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Contractor's Construction Schedule.

During the construction of the Project, the Contractor shall provide the Department with Contractor's Construction Schedules that are sufficiently detailed to give the Department a minimum of two working days advance notice of all significant construction and fabrication activities. In addition to the requirements in section 5.5 of the DBFO Agreement, the Contractor shall provide the Department with updates to the detailed schedule on a monthly basis and within 48 hours of the Department's request.

100.2.5 TRAFFIC MANAGEMENT PLAN

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Traffic Management Plan, as attached in Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement. The Traffic Management Plan for specific components of the Project or the O&M, as applicable, shall be reviewed in accordance with Schedule 5 (Design and Plan Certification and Review Procedure) prior to the start of that component of the Project or the O&M, as applicable. The Contractor's Traffic Management Plan shall include a component of coordination with the Contractor's website and to the Department's 511 Alberta group to provide frequent updates for the public.

100.2.6 SAFETY PLAN

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Safety Plan, as attached in Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement. The Safety Plan for a specific component of the Project or the O&M, as applicable, shall be reviewed in accordance with Schedule 5 (Design and Plan Certification and Review Procedure) prior to the start of that component of the Project or the

O&M, as applicable.

100.2.7 PUBLIC COMMUNICATION STRATEGIES

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Public Communication Strategies, as attached in Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement. The Public Communication Strategies for a specific component of the Project or the O&M, as applicable, shall be reviewed in accordance with Schedule 5 (Design and Plan Certification and Review Procedure) prior to the start of that component of the Project or the O&M, as applicable.

The Contractor shall be responsible for all public communications, which shall include but not be limited to, public presentations and construction update open houses, public advertisements and mail drops, project website development and maintenance, project phone hotlines, handling public complaints, etc. The Contractor's website shall be updated at least on a monthly basis and shall provide the public with information regarding construction progress and traffic management.

The Contractor shall hold annual construction update open houses during the Construction Period with the first set of construction update open houses being held within three months of Execution of the DBFO Agreement. The first set of construction update open houses shall be held at three separate and evenly geographically distributed locations nearby the Project Limits over sequential days. Annual construction update open houses after the first set are only required to be held at a single geographical location centrally located nearby the Project Limits.

The Contractor shall coordinate with the Department's 511 Alberta group to ensure that all roadway issues pertinent to the public have been communicate for dissemination on the 511.alberta.ca website.

Any direct contact the Contractor makes with the media or Local Authority elected officials shall be subject to the prior review and approval of the Department. This shall include media releases, interviews, advertisements, etc.

The Contractor shall maintain comprehensive records of all communications activities including documentation of the information presented, the audience, relevant dates, etc.

If the Contractor proposes major deviations from the Functional Plan or approved plans, at any time after Execution of the DBFO Agreement until the end of the Term, and is deemed to be meeting the Technical Requirements, the Contractor shall in any event proceed through a public consultation process to obtain public approval/acceptance of such deviations including undertaking the following:

- defining who the stakeholders are;
- developing a communication plan that includes the defined stakeholders as participants;

- determining a process and mechanism on how public acceptance is to be determined, measured, and obtained;
- seeking and obtaining acceptance of the communication plan and approval process from the Department; and
- potentially seeking and obtaining approval from the Local Authority and meeting the Local Authority design standards for the deviation.

100.2.8 CONSTRUCTION MANAGEMENT PLAN

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Construction Management Plan, as attached in Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement. The Construction Management Plan for a specific component of the Project or the O&M, as applicable, shall be reviewed in accordance with Schedule 5 (Design and Plan Certification and Review Procedure) prior to the start of that component of the Project or the O&M, as applicable.

100.2.9 OPERATION AND MAINTENANCE PLAN

Subject to section 5.5 of the DBFO Agreement, the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Operation and Maintenance Plan, as attached in Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement.

The Operation and Maintenance Plan shall be finalized prior to the date which is two month's after Execution of the DBFO Agreement and with the exception of the snow clearing and ice control portion of the plan (the "**Snow Clearing and Ice Control Operations Plan**") and the preferential bridge deck icing control portion of the plan (the "**Preferential Bridge Deck Icing Plan**"), shall be updated annually prior to the start of each calendar year.

The Snow Clearing and Ice Control Operations Plan and Preferential Bridge Deck Icing Plan shall be updated annually and reviewed in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure) prior to September 15 of each year.

Traffic Availability shall not be achieved until after the Operation and Maintenance Plan for the calendar year in which Traffic Availability is to occur has been reviewed in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure).

The Contractor shall ensure that it addresses in the Operation and Maintenance Plan all of the components necessary for the safe and efficient operation of the Infrastructure and the In-Service Roads. It may also be necessary for the Contractor to modify its operations to address deficiencies not specifically identified in the Technical Requirements but which are required for the safety of the travelling public or are recognized by the industry as a normal industry practice.

The Preferential Bridge Deck Icing Plan shall be reasonably designed to prevent preferential bridge deck icing from occurring on the PBD Bridges (as defined in Section 200.2.16 (Preferential Bridge Deck Icing)).

100.2.9.1 Payment Adjustments

If the Contractor fails to develop and provide the Department with an updated Operations and Maintenance Plan (with the exception of the Snow Clearing and Ice Control Operations Plan and Preferential Bridge Deck Icing Plan) by the start of each calendar year, the Payment Adjustment shall be \$1,200/week or any partial week, until it is submitted.

If the Contractor fails to develop and provide the Department with an updated Snow Clearing and Ice Control Operations Plan and Preferential Bridge Deck Icing Plan by September 15 of each year, the Payment Adjustment shall be \$6,000/week or any partial week, for the first four weeks and then \$12,000/week or any partial week, thereafter until it is submitted.

100.2.10 INFRASTRUCTURE WHOLELIFE MANAGEMENT PLAN

Subject to section 5.5 of the DBFO Agreement and in accordance with Section 100.2.1.3 (Quality Management System – Operations), the Contractor shall further develop, implement, and maintain and shall monitor, update, and manage, during the Construction Period and the Operating Period, the Infrastructure Wholelife Management Plan, as attached in Schedule 4 (Contractor’s Management Systems and Plans) to the DBFO Agreement.

The Infrastructure Wholelife Management Plan shall be reviewed in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure) prior to Traffic Availability and shall be updated annually prior to the start of each calendar year.

Traffic will not be allowed on the New Infrastructure until after the initial Infrastructure Wholelife Management Plan has been reviewed in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure).

100.2.10.1 Payment Adjustments

If the Contractor fails to develop and provide the Department with an updated Infrastructure Wholelife Management Plan by the start of each calendar year, the Payment Adjustment shall be \$1,200/week or any partial week, until it is submitted.

100.3 DEPARTMENT REVIEW

The Contractor shall make all design, construction and operations documentation relating to the design, construction, operation and performance of the Infrastructure available to the Department for the Department’s review, measurement and observation purposes.

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200.1 INFRASTRUCTURE LIMITS

200.1.1 NEW INFRASTRUCTURE

The New Infrastructure consists of the southwest portion of the Calgary Ring Road, generally described as the portion from east of Macleod Trail SW to west of 69 Street SW, the portion of Highway 8 from west of 69 Street SW to west of the Lott Creek Drive/Range Road 25 intersection, the portion of Glenmore Trail from Sarcee Trail to east of 37 Street SW, and the portion of Highway 22X west of the Calgary Ring Road to the intersection of Highway 22X and 128 Street W/85 Street SW. The New Infrastructure is set out in Schedule 13 (New Infrastructure) to the DBFO Agreement.

Existing roadways, existing grading and related appurtenances (such as drainage works, lighting, and signage) located within the Project Limits, including, but not limited to, the following components:

- Portions of Macleod Trail;
- Portions of Sheriff King Street SW / 6 Street SW;
- Portions of James McKeivitt Road;
- Portions of Highway 22X;
- Portions of 162 Avenue SW;
- Portions of 146 Avenue SW;
- Portions of 130 Avenue SW;
- Portions of Anderson Road SW;
- Portions of 90 Avenue SW;
- Portions of Southland Drive SW;
- Portions of Strathcona Street SW;
- Portions of Sarcee Trail SW;
- Portions of Glenmore Trail SW;
- Portions of 37 Street SW;
- Portions of Westhills Way SW;
- Portions of 69 Street SW; and
- Portions of Highway 8,

all shall be deemed to form part of the New Infrastructure.

Highway 22X is also known as Spruce Meadows Trail, Calgary Ring Road, or Stoney Trail; Highway 8 is also known as Glenmore Trail; and the Calgary Ring Road is also known as Highway 201 or Stoney Trail. Any references to Spruce Meadows Trail, Glenmore Trail, and Stoney Trail shall mean Highway 22X, Highway 8 and Highway 201/Calgary Ring Road respectively; and vice versa.

Generally, the Calgary Ring Road alignment is within the TUC, but portions of Highway 22X and Highway 8 are within provincial road rights-of-way. Unless otherwise specified, the Project

Limits will be the boundary of the TUC or provincial road right-of-way boundary, except where the New Infrastructure must extend beyond the boundary of the TUC or provincial road right-of-way boundary to tie into the adjacent existing roadways, in which case the New Infrastructure located outside of the TUC or provincial road right-of-way boundary will be considered within the Project Limits.

200.1.1.1 New Infrastructure Limits - Interim Restrictions

As of Execution of the DBFO Agreement, the Province may still be in the process of acquiring some properties required for the construction of the New Infrastructure. Such properties are known as “**To Be Acquired Lands**” and such term is defined in the second paragraph of section 4 (Lands) of Schedule 12 (Lands) of the DBFO Agreement. Unless otherwise authorized in advance and in writing by the Department, the Contractor shall not enter upon the To Be Acquired Lands until the To Be Acquired Lands have been transferred to the Department, which will be by March 31, 2017.

200.2 DESIGN AND CONSTRUCTION OF NEW INFRASTRUCTURE

200.2.1 GENERAL

The Contractor is responsible for the design, construction, operation, maintenance and rehabilitation of the New Infrastructure which includes, but is not limited to, a multi-lane roadway, connecting roadways, crossroads, interchanges, bridge structures and associated infrastructure.

The design and construction requirements of the Department with respect to the location, function, staging and interconnection of the New Infrastructure are set out in the Functional Plan and further defined in the Technical Requirements.

The requirements of the Department for the New Infrastructure are consistent with staged project delivery of components of the Functional Plan, as generally described below:

- Construction of the Calgary Ring Road from east of Macleod Trail SE to Highway 8;
- Construction of twinned Highway 8 from the Calgary Ring Road (west of 69 Street SW) to west of the Lott Creek Drive/Range Road 25 intersection;
- Construction of twinned Hwy 22X from 37 Street SW/96 Street W to 69 Street SW/128 Street W
- Calgary Ring Road interchanges, flyovers and river crossings at the following locations generally within the TUC as further described in Section 200.2.3.6 (Interchanges and Grade Separations) and Section 200.2.3.7 (Other Crossings):
 - Portions of Macleod Trail SE;
 - Sheriff King Street SW/6 Street SW;
 - James McKeivitt Road;
 - Highway 22X;
 - 162 Avenue SW;
 - 146 Avenue SW/Fish Creek Boulevard SW;

- Fish Creek;
 - 130 Avenue SW;
 - Anderson Road;
 - 90 Avenue SW;
 - Elbow River;
 - Weaselhead Road;
 - Strathcona Street SW;
 - Sarcee Trail and Glenmore Trail;
 - Westhills Way SW; and
 - 69 Street SW;
- Glenmore Trail and 37 Street SW Interchange;
 - Grade separation of the Calgary Ring Road over CPR tracks west of Macleod Trail SE;
 - Southland Drive SW;
 - Pedestrian bridge crossing the Calgary Ring Road south of Anderson Road; and
 - Highway 8 crossings over Elbow River and Cullen Creek generally within the provincial road right-of-way boundaries.

Stage 1 shall include grading of the Mainline, interchanges, and crossroads to the Ultimate Stage, with exceptions as noted in Section 200.2.3 (Design Specifics). Stage 1 shall also include the construction of embankments for Ultimate Stage ramps, construction of Ultimate Stage retaining walls and construction of Ultimate Stage bridge embankments.

Stage 1 shall also include the construction of bridge structures to span the Outer Ring Road carriageways to be constructed between the Stage 1 carriageways.

The Outer Ring Road consists of future carriageways in between the Calgary Ring Road carriageways with a design speed of 110 km/h and is subject to the Technical Requirements required for the Southwest Calgary Ring Road, contained herein. The Contractor shall carry out the Project so as to not negatively affect the design and construction of the future Outer Ring Road. No permanent infrastructure that will conflict with the Outer Ring Road is permitted.

Prior to Traffic Availability, the Contractor will be required to design and construct Service Roads at the following locations as further described in Section 200.2.3.18 (Service Roads):

- Macleod Trail SE;
- Sheriff King Street SW / 6 Street SW;
- James McKeivitt Road;
- Highway 22X;
- 146 Avenue SW;
- Weaselhead Road;
- 37 Street SW;
- Lower Springbank Road; and
- 101 Street SW/Highway 8.

The Local Authority will assume responsibility for Service Roads upon opening of the particular Service Road to traffic in accordance with section 5.18 (Service Roads) of the DBFO

Agreement.

The design of all crossroad elements, including ramps and intersections shall be supported by traffic simulation in accordance with Section 300.4.1.2.1 (Traffic Simulation) using Synchro/Sim Traffic or Sidra software for the following interchanges:

- Sheriff King Street SW / 6 Street SW;
- James McKeivitt Road;
- 162 Avenue SW;
- 146 Avenue SW;
- 130 Avenue SW;
- Anderson Road SW;
- 90 Avenue SW;
- Strathcona Street;
- Westhills Way;
- 69 Street SW; and
- 37 Street SW at Glenmore Trail.

200.2.2 GEOMETRIC DESIGN

The following design guides shall form the basis for the geometric design, and the order of hierarchy of these guides, unless specifically indicated otherwise, shall be consistent with the numeric order presented:

1. *Alberta Transportation Highway Geometric Design Guide*, any applicable Alberta Transportation *Design Bulletins*, and any applicable updates (the “**Highway Geometric Design Guide**”);
2. *Alberta Infrastructure and Transportation Roadside Design Guide*, November 2007 and any applicable Alberta Transportation *Design Bulletins* (the “**Roadside Design Guide**”);
3. *Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads* (the “**TAC Geometric Design Guide**”);
4. *The City of Calgary’s Roads Construction – Standard Specifications*; and
5. County and MD – engineering standards, as applicable.

In addition, the design, unless specified otherwise, shall meet the following requirements:

- The Mainline shall be designed as a rural, barrier-free, illuminated, high speed, free-flow, fully access controlled facility;
- All interchange ramp exits and entrances shall be located on the right-hand side, and no left-hand exit or entrance ramps will be permitted;
- No left hand side (median) lane additions or lane drops will be permitted on the Calgary Ring Road except in Stage 1 where Highway 22X EB joins the Calgary Ring Road NB;
- The use of a diverging diamond interchange (“**DDI**”) or double crossover diamond (“**DCD**”) design concept for interchanges is prohibited;
- Two-lane entrance ramp design shall follow the guidance shown in the publication *A Policy on Geometric Design of Highways and Streets 2011* (pages 10-120 to 10-122) by AASHTO;

the parallel design as shown in Exhibit 10-73 should be used, the required acceleration length shall be a minimum of 200 m from the painted gore;

- Two-lane exit ramp design shall generally follow the guidance shown in the publication *A Policy on Geometric Design of Highways and Streets 2011* (pages 10-123 to 10-124) by AASHTO; the tapered design as shown in Exhibit 10-74 should be used. The divergent angle specified in Exhibit 10-74 shall conform to the ratio specified for the “tapered deceleration lane length from the beginning to 11 m offset to physical gore” in Figure E-1.1 (Design Standards of Exit and Entrance Terminals for Divided Highways at Interchanges) in the Highway Geometric Design Guide;
- Auxiliary lane design shall follow the guidance shown in the publication *A Policy on Geometric Design of Highways and Streets 2011* (pages 10-76 to 10-79) by AASHTO;
- Only one exit ramp per direction is to be provided at freeway to freeway interchanges; that is, consecutive exits for two different directions are to be combined into a single exit or from a C-D road, except for SB-EB/WB movements at Macleod Trail SE. The following interchanges are considered freeway to freeway interchanges:
 - Calgary Ring Road/Macleod Trail SE;
 - Calgary Ring Road/Highway 22X;
 - Calgary Ring Road/Anderson Road;
 - Calgary Ring Road/Sarcee Trail SW/Glenmore Trail; and
 - Calgary Ring Road/Highway 8;
- Stormwater runoff is to be accommodated in open surface ditch drainage, roadway culverts, stormwater management facilities and/or grass or other emergent vegetation as per Section 6.4.3 (Grassed Swales) of the *Stormwater Management Guidelines for the Province of Alberta*, with check dams where volumetric and water quality controls are required, and concrete or CSP pond outflow control facilities and discharge sewers;
- Interchange exit terminals shall provide appropriate decision sight distance required for the design speed of the Mainline at Mainline terminals, and as required for the design speed of the crossroad for crossroad terminals;
- Alignment of crossroads that exist on tangent within the Project Limits shall remain on tangent in Stage 1 unless the Department provides the Contractor with prior written consent allowing a curvilinear alignment to address the following:
 - land constraints; or
 - to complement natural topography; or
 - to facilitate the staged delivery of the Ultimate Stage;
- Transition from rural freeway standards to urban standards (curb and gutter), where applicable, shall occur at the urban end of interchange ramps connecting to the crossroads;
- Lane balance shall be provided in Stage 1 and shall be maintained for subsequent staging up to the Ultimate Stage;
- The use of combinations of inter-related minimum design criteria will not be permitted;
- All Elevated Directional Ramps shall be designed to accommodate two lanes;
- The existing vertical geometry on Macleod Trail SE south of Highway 22X to the Project Limits shall generally follow the existing geometric profile;
- The existing vertical geometry and shoulder widths of Highway 22X westbound west of the intersection of 37 Street SW/96 Street W to the Project Limits shall generally follow the existing geometric profile and cross-section elements;

- The vertical geometry of 188 Avenue SW Service Road west of the intersection of 37 Street SW/96 Street W to the Project Limits shall generally follow the existing geometric profile of the existing Highway 22X eastbound;
- The vertical geometry of Highway 8 eastbound from the vicinity of 85 Street SW to immediately west of the Elbow River crossing shall generally follow the existing geometric profile of Highway 8.
- Design Speed and Radii:
 - Mainline 110 km/h
 - Crossroad (expressways)..... 90 km/h
 - Crossroad (arterials) 70 km/h
 - C-D road 80 km/h
 - Directional ramp – freeway to freeway (main level) 80 km/h
 - Elevated Directional Ramp – freeway to freeway, with the exception of lateral stopping sight distance 80 km/h
 - Minimum radii of Elevated Directional Ramps 340 m
 - Directional ramp – entering crossroad match design speed of crossroad
 - Loop ramp off Mainline, crossroads and C-D roads..... 50 km/h
 - Minimum radii of loop ramp off Mainline, crossroads and C-D roads 90 m
 - Other directional ramps entering freeway (at gore) 90 km/h
 - Ramps entering and exiting freeways, use running speed at entrance and exit gores as outlined in the Highway Geometric Design Guide.

Exceptions to design criteria:

- Minimum radii for the Calgary Ring Road WB to Macleod Trail SB Elevated Directional Ramp.....260 m
- Macleod Trail south of the Calgary Ring Road..... 110 km/h
- Minimum radius of James McKeivitt Road SB and NB to Calgary Ring Road WB loop ramp 60 m
- Calgary Ring Road SB to Highway 22X EB ramp 70 km/h
- Calgary Ring Road SB to 162 Avenue SW WB ramp..... 40 km/h
- 162 Avenue SW EB to Calgary Ring Road SB ramp 50 km/h
- Minimum radius of 146 Avenue SW EB to Calgary Ring Road NB loop ramp ..60 m
- 146 Avenue SW WB to Calgary Ring Road NB..... 50 km/h
- Calgary Ring Road SB to 146 Avenue SW WB 50 km/h
- Calgary Ring Road NB to 146 Avenue SW EB/WB 50 km/h
- Calgary Ring Road NB to 130 Avenue SW EB/WB 40 km/h
- 130 Avenue SW EB to Calgary Ring Road SB ramp, prior to merge with WB-SB ramp 50 km/h
- Anderson Road SW west of the section of ramp from the SB Calgary Ring Road to EB Anderson Road SW parallel and adjacent to the Calgary Ring Road SB . 60 km/h
- Calgary Ring Road NB to 90 Avenue SW EB ramp at entrance to 90 Avenue SW only 50 km/h
- Minimum radius for Buffalo Run Boulevard NB to Calgary Ring Road SB ramp50 m

- Calgary Ring Road SB to 90 Avenue SW EB (Curved portion approaching 90 Avenue SW in Stage 1 only)..... 50 km/h
 - Minimum radius of Weaselhead Road immediately west of the Calgary Ring Road and north of the Elbow River 90 m
 - SB Sarcee Trail SW to SB Calgary Ring Road..... 90 km/h
 - WB Glenmore Trail to WB Calgary Ring Road 90 km/h
 - NB Calgary Ring Road to NB Sarcee Trail..... 90 km/h
 - EB Calgary Ring Road to EB Glenmore Trail ramp..... 90 km/h
 - NB-EB directional ramp at Sarcee Trail/Glenmore Trail 60 km/h
 - SB-EB Elevated Directional Ramp at Sarcee Trail/Glenmore Trail 70 km/h
 - Minimum radius of SB-EB Elevated Directional Ramp at Sarcee Trail/Glenmore Trail.....300 m
 - WB-SB Elevated Directional Ramp at 37 Street SW/Glenmore Trail (Ultimate Stage ramp)..... 60 km/h
 - 37 Street SW SB to Glenmore Trail SW WB ramp 40 km/h
 - 37 Street SW NB to Glenmore Trail SW EB ramp..... 40 km/h
 - Glenmore Trail SW WB to 37 Street SW NB ramp 40 km/h
 - Glenmore Trail SW EB to 37 Street SW SB ramp..... 40 km/h
 - SB-WB directional ramp at Sarcee Trail/Calgary Ring Road 50 km/h
 - Minimum radius of SB-EB loop ramp at Anderson Road SW/Calgary Ring Road 70 m
 - Minimum radius of WB-SB directional ramp at Anderson Road SW/Calgary Ring Road250 m
 - Minimum radius WB-SB loop ramp at 90 Avenue SW/Calgary Ring Road..... 70 m
 - Minimum radius WB-SB loop ramp at Sarcee Trail/Glenmore Trail 70 m
 - Highway 8 EB/WB immediately west of 85 Street SW to immediately east of Cullen Creek..... 90 km/h
 - Notwithstanding the above, no loop ramp shall have a radius less than that shown on the Drawings in Appendix A.
 - The SB Sarcee Trail to EB Glenmore Trail movement as shown on Drawing 18-A-03.08SW in Appendix A is permitted to enter the EB lanes from the left.
 - The NB Sarcee Trail to EB Glenmore Trail directional ramp design speed shall match the minimum radius shown on Drawing 18-A-03.08SW in Appendix A.
- **Posted Speed:** The posted speed shall be 10 km/h less than the design speed.
 - **Vertical Grades:**
 - Mainline 3.0% Max.
 - Directional ramps, C-D roads, and other cross roads (90 km/h)..... 4.0% Max.
 - Directional ramps, C-D roads, and other cross roads (80 km/h)..... 4.5% Max.
 - Ramps
 - Entrance ramps..... 6.0% Max.
 - Exit ramps 4.0% Max.
 - Crossroads (design speed 70 km/h or less)
 - Interchanges 4.0% Max.
 - Flyovers..... 5.0% Max.

- Urban cross-sections (curb & gutter).....0.6% Min.
 - Bridge deck longitudinal gradient 3.0% Max.
- **Exceptions to vertical grade criteria:**
 - Highway 22X EB/WB west of the Calgary Ring Road..... 4.0% Max.
 - Calgary Ring Road SB to 162 Avenue SW EB ramp..... 6.0% Max.
 - 146 Avenue SW WB to Calgary Ring Road SB ramp 7.0% Max.
 - Calgary Ring Road NB to 130 Avenue SW EB/WB ramp 6.0% Max.
 - 130 Avenue SW EB/WB to Calgary Ring Road SB ramp 7.0% Max.
 - Sarcee Trail SB to Calgary Ring Road WB directional ramp 5.5% Max.
 - Glenmore Trail WB Ascending to 37 Street SW SB Elevated Directional Ramp (Ultimate Stage) 5.0% Max.
 - Glenmore Trail WB Descending to 37 Street SW SB Elevated Directional Ramp (Ultimate Stage) 7.0% Max.
- **Exceptions to bridge deck longitudinal gradient criteria:**
 - Anderson Road WB to Calgary Ring Road SB over Anderson Road EB, as shown on Drawing 18-A-05.26SW in Appendix A 4.0 % Max
 - Anderson Road WB to Calgary Ring Road SB ramp bridge structure over the Calgary Ring Road, as shown on drawing 18-A-05.25SW in Appendix A 4.0% Max

• **K Values:**

The K values shall meet or exceed the values shown in the following table:

Design Speed (Km/h)	Crest K Factor	Sag K Factor
120	190	92
110	141	78
100	98	63
90	66	51
80	45	40
70	29	31
60	17	22
50	10	15
45	7	12

• **Exceptions to K-Value:**

- The sag curve on the Calgary Ring Road SB to 162 Avenue SW EB ramp, which shall be greater than or equal to a sag K factor of 35;
- The sag curve on the 146 Avenue SW WB to Calgary Ring Road SB ramp, which shall be greater than or equal to a sag K factor of 28;
- The sag curve on the Calgary Ring Road NB to 130 Avenue SW EB/WB ramp, which shall be greater than or equal to a sag K factor of 35;
- The sag curve on Anderson Road SW under the WB to SB ramp, which shall be greater than or equal to a sag K factor of 25;

- The crest curve on the Ultimate Stage Glenmore Trail WB to 37 Street SW SB Elevated Directional Ramp, which shall be greater than or equal to a crest K factor of 30;
- **Vertical Curves:**
 - Minimum length of sag and crest vertical curves:
 - i. On Mainline 300 m
 - ii. On directional ramps, C-D roads and other roads
(design speed = 90 km/h).....250 m
 - iii. On Elevated Directional Ramps, directional ramps, C-D roads and
other roads
(design speed = 80 km/h)..... 200 m
 - iv. On other roads (design speed = 70 km/h) 150 m
 - Minimum distance between crest and sag vertical Points of Intersection (“VPI”):
 - i. On Mainline and other roads (design speed = 110 km/h).....500 m
 - **Exceptions to minimum length of sag and crest vertical curves:**
 - The length of vertical curve for the Calgary Ring Road SB to 162 Avenue SW EB ramp shall be equal to or greater than the design speed of the ramp;
 - The length of vertical curve for the 146 Avenue SW WB to Calgary Ring Road SB ramp shall be equal to or greater than the design speed of the ramp;
 - The length of vertical curve for Macleod Trail SE south of Highway 22X shall be greater than or equal to the design speed;
 - The length of vertical curve for Highway 22X westbound west of 37 Street SW/96 Street W shall be greater than or equal to the design speed;
 - **Exceptions to minimum distance between crest and sag vertical Point of Intersection:**
 - The minimum distance requirement between crest and sag vertical Points of Intersection along Macleod Trail SE south of Highway 22X is waived;
 - The minimum distance requirement between crest and sag vertical Points of Intersection along Highway 22X westbound west of 37 Street SW/96 Street W intersection is waived;
 - **Superelevation:**
 - All roads and bridges (e max) 0.06 m/m
 - Bridges shall not be on spiral curve or superelevation transition
 - **Exceptions to spiral curve or superelevation transition on bridges:**
 - Calgary Ring Road EB to Macleod Trail SE NB ramp over Macleod Trail mainline;
 - **Ramp Terminals Along Mainline, Freeways and C-D Lanes:**
 - Direct taper design as per Figures E-1.1, E.-1.2, E-1.3 of the Highway Geometric Design Guide for both exit and entrance terminals.
 - A two-lane exit shall be used for all-ramps with design year traffic volumes of 1500 vph or higher.

- **Weaving Distance:**
 - The absolute minimum weaving distance between consecutive Systems Interchange ramps shall be no less than 800 metres in all cases.
 - The absolute minimum weaving distance between any Systems Interchange ramp and any other ramp shall be no less than 800 metres in all cases.
 - The absolute minimum weaving distance between all other ramps shall be no less than 600 m in all cases.
 - Weaving sections are not permitted on Systems Ramps.
 - The weave distances shall be measured in accordance with the Highway Geometric Design Guide.

- **Exceptions to Weaving Distance:**
 - Weaving distance on the Calgary Ring Road between Macleod Trail SE and Chaparral Boulevard SE in the EB direction shall be at least 600 m.
 - Weaving distance on Macleod Trail SE between the Calgary Ring Road and 162 Avenue SE in the NB direction shall be at least 550 m.
 - Weaving distance on Macleod Trail SE between 162 Avenue SE and the Calgary Ring Road in the SB direction shall be at least 550 m.
 - Weaving distance on the Calgary Ring Road between 146 Avenue SW and 162 Avenue SW in the SB direction shall be at least 425 m.
 - Weaving distance on the Calgary Ring Road between 146 Avenue SW and 162 Avenue SW in the NB direction shall be at least 465 m.
 - Weaving distance on Glenmore Trail SW between Sarcee Trail and 37 Street SW in the EB direction shall be at least 515 m.
 - Weaving distance on Glenmore Trail SW between 37 Street SW and Sarcee Trail in the WB direction shall be at least 620 m.
 - Weaving distance on Glenmore Trail SW directional ramp between Westhills Way SW and Sarcee Trail in the EB direction shall be at least 475 m.
 - Weaving distance on the Calgary Ring Road between 69 Street SW and Westhills Way SW in the EB direction shall be at least 510 m.
 - Weaving distance on the Calgary Ring Road between 69 Street SW and Glenmore Trail SW in the EB direction shall be at least 710 m.
 - Weaving distance on Sarcee Trail C-D road between Glenmore Trail WB to Sarcee Trail SB loop ramp and Sarcee Trail SB to Strathcona Street ramp shall be at least 300 m.
 - Weaving distance on Glenmore Trail WB between Richard Road SW entrance ramp and 37 Street SW exit ramp shall be at least 350 m.
 - Weaving distance on Sarcee Trail SB between Richmond Road SW entrance ramp and Glenmore Trail EB exit ramp shall be at least 400 m.
 - Weaving distance on Sarcee Trail SB between Glenmore Trail WB entrance ramp and Richmond Road SW exit ramp shall be at least 500 m.

- **Lane Widths:**
 - Mainline, Glenmore Trail, Macleod Trail, Highway 22X..... 3.7 m

- C-D road - 1 lane 4.8 m
- 2 lanes 3.7 m
- Ramp - 1 lane 4.8 m
- 2 lanes 3.7 m
- Crossroads (Refer to Appendix A Drawings 18-A-04.02SW to 18-A-04.09SW).
- Directional ramps
- 2 lanes 3.7 m
- 1 lane 4.8 m

• **Shoulder Widths:**

- Mainline
- Inside (4 and 6 basic lanes) 2.5 m
- Inside (8 and 10 basic lanes) 3.0 m
- Outside 3.0 m

Notwithstanding the foregoing all Stage 1 shoulders on the Calgary Ring Road that will become a future traffic lane shall be 3.7 m wide, except on bridge structures.

- Elevated Directional Ramps
- Inside 2.5 m
- Outside 3.0 m
- Directional ramps
- Inside (1 lane) 1.0 m
- Outside (1 lane) 2.5 m
- Inside (2 lanes) 2.5 m
- Outside (2 lanes) 3.0 m
- C-D road
- Inside (1 lane) 1.0 m
- Outside (1 lane) 2.5 m
- Inside (2 lanes) 2.5 m
- Outside (2 lanes) 3.0 m
- Ramp
- Inside (1 lane) 1.0 m
- Outside (1 lane) 2.5 m
- Inside (2 lanes) 2.0 m
- Outside (2 lanes) 3.0 m
- Crossroads (Refer to Drawings in Appendix A)

Notwithstanding the shoulder widths stated above, wider shoulders may be required to satisfy shy distance requirements or stopping sight distance requirements on bridge structures. In no case shall the shoulder on a bridge be wider than 3.5 m.

• **Median Width** (as defined in the Highway Geometric Design Guide):

- Future Outer Ring Road carriage ways 23.2 m
- Distance between edge of travel lanes on Ultimate Stage Calgary Ring Road and Outer Ring Road carriage ways 28.2 m

- Stage 1 and Ultimate Stage Mainline..... no less than 23.2 m

Please note that the Contractor is responsible for designing the Stage 1 New Infrastructure to achieve a 28.2 m separation from each of the adjacent future Outer Ring Road carriage way to the Calgary Ring Road Ultimate Stage lanes, of the same direction of travel, at such time that the Ultimate Stage is constructed and the Outer Ring Road is constructed. The Contractor’s Stage 1 design shall accommodate the future Outer Ring Road with a minimum centre median separation of 23.2 m. All bridge structures and roadway works shall be constructed to allow for the retention of structures and roadway infrastructure at such time that the Ultimate Stage and Outer Ring Road are constructed. The Contractor shall construct all ramp gores in their Ultimate Stage location in Stage 1. The Contractor shall also design and construct the Mainline to avoid crown shifts at the Ultimate Stage widening.

- **Outer Separation for C-D roads in a multiple interchange configuration shall be as follows:**
 - 17.0 m minimum single interchange, no transfer lane
 - 20.0 m minimum multiple interchanges, no transfer lane
 - 30.0 m minimum multiple interchanges, with transfer lane(s)

Outer separation is measured from outer edge of travel lane on the Mainline to inner edge of travel lane on the C-D road.

- **Pedestrian Walk and Multi-Use Trails:**
 - Width of multi-use trail
 - On grade 3.0 m
 - On bridges and along retaining structures 4.2 m

(The 4.2 m width of multi-use trail allows for 0.6 m shy distance to the barrier and/or railing on each side.)
 - Width of pedestrian walk
 - On grade and structures2.5 m
 - Height of bridge barrier and/or railing on bridge and downslope retaining structures outside of multi-use trail and pedestrian walk 1.4 m
 - Multi-use trail and pedestrian walk on bridge structures and downslope retaining structures shall be separated from the traffic lanes by a barrier.

- **Slopes** *(All slope ratios are expressed in horizontal:vertical. All references to slope requirements mean that no slopes shall be steeper than those listed below):*

- Pavement Structure Sideslopes
 - Mainline, system connectors, and directional ramps 6:1
 - C-D roads, ramps, and crossroads..... 5:1
- Subgrade Sideslopes
 - Mainline and System Connector
 - Fill 0 - 2.5 m 6:1
 - Fill 2.5 - 3.0 m Slope Variable, Toe at 15 m Fixed
 - Fill 3.0 - 4.0 m 5:1
 - Fill 4.0 - 5.0 m Slope Variable, Toe at 20 m Fixed

- Fill Over 5.0 m 4:1
- Crossroads, C-D roads and ramps
 - Fill 0 - 4.0 m 5:1
 - Fill 4.0 - 5.0 m Slope Variable, Toe at 20 m Fixed
 - Fill Over 5.0 4:1
- Bridge approaches
 - Sideslopes at bridge locations with guardrail 3:1
- Service Roads
 - All cases 4:1
- Bridge Headslopes No steeper than 2:1
- Ditch Backslopes (Top of backslopes to be rounded)
 - Height 0.0 - 3.0 m 5:1
 - Height 3.0 - 5.0 m Slope Variable, Toe at 15 m Fixed
 - Height Over 5.0 m:
 - Slope inclination shall be determined based on the results of a geotechnical investigation and slope stability analyses such that a minimum long term factor of safety of 1.3 is attained, but no steeper than 3:1
- Berms within the Road Right of Way No steeper than 3:1
- Berms within the TUC but outside the Road Right of Way No steeper than 6:1*
(* unless otherwise approved in writing and in advance by the Department of Infrastructure)
- Slopes in front of retaining walls that are nominally parallel to the roadway 3:1
- **Width of Non-median Ditches and Ditches where Medians are equal to or greater than 31.8 m in width** (*Ditches shall be rounded.*): 3.0 m Min. (before rounding)
- **Width of Ditches for Medians less than 31.8 m in width** (*Ditches shall be rounded.*): a v-ditch using required previously noted subgrade sideslope ratios is acceptable (before rounding)
- **Vertical Clearances** (*Allowance to be made during design for all future pavement overlays proposed prior to end of the Term*):
 - Roadway - underside of superstructure to top of roadway 5.51 m Min.
 - Roadway - underside of straddle bent to top of roadway 6.00 m Min.
 - Roadway – underside of High Load Corridor superstructure to top of roadway 9.14 m Min.
 - Railway over roadway - underside of superstructure to top of roadway.... 5.51 m Min.
 - Sign structures – roadway surface to underside of sign panel 6.0 m Min.
 - Pedestrian overpass - underside of superstructure to top of roadway ** m Min.
(** the greater of 6.0 m and 0.6 m higher than the nearest road bridges over approaching traffic in either direction)
 - Roadway over railway - underside of superstructure to top of rail 7.01 m Min.
 - High Load Corridor roadway - to high voltage power lines (69 kV and greater)..... 11.4 m Min.

(The Contractor shall obtain written confirmation of clearance requirements from power line utility companies.)

- Roadway – to high voltage power lines:
 - ≤22 kV 6.0 m Min.
 - >22 kV to 50 kV 6.4 m Min.
 - >50 kV to 90 kV 6.7 m Min.
 - >90 kV to 120 kV 6.9 m Min.
 - >120 kV to 150 kV 7.3 m Min.
 - >150 kV to 200 kV 7.8 m Min.

(The Contractor shall confirm clearance requirements with the Alberta Electrical Utility Code and the power line utility and obtain confirmation in writing.)

- **Horizontal Clearances:**

- The distance between the outside shoulder edge and the toe of bridge slope ... 3.0 m Min.
- Edge of Ultimate Stage travel lane to face of bridge substructure element, retaining walls, existing or relocated power poles and towers, cantilevered sign support structures and overhead sign support structures shall be equal to or greater than the clear zone as specified in the Roadside Design Guide. Use of guardrail/barrier to reduce clear zone dimensions is only permitted on the raised medians of crossroads with a design speed of 80 km/h or less and on Service Roads.
- Edge of travel lane to face of bridge barrier or guardrail
 - Shall not exceed 3.5 m.
- Back of guardrail to solid object
 - Distance to meet manufacturer’s recommendation for design deflection at each design speed.
- Clear zone calculations for parclo entrance ramps adjacent to bridges shall be based on the directional ramp standard of 90 km/h.
- Clear zone calculations for entrance and exit ramp tapers adjacent to bridges shall be based on the design speed of the adjacent roadway from which the taper is developed.
- Clear zone calculations for bridges at systems interchanges and basket weave bridge structures shall be based on a design AADT over 6000 vehicles per day.
- Clear zone calculations for slopes in front of bridge piers, power poles, towers, cantilevered and overhead sign structure supports and retaining walls that are nominally parallel to the roadway shall be based on ‘fill slopes’ values.
- The distance from face of barrier to a continuous feature (e.g. MSE wall) shall be equal to or greater than the applicable zone of intrusion as identified in the Roadside Design Guide, Section H5.4.4.
- For loop ramps with design speed less than 60 km/h and with a curve radius of less than 100 m, the curve modification factor shall be 1.5.

- **Clear Zone Exceptions**

- Concrete barrier is required along NB Mainline adjacent to the Weaselhead Park retaining wall;
- Concrete barrier is required between the Sarcee Trail SB to Calgary Ring Road SB ramp and the adjacent C-D ramp; and
- Continuous concrete barrier is required between the Glenmore EB mainline and

Sarcee Trail SB to Glenmore EB ramp from Sarcee Trail to beyond the exit gore to 37 Street SW.

- Continuous concrete barrier is permitted between Glenmore Trail EB mainline and Glenmore Trail WB mainline east of Sarcee Trail SW

- **Roadside Design**

- Roadside barriers that are not located on bridges or on top of retaining walls shall meet the following criteria:
 - If the design speed is 100 km/h or greater..... TL-4
 - If the design speed is less than 100 km/h TL-3
- The longitudinal traffic barrier systems shall be selected based on the guidance in section H3.2.3.1 of the Roadside Design Guide.
- Concrete barriers may be used at bridge locations on crossroads. Vehicular traffic barriers on structures shall be rigid barriers and shall meet, the requirements of Test Level 4 (TL-4) or as defined by the Bridge Design Code, except that Test Level 5 (TL-5) barriers shall be provided on all of the following structures:
 - All structures carrying the Mainline;
 - All structures located on Elevated Directional Ramps;
- Bicycle barriers meeting the requirements of the Bridge Design Code shall be provided in locations where sidewalks and multi-use trails are located adjacent to and on the high side of a retaining wall or on bridges over water courses;
- Energy attenuator systems for guardrail approach terminals shall pass all required tests for a Test Level 3 (TL-3) for terminals and redirective crash cushions of the *AASHTO Manual for Assessing Safety Hardware (2009)* (“**MASH**”);
- Transitions to Bridge barriers - The transitions to bridge barriers shall pass all required tests for a Test Level 4 (TL-4) as described in the National Cooperative Highway Research Program Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features” (NCHRP 350);
- Roadway set-back distances from oil and gas wells shall be compliant with Alberta Energy Regulator (or its successor) regulations and guidelines and shall address both the current operating status of the wells (which may include abandoned, decommissioned, or active wells) and the potential future operating status;
- Longitudinal rumble strips on either shoulder or centreline shall not be used; and
- Where curbs are used to control roadway surface drainage and are combined with a roadside barrier, the provisions in the Roadside Design Guide shall apply except as modified below:

- Curbs shall be mountable type and shall only be used in combination with W-beam strong post barrier systems (with steel or wood posts) or standard Department approach rail transitions;
- Curbs shall not be used on the Mainline roadways.
- **Stopping Sight Distance (“SSD”):**
 - Horizontal - Meet or exceed the Highway Geometric Design Guide values for lateral clearance on horizontal curves for stopping sight distance (Figure B-3.9b); and
 - Horizontal – In the case of curves at bridge and/or guardrail locations, meet or exceed the Highway Geometric Design Guide for lateral clearance on horizontal curves for stopping sight distance (Figure B-3.9b) with shoulder width not to exceed 3.5 m.
- **Decision Sight Distance:**
 - Calgary Ring Road, Highway 8, Highway 22X, Glenmore Trail SW, Sarcee Trail SW, Anderson Road SW, and Macleod Trail interchange exit terminals - decision sight distance shall be based on a driver’s eye height of 1.05 m and an object height of 0.0 m at the physical gore. Decision sight distance shall be provided appropriate to the applicable design speed.
 - Crossroads (design speed 70 km/h or less) - interchange exit terminals - decision sight distance shall be based on a driver’s eye height of 1.05 m and an object height of 0.38 m at the physical gore. Decision sight distance shall be provided appropriate to the applicable design speed and shall exceed the upper values for vertical stopping sight distance requirements listed in the TAC Geometric Design Guide by 25%.
 - Directional Ramps and C-D roads – interchange exit terminals – decision sight distance shall be based on a driver’s eye height of 1.05 m and an object height of 0.0 m at the physical gore. Decision sight distance shall be provided for the applicable design speed.
- **Exceptions to Decision Sight Distance:**
 - On Glenmore Trail WB approaching the exit ramp to Westhills Way SW, the decision sight distance provided shall be a minimum of 180 m.
- **Horizontal and Vertical Alignments –Mainline:**
 - The Contractor shall design the Mainline horizontal and vertical alignment to avoid any perceived roller coaster or kinked curve appearance, and shall ensure that the alignment complements the existing topography.
- **Horizontal and Vertical Alignments – Crossroads:**
 - Vertical Alignment – K values specified above shall be used as a minimum.
 - Horizontal Alignment at intersections shall follow TAC Geometric Design Guide section 2.3.
 - Transition between two-lane/four-lane roadways at intersections – follow TAC Geometric Design Guide in designing two-lane/four-lane transitions, with the

parallel lane length calculated based on the value of the design domain (TAC Geometric Design Guide section 2.3.9).

- Turn Bay Length at Intersection – The length of a Left or Right Turn Bay shall satisfy both deceleration and storage requirements below:
 - Measurement of turn bay length is from the point where the turn bay lane width is 3.0 m to the stopline at the end of the turn bay.
 - Deceleration requirements:

Design Speed of Roadway	Minimum Length of Deceleration Lane including Taper, L_d
60 km/h	90 m
70 km/h	110 m
80 km/h	130 m
90 km/h	150 m
100 km/h	170 m
110 km/h	185 m
120 km/h	200 m

- Storage requirements – to be determined based on results of simulation analysis. The length of the turn bay shall be designed so that either the queue in the through lane will not block the turn bays, or the queue in the turn bays will not spill out of the turn bay and block the adjacent through lane.

- Turn Bay/Taper Length Leading into a Loop Ramp or Free-Flow Right Turn Roadway – The length of a turn bay/taper shall satisfy both deceleration and storage requirements below:
 - Measurement of turn bay length is from the point where the turn bay lane width is 3.0 m to the start of the controlling radius of the turning roadway
 - Deceleration requirements:

Design Speed of Roadway	Minimum Length of Deceleration Lane including Taper, L_d				
	Design Speed of Turning Roadway Curve (km/h)				
	40	45	50	55	60
60 km/h	70 m	65 m	55 m	50 m	n/a
70 km/h	90 m	85 m	75 m	70 m	60 m
80 km/h	105 m	100 m	95 m	90 m	80 m
90 km/h	125 m	120 m	115 m	110 m	100 m
100 km/h	145 m	140 m	135 m	130 m	120 m
110 km/h	160 m	155 m	150 m	145 m	140 m
120 km/h	180 m	175 m	170 m	165 m	155 m

- Storage requirements – to be determined based on results of simulation analysis. The length of the turn bay shall be designed so that either the queue

in the through lane will not block the turn bays, or the queue in the turn bays will not spill out of the turn bay and block the adjacent through lane.

- Curves shall be introduced at all through-lane deflections in the vicinity of ramp intersections along crossroads (deflections exceeding one degree). Curves shall be long enough to avoid the appearance of a kink but not so short as to require superelevation.
- Spiral curves shall be introduced at both ends of all ramp curves.
- **Number of Ramp Approach Lanes at Intersection:**
 - For crossroads with cross-section of four lanes or more, the ramp intersection approach shall have two lanes to permit double left turn movements from the ramp.
- **Medians:**
 - Except in locations where exceptions to median width have been identified elsewhere in this Section 200.2.2, the Contractor shall design the roadway to ensure median barriers are not required on the Mainline. Medians on crossroads shall be the raised type on roadways where the design speed is less than 80 km/h except at Strathcona Street and Westhills Way SW.
 - Anderson Road SW shall have a raised median from the Buffalo Run Boulevard/Chiila Boulevard roundabout eastwards across the bridge to the east end of the eastbound to northbound turn lane as shown on Drawing 18-A-03.06SW in Appendix A.
 - All single bridge piers located in the medians of the Calgary Ring Road, Macleod Trail SE, Highway 8, Highway 22X and Glenmore Trail SW shall be centred in the Ultimate Stage median.
- **Intersections:**

At-grade intersections shall be designed to accommodate a WB-36 design vehicle as identified in the Highway Geometric Design Guide except for the design of the Service Roads intersections, in which case the WB-21 shall be the design vehicle. Intersection design shall use *desirable* standards from design guides and bulletins as an absolute minimum.

Where permitted by the Technical Requirements ramp terminal intersections may be designed and constructed as roundabouts. If the Contractor elects to design and construct roundabouts at locations where the ramp terminal intersection must accommodate dual left turn movements, the design of the roundabouts shall comply with the November 5, 2014 Amendment to Alberta Transportation's Design Bulletin #68/2010 - Technical Guidelines 4.4 Design Vehicle Accommodations on Multi-Lane Roundabouts that stipulates that in Case 3, SU-9 (inside lane) and WB-21 (outside lane) design vehicles shall maintain their own lane simultaneously as they enter, circulate and exit multi-lane roundabouts. The WB-36 design vehicle shall be accommodated according to Case 1 requirements where the WB-36 design vehicle may track across adjacent lanes as they enter, circulate and exit multi-lane roundabouts.

At the following intersections where dual left turn movements are required, the WB-36 design vehicle shall be accommodated on the outside lane and the WB-21 design vehicle shall be accommodated on the inside lane.

- South ramp terminal intersection at Sheriff King Street SW;
- Both ramp terminal intersections at 146 Avenue SW; and
- South ramp terminal intersection at 37 Street SW and Glenmore Trail SW.

For all other dual left turn movements, a WB-21 design vehicle shall be accommodated on the outside lane and the SU-9 design vehicle shall be accommodated on the inside lane.

● **Exceptions to design vehicle standards:**

- The Service Road EB to James McKeivitt Road NB single left turn shall be designed to accommodate a WB-21 design vehicle;
- The 130 Avenue SW WB to Calgary Ring Road SB single left turn shall be designed to accommodate a WB-21 design vehicle; and
- The 69 Street SW NB to Calgary Ring Road WB single left turn shall be designed to accommodate a WB-21 design vehicle.

200.2.3 DESIGN SPECIFICS

Additional location specific requirements have been developed to provide additional direction for Stage 1 construction. These requirements are intended to ensure specific key elements are addressed in the New Infrastructure.

200.2.3.1 Local Authority Responsibilities

Each Local Authority is responsible for the design and construction of all roadway connections of the crossroads that are outside of the Project Limits but within the Local Authority's respective corporate limits, except as otherwise provided elsewhere in Section 200 (Project Specifics). The Contractor is responsible for the coordination of road closures and removal of roads in the TUC or within the Project Limits with the Local Authority.

200.2.3.2 Intentionally Deleted

200.2.3.3 Roadway Mainline

Stage 1 construction shall include the construction of any Ultimate Stage retaining walls to accommodate Ultimate Stage bridge structure fills at the abutments. Stage 1 construction shall be compatible with the future Outer Ring Road. The Contractor shall carry out the Project so as to not negatively affect the design and construction of the future Outer Ring Road.

200.2.3.3.1 Calgary Ring Road:

Stage 1 construction shall include Ultimate Stage subgrade for all travel lanes, bridge structure fills, associated loops and ramps, and Outer Ring Road mainline lanes, unless noted otherwise on

Drawings 18-A-03.01SW to 18-A-03.11SW in Appendix A. Stage 1 paving shall include lane configuration as shown on Drawings 18-A-03.01SW to 18-A-03.11SW and 18-A-04.01SW to 18-A-04.09SW in Appendix A. The subgrade for the Ultimate Stage shall be designed and constructed to be consistent with the pavement structure proposed for the Ultimate Stage in the Functional Plan.

Stage 1 shall include the design and construction of the subgrade for the future Outer Ring Road express lanes located in the median from Highway 22X to west of 69 Street SW. The subgrade for the future Outer Ring Road shall be designed and constructed to be consistent with the pavement structure proposed for the Outer Ring Road in the Functional Plan. The Contractor shall not propose any permanent infrastructure that would infringe on the future express lanes nor the adjacent clear zones and transfer lanes.

Stage 1 shall include the design and construction of Calgary Ring Road Mainline from east of Macleod Trail to Highway 8, with paving of four core lanes in each direction, unless otherwise shown on the Drawings in Appendix A. Future expansion from 8 basic lanes will generally be to the median side as shown in Drawings 18-A-03.01SW to 18-A-03.11SW and 18-A-04.01SW to 18-A-04.09SW in Appendix A. All Mainline bridges shall be designed to accommodate the Ultimate Stage laning configuration and the Outer Ring Road carriageways. The Stage 1 EB Mainline lanes adjacent to the community of Discovery Ridge east of 69 Street shall be designed and constructed on the alignment of the EB Outer Ring Road carriageway as shown on Drawing 18-A-03.10SW in Appendix A.

Subject to Section 200.2.3.23 (Detours), the Contractor shall ensure that public traffic on the existing portion of the Calgary Ring Road is allowed to operate unimpeded within the Project Limits with all turn movements and accesses maintained throughout the Construction Period.

200.2.3.3.2 Glenmore Trail

Stage 1 construction shall include Ultimate Stage subgrade for all travel lanes, bridge structure fills, associated loops and ramps, and Outer Ring Road mainline lanes, unless noted otherwise in this Section 200.2.3 (Design Specifics). Stage 1 paving shall include the lane configuration as shown on the Drawings in Appendix A. The subgrade for the Ultimate Stage shall be designed and constructed to be consistent with the pavement structure proposed for the Ultimate Stage in the Functional Plan.

Stage 1 shall include the design and construction of Glenmore Trail from east of 37 Street SW to Highway 8, with paving of five and three lanes in each direction, unless otherwise shown on Drawings 18-A-03.01SW to 18-A-03.11SW and 18-A-04.01SW to 18-A-04.09SW in Appendix A. All bridges shall be designed to accommodate the Ultimate Stage laning configuration.

Stage 1 construction of Glenmore Trail from east of 69 Street SW to east of 37 Street SW forms part of the Priority New Infrastructure.

Subject to Section 200.2.3.23 (Detours), the Contractor shall ensure that public traffic on Glenmore Trail is allowed to operate unimpeded within the Project Limits throughout the

Construction Period.

Maintenance cross-overs in the median of the Mainline or between the Mainline, C-D roads or ramps are not permitted except on Highway 8 west of 101 Street intersection.

200.2.3.3.3 Highway 8

As shown on Drawings 18-A-03.10SW, 18-A-03.11SW, and 18-A-04.05SW in Appendix A, Highway 8 will be designed and constructed as a 4-lane divided roadway that transitions into a 2-lane undivided roadway west of the Lott Creek Drive/Range Road 25 intersection. The WB bridge over the Elbow River shall be designed and constructed to accommodate the Ultimate Stage interchange of Highway 8 and the Calgary Ring Road. The design and construction of the Stage 1 connection may include the use of the existing bridge over the Elbow River (Department's Bridge File 2430). The existing bridge structure will be replaced by a new bridge in the Ultimate Stage and the Contractor's Stage 1 and Ultimate Stage designs shall accommodate the design and construction of a replacement structure in the Ultimate Stage. The improvements at Highway 8 are deemed to be a part of the Remaining New Infrastructure.

The Contractor shall design and construct a 9.0 m wide gravel surfaced median cross-over as shown on Drawing 18-A-03.11SW in Appendix A.

Subject to Section 200.2.3.23 (Detours), the Contractor shall ensure that public traffic on Highway 8 is allowed to operate unimpeded within the Project Limits throughout the Construction Period.

200.2.3.3.4 Highway 22X

As shown on Drawings 18-A-03.03SW and 18-A-03.04SW in Appendix A, the Contractor shall design and construct a 4-lane divided roadway that ties into existing Highway 22X at 69 Street SW/128 Street W. The Contractor may utilize the existing westbound carriageway of Highway 22X west of 37 Street SW/90 Street W. The new eastbound carriageway shall generally follow the vertical geometry of the existing westbound carriageway. The existing westbound carriageway and appurtenances of Highway 22X shall be deemed to be part of the Remaining New Infrastructure.

Subject to Section 200.2.3.23 (Detours), the Contractor shall ensure that public traffic on Highway 22X is allowed to operate unimpeded within the Project Limits throughout the Construction Period.

200.2.3.4 Crossroads

Roadways crossing the Mainline shall be designed and constructed in accordance with the Geometric Design standards presented in Section 200.2.2. At transition locations for roadway connections beyond the Project Limits the roadways shall meet the current standards of the Local Authority. Crossroads to be constructed in Stage 1 are:

- Macleod Trail SE;
- 6 Street SW/Sheriff King Street;
- James McKeivitt Road SW/Spruce Meadows Way;
- 162 Avenue SW;
- 146 Avenue SW/Fish Creek Boulevard SW;
- 130 Avenue SW;
- Anderson Road SW;
- 90 Avenue SW;
- Southland Drive;
- Strathcona Street;
- Sarcee Trail;
- 37 Street SW/Glenmore Trail;
- Westhills Way SW; and
- 69 Street SW.

The Contractor shall consult with and coordinate its work with each Local Authority, as appropriate, regarding timing and tie-ins of the crossroads at the Project Limits. The Contractor shall grade all crossroads to the Ultimate Stage configuration unless noted otherwise in this Section 200.2.3 (Design Specifics). Crossroads shall be paved to the Stage 1 configuration up to the Project Limits and then transitioned beyond the Project Limits to match the crossroad section that is in place on July 1, 2020. These transitions must meet current Local Authority standards or be as specified in the typical cross sections in Appendix A for the crossroad and shall be deemed Service Roads for the purposes of section 5.18 of the DBFO Agreement except the warranty period shall only be one year.

Unless otherwise specified, the Contractor shall ensure that public traffic on existing crossroads within the Project Limits continue to operate unimpeded and in accordance with Section 200.2.3.23 (Detours) within the Project Limits until RNI Traffic Availability.

All existing roadway lighting and traffic signals on crossroads to be reconstructed in Stage 1 shall be replaced as part of the New Infrastructure. The Contractor shall verify that design and construction of the New Infrastructure will not compromise the integrity of the operation of the existing roadway lighting and traffic signals infrastructure outside the Project Limits. The Contractor shall ensure that areas within the Project Limits that operate with roadway lighting and/or traffic signals will continue to have lighting/signals during the Construction Period. All non-permanent lighting used during the Construction Period shall be equal to or better than the existing roadway lighting and shall be pole mounted.

Drawings 18-A-03.01SW to 18-A-03.11SW and 18-A-04.01SW to 18-A-04.09SW, inclusive, in Appendix A show the requirements for major arterial crossroads. Multi-use trails and pedestrian walks requirements shall be as shown on Bridge Information Drawings in Appendix A for individual crossroads. Multi-use trails and pedestrian walks off bridge structures shall extend to the Project Limits and shall match the dimensions and material of multi-use trails and pedestrian walks at the Project Limits on July 1, 2020. Generally, the alignment of multi-use trails and pedestrian walks off structures shall be parallel to and offset from the centreline of the crossroad.

Wheel chair curb ramps shall be constructed at all pedestrian crossings. These ramps shall be in accordance with the requirements of the Local Authority.

Approach nose treatments for islands and medians shall be in accordance with the requirements of the Local Authority.

Curbs installed on crossroads with design speed exceeding 70 km/h shall be mountable curbs.

200.2.3.5 Bridge Sections

Bridge Information Drawings 18-A-05.01SW to 18-A-05.47SW inclusive, included in Appendix A identify bridge deck cross-section, shoulder, and sidewalk configurations, key plan, and other information for all New Infrastructure bridge structures.

All bridge structures shall be designed and constructed to enable widening of the structure to accommodate the Ultimate Stage laning configuration of the bridge structure. Bridges constructed in Stage 1 that span roadways shall be constructed to span the Ultimate Stage laning configuration and Outer Ring Road carriageways of the underpassing roadway.

The design of bridge structures, where applicable, shall be in accordance with the recommendations as listed in Alberta Transportation's *Design Bulletin #45, Use of Retaining Wall Structures for Bridges and Roadways in Active Watercourse Environments*.

Unless otherwise noted the Contractor shall be responsible for demolition and removal of existing bridge structures. The existing bridge structures requiring demolition and removal are:

- Highway 22X over Macleod Trail SE (Department Bridge File 77546-1);
- Highway 22X over CPR Track Mile 10.75 Macleod Subdivision (Department Bridge File 77545-1);
- Weaselhead Road over the Elbow River;
- 37 Street over Glenmore Trail; and
- Cullen Creek bridge size culvert (Department Bridge File 71710-1).

The Contractor shall complete the demolition of each bridge structure in accordance with Section 200.2.3.24 (Demolition), unless otherwise noted.

All bridges shall be evaluated for permit vehicle configurations as shown in SK-2 through SK-8 inclusive in Appendix B. These permit vehicles shall be evaluated as Permit-Single Trip (“PS”) vehicles in accordance with section 14 of the Bridge Design Code. The outcome of the Contractor’s evaluation shall be the maximum gross vehicle weight (“GVW”) that the bridge can carry for each permit vehicle configuration, and this information shall be indicated on the bridge drawings in a concise format consistent with the Department’s *Engineering Drafting Guidelines for Highway and Bridge Projects*, and also this information shall be presented to the Department in a separate summary report as part of the As-Built Construction Reports. It should be noted that these permit vehicles do not meet the requirements for the simplified methods of analysis for live load as outlined in section 5 of the Bridge Design Code.

200.2.3.6 Interchanges and Grade Separations

Stage 1 construction shall include Ultimate Stage subgrade for all grade separations and interchanges unless noted otherwise in this Section 200.2.3 (Design Specifics). Stage 1 paving shall include lane configurations as shown on Drawings 18-A-03.01SW to 18-A-03.11SW in Appendix A. The subgrade for the Ultimate Stage shall be designed and constructed to be consistent with the pavement structure proposed for the Ultimate Stage in the Functional Plan. All non-hard surface areas within the Road Right of Way and other disturbed areas within the TUC including Ultimate Stage subgrade shall be topsoiled and seeded in accordance with the requirements of Section 200.2.9 (Topsoil and Seeding).

The Contractor shall ensure that traffic on existing roadways and interchanges operates unimpeded and in accordance with Section 200.2.3.23 (Detours) within the Project Limits throughout the Construction Period. The public use of an existing road during the Construction Period shall be considered a detour and is subject to the requirements of Section 200.2.3.23 (Detours).

Existing roadways or ramps that the Contractor does not incorporate into the Stage 1 design shall be obliterated in accordance with Section 200.4.12 (Roadway Obliteration).

In locations where Ultimate Stage interchange construction is not required as part of the Project, design submissions for the Ultimate Stage interchange are required to support bridge structure design and grading design.

- **Paving**
The surface of all pavement structures in the New Infrastructure shall tie smoothly to the existing pavement structures at all Project Limits. In the event that the pavement structure for the New Infrastructure differs from that of the existing pavement, grading surfaces shall be transitioned to match seamlessly at Project Limits ensuring that base course drainage is maintained.
- **Retaining Structures**
The Contractor is responsible for all retaining structures necessary for grading of all New Infrastructure within the Project Limits, including those associated with the Contractor's bridge designs.

All retaining wall structures shall have barriers or railings along the top edge. Barrier placement and construction shall be in accordance with safe roadside design practices as established in the Roadside Design Guide, and Section 300.5 (Bridge Structures). Where a situation is not covered by the Roadside Design Guide or Section 300.5 (Bridge Structures), provisions in the TAC Geometric Design Guide shall be used.

- **Bridges**

All bridge structures shall be designed and constructed to the Ultimate Stage bridge opening, lane arrangement, clearance box, clear zone requirements and grading, unless shown otherwise in Drawings 18-A-05.01SW to 18-A-05.47SW inclusive in Appendix A. The Contractor is responsible for the design and construction of all bridge structures associated with interchanges and grade separations.

- **Hazard Protection**
The Contractor is responsible for the design and construction of all required hazard protection for the Contractor's constructed roadway and bridge structure elements.
- **Signage**
The Contractor is responsible for the design, supply, and installation of all required signage for the Contractor's constructed roadway and bridge structure elements.
- **Roadway Lighting**
The Contractor is responsible for design and installation of all required roadway lighting for the Contractor's constructed roadway and bridge structure elements.

The Contractor shall design and construct the power feeds to provide separate circuits to the street lights and traffic signals that are part of the Service Roads or outside the Project Limits, in order to clearly demarcate areas of responsibility between the Local Authority and the Province.

All existing roadway lighting, located at the proposed interchanges that are part of Stage 1 construction, shall be removed and salvaged. The Contractor shall provide written notice to the appropriate Local Authority that existing roadway lighting hardware has been removed and salvaged and will be available for pick up for a period of three months. The Contractor shall be responsible for disposal of salvaged roadway lighting components that have not been removed by the appropriate Local Authority once the three month period has ended.

The Contractor shall verify that the design and construction of the New Infrastructure will not compromise the integrity of the operation of the existing roadway lighting infrastructure outside the Project Limits. All non-permanent lighting used during the Construction Period shall be equal to or better than the existing roadway lighting and shall be pole mounted.

- **Pavement Markings**
The Contractor is responsible for design and construction of all required pavement markings for the New Infrastructure roadway and bridge structure elements.

On roadways with design speed less than or equal to 70 km/h, urban pavement marking arrows shall be used in accordance with Figures TCS-C-401.1, TCS-C-405 and TCS-C-405.1 of the Department's *Highway Pavement Marking Guide* (March 2003). On roadways with a design speed greater than 70 km/h, rural pavement marking arrows shall be used in accordance with Figure TCS-C-401 of the Department's *Highway Pavement Marking Guide* (March 2003).

- **Walks and Multi-Use Trails**
The Contractor is responsible for the design and construction of all walks and multi-use trails such that they are in accordance with the requirements of the Local Authority.
- **Ramp Terminal Intersections**
The Contractor is responsible for the design and construction of ramp terminal intersections as part of the interchange design and construction. Where possible and not prohibited in the Technical Requirements, the Contractor may design and construct roundabouts at the ramp terminals provided that the traffic simulation analysis demonstrates that an equivalent or better level of service is achieved in Stage 1, and accommodates the Ultimate Stage.

200.2.3.6.1 69 Street SW Interchange

69 Street SW is classified as an arterial with a 70 km/h design speed. The Contractor shall design and construct the Ultimate Stage grade-separated fully directional service interchange at 69 Street SW, as part of the Remaining New Infrastructure as shown on Drawing 18-A-03.10SW in Appendix A. The work includes the design and construction of the bridge structure at 69 Street SW in its Ultimate Stage configuration. The Contractor shall construct a 2.5 m sidewalk along the west side and a 3.0 m multi-use trail along the east side of 69 Street SW within the Project Limits. The sidewalk and multi-use trail will be carried across the bridge structure as two 2.5 m sidewalks.

The ramp terminal intersections of 69 Street SW and Calgary Ring Road shall be either signalized intersections or roundabouts that shall accommodate the traffic volumes and a WB-36 design vehicle.

Construction of the 69 Street SW interchange will require closure of the existing access east of 69 Street SW to the Westside King's Church and adjacent properties as shown on Drawing 18-A-03.10SW in Appendix A. The existing access shall remain open to public traffic until the east leg of the intersection of Springbank Boulevard SW and 69 Street SW is completed and opened to traffic as shown on Drawing 18-A-03.10SW in Appendix A.

The Contractor shall design and construct the east leg of the Springbank Boulevard SW and 69 Street SW. The east leg of the intersection is considered to be a Service Road. The NB-EB movement shall be a two lane channelized right turn. The Contractor shall design and construct the intersection such that the management of stormwater runoff associated with the intersection, within the Road Right of Way, is captured and treated in conformance with the Technical Requirements. The landowners of the lands east of 69 Street SW, immediately north and south of the east leg of 69 Street SW/Springbank Boulevard SW intersection, are responsible for the design and construction of the utilities required to service these lands including the management of stormwater runoff, east of the Road Right of Way, on the Service Road.

The Local Authority is responsible for the design and installation of traffic signals at the intersection of Springbank Boulevard SW and 69 Street SW. If the Local Authority has not installed the traffic signals by the time the east leg of the intersection of Springbank Boulevard SW and 69 Street SW is completed and opened to traffic the Contractor shall install a stop condition such that the intersection functions as a four way stop. The Contractor shall coordinate

the design and construction of the signalized intersection with the Local Authority.

Construction of the 69 Street SW interchange will require closure of Lower Springbank Road SW east of 85 Street SW as shown on Drawing 18-A-03.10SW in Appendix A. Lower Springbank Road SW shall remain open to public traffic until the completion and opening of the new Service Road connecting Lower Springbank Road to 85 Street SW as shown on Drawing 18-A-03.10SW in Appendix A and outlined in Section 200.2.3.18.1 (Highway 8 Interchange Service Roads).

A berm shall be constructed on the north side of the Discovery Ridge community as noted on Drawing 18-A-03.10SW in Appendix A. The berm shall generally be 3 m in height with a 3 m top width. The Contractor shall ensure that runoff along or from the berm is contained within the TUC and does not flow into the adjacent properties south of the berm. The Contractor shall coordinate the design and construction of the berm to ensure there are no conflicts with any utilities including but not limited to ENMAX's 7.82L 138 kV transmission line.

As part of the Priority New Infrastructure, the Contractor shall construct the Mainline lanes and have the lanes open to traffic up to the east side of the 69 Street SW crossing. The 69 Street SW interchange is not part of the Priority New Infrastructure.

200.2.3.6.2 Westhills Way SW Interchange

There is currently no access at the location of the Westhills Way SW interchange. The crossroad is referred to as Westhills Way SW north of the Calgary Ring Road and Strathcona Street south of the Calgary Ring Road. Westhills Way SW and Strathcona Street are classified as arterial roadways with a 70 km/h design speed.

Without limitation, the Contractor shall design and construct a new service interchange as part of the Priority New Infrastructure providing the following movements:

- SB Westhills Way SW to SB Strathcona Street;
- NB Strathcona Street to NB Westhills Way SW;
- EB and WB Calgary Ring Road;
- EB Calgary Ring Road to Strathcona Street SB;
- EB Calgary Ring Road to NB Westhills Way SW;
- NB Strathcona Street to WB Calgary Ring Road;
- NB Strathcona Street to EB Calgary Ring Road;
- SB Westhills Way SW to WB Calgary Ring Road;
- SB Westhills Way SW to EB Calgary Ring Road;
- WB Calgary Ring Road to SB Strathcona Street; and
- WB Calgary Ring Road to NB Westhills Way SW.

The Contractor shall design and construct the interchange at Westhills Way SW to meet the requirements of the Stage 1 configuration as shown on Drawing 18-A-03.08SW in Appendix A. Construction of the bridge for Stage 1 shall be as shown on Drawing 18-A-05.41SW in Appendix A. Grading for the interchange shall be to the Ultimate Stage configuration. The

Contractor shall ensure that the Stage 1 design does not negatively affect the upgrading of the bridge to the Ultimate Stage. The Contractor shall construct a 3.0 m multi-use trail along the west side of Westhills Way SW within the Project Limits. The Contractor shall construct a 3.0 m multi-use trail along the east side of Westhills Way SW from the north TUC boundary to the north ramp terminal intersection. The east side multi-use trail shall connect to the west side multi-use trail at the north ramp terminal intersection.

A stormwater management facility (“**SWMF**”) for the Local Authority’s Sarcee Operations Work Centre is located in the NE quadrant of the interchange. The Local Authority has advised that this SWMF can contain runoff up to the 1:500 year event before any pond overflow occurs. Any overflow from this SWMF will be directed to an overland spillway located in the southwest corner of the SWMF.

The design and construction of the south roundabout shall include an EB Calgary Ring Road to Strathcona Street SB bypass lane as shown on Drawing 18-A-03.08SW in Appendix A.

The Contractor may design and construct signalized intersections instead of roundabouts at the ramp terminals provided that the traffic simulation analysis illustrates an equivalent or better operation than roundabouts in Stage 1 and accommodates the Ultimate Stage without impacts to the bridge structure.

The Contractor shall design and construct a 6 m wide gravel, restricted (locked gate) access road to accommodate a WB-21 design vehicle from Westhills Way SW to the City’s existing access road to the City’s 69 Street Storm Pond and sanitary lift station L57A as shown on Drawings 18-A-03.09SW and 18-A-03.10SW in Appendix A and typical section “Gravel Access Road (6 m)” as shown on Drawing 18-A-04.06SW in Appendix A. The access road shall be capable of accommodating a WB-21 design vehicle with a GVRW of 53,500 kg. The Contractor shall coordinate the design and construction of the access road with the Local Authority. The gated access shall be consistent with specific Local Authority requirements and the City’s Standard Drawings 454.1001.027 and 454.1001.031 as modified herein:

- a 6 m wide double swing gate with spring loaded castors on each side;
- a 1.5 m pedestrian opening; and
- the ability to open 90° inward, with stops to prevent further opening and locks to prevent it from closing.

The Local Authority is responsible for constructing Westhills Way SW outside of the Project Limits. If the Local Authority has constructed the connecting roadways prior to July 1, 2020, the Contractor shall tie into the connecting roadway at the Project Limits. If the Local Authority has not constructed the connecting roadways, the Contractor shall design and construct the crossroad to the Project Limits to be compatible with the Local Authority’s plans and supply and install temporary concrete barriers until the tie-ins are complete.

200.2.3.6.3 Sarcee Trail – Glenmore Trail Interchange

The intersection of Sarcee Trail and Glenmore Trail currently operates as a three-legged signalized at-grade intersection. The Contractor will be required to replace the intersection with a Systems Interchange as shown on Drawings 18-A-03.08SW to 18-A-03.09SW and bridge

Drawings 18-A-05.34SW – 18A-05.40SW, inclusive, and Drawing 18-A-05.42SW in Appendix A.

Without limitation, the Contractor shall design and construct a new Systems Interchange as part of the Priority New Infrastructure providing the following freeflow movements:

- EB Calgary Ring Road to SB Calgary Ring Road;
- NB Calgary Ring Road to WB Calgary Ring Road;
- EB Calgary Ring Road to EB Glenmore Trail;
- NB Calgary Ring Road to EB Glenmore Trail;
- EB Calgary Ring Road to NB Sarcee Trail
- NB Calgary Ring Road to NB Sarcee Trail;
- WB Glenmore Trail to WB Calgary Ring Road;
- WB Glenmore Trail to SB Calgary Ring Road;
- WB Glenmore Trail to NB Sarcee Trail;
- SB Sarcee Trail to WB Calgary Ring Road;
- SB Sarcee Trail to SB Calgary Ring Road; and
- SB Sarcee Trail to EB Glenmore Trail.

The SB Sarcee Trail to EB Glenmore Trail movement as shown on Drawing 18-A-05.40SW in Appendix A enters the EB lanes from the left. This left entrance is permitted at this location only as described in Section 200.2.2 (Geometric Design). For safety and operational reasons, the weaving movement from the entrance of the SB Sarcee Trail to EB Glenmore Trail ramp to the 37 Street SW exit must be prohibited by means of a concrete barrier to be designed and constructed by the Contractor.

All bridge structures for this interchange shall be designed and constructed to the Stage 1 requirements as shown on Drawings 18-A-03.08SW to 18-A-03.09SW and bridge Drawings 18-A-05.34SW to 18A-05.40SW, inclusive, and Drawing 18-A-05.42SW in Appendix A.

200.2.3.6.4 37 Street SW/Glenmore Trail Interchange

37 Street SW is an arterial roadway with design speed of 70 km/h. The Contractor shall design and construct the interchange to its Stage 1 configuration as shown on Drawing 18-A-03.09SW in Appendix A. 37 Street SW and Glenmore Trail is currently configured as, and operates as, an interim service interchange.

The new interchange requires realignment of 37 Street SW as shown on Drawing 18-A-03.09SW in Appendix A. Grading for all roads and ramps with the exception of the WB Glenmore Trail to SB 37 Street SW shall be to the Ultimate Stage. The Ultimate Stage grading of WB Glenmore Trail to SB 37 Street SW directional ramp is not required.

The Contractor is required to design and construct a new extension of 37 Street SW south of Glenmore Trail, which will tie into the future Strathcona Street as shown on Drawing 18-A-03.09SW in Appendix A. The Contractor will also be required to design and construct the extension of Grey Eagle Drive to connect to the realigned extension of 37 Street SW.

Without limitation, the Contractor shall design and construct a new service interchange, as part of the Priority New Infrastructure, to replace the existing interim interchange, providing the following movements:

- SB 37 Street SW to SB Strathcona Street;
- NB Strathcona Street to NB 37 Street SW;
- WB and EB Glenmore Trail across 37 Street SW/Strathcona Street;
- EB Glenmore Trail to SB Strathcona Street;
- EB Glenmore Trail to NB 37 Street SW;
- WB Glenmore Trail to SB Strathcona Street;
- WB Glenmore Trail to NB 37 Street SW;
- NB Strathcona Street to WB Glenmore Trail;
- NB Strathcona Street to EB Glenmore Trail;
- SB 37 Street SW to WB Glenmore Trail; and
- SB 37 Street SW to EB Glenmore Trail.

Design and construction of the bridge carrying 37 Street SW over Glenmore Trail SW shall be to the Ultimate Stage and shall include a 4.2 m wide multi-use trail on the east side of the bridge as shown on Drawing 18-A-05.33SW in Appendix A.

The Local Authority is responsible for constructing Glenmore Trail SW outside of the east Project Limit. If the Local Authority has reconstructed Glenmore Trail SW prior to July 1, 2020, the Contractor shall tie into the reconstructed Glenmore Trail SW at the east Project Limit. If the Local Authority has not reconstructed Glenmore Trail SW by July 1, 2020, the Contractor shall design and construct the tie-in to existing Glenmore Trail SW east of the east Project Limit.

The Contractor shall design and construct a 3.0 m wide multi-use trail from the south end of the new bridge on the east side along the new 37 Street SW/Strathcona alignment to the new Grey Eagle Drive intersection then east along the north side of the new connection to the new roundabout and then south along the west side of the realigned 37 Street SW. The alignment of the 3.0 m wide multi-use trail will be as shown on Drawing 18-A-03.09SW in Appendix A.

The Contractor shall design and construct a 3.0 m wide multi-use trail from the north end of the new bridge on the east side to connect with the existing multi-use-trail at the TUC boundary.

The Contractor shall be responsible for the demolition and removal of the existing interim service interchange bridge structure and related infrastructure, carrying 37 Street SW over Glenmore Trail. The Contractor shall complete the demolition of the bridge structure in accordance with Section 200.2.3.24 (Demolition).

Notwithstanding the above noted requirement to demolish and remove existing interim service interchange bridge structure and related infrastructure, the Contractor shall salvage and remove the girders, MSE wall panels and all railings carefully to avoid damage and carefully deliver the salvaged material to the City's Bears paw yard.

During the Construction Period, the Contractor shall ensure that all movements, as provided by the existing interim service interchange, are maintained at the level of service that existed at Execution of the DBFO Agreement. At the commencement of construction activities related to the construction of the new 37 Street SW/Glenmore Trail service interchange, the use of existing overpass structure and related roadways shall be considered to form a detour and as such the Contractor shall maintain the noted infrastructure, throughout the Construction Period, in accordance with the requirements of Section 200.2.3.23 (Detours).

The Contractor is required to close the existing intersection at 45 Street SW and Glenmore Trail. The existing intersection shall not be taken out of service until April 30, 2018. The Contractor shall provide written notice to the Department six months prior to closure of the existing intersection at 45 Street SW and Glenmore Trail.

The City owns an existing noise attenuation wall between the residential area and the roadway that runs between 37 Street SW and 45 Street SW. If the Contractor's design and construction requires impacts to the existing noise attenuation wall, the existing elevation at the top of the wall shall be retained. The Contractor is to maintain the existing noise attenuation wall at the existing location throughout construction. The Contractor shall extend the existing noise attenuation wall at 45 Street SW west to 50 Street SW. The extension to the noise attenuation wall shall be a minimum height of 1.8 m.

Prior to PNI Traffic Availability, the Contractor shall design and construct the Grey Eagle Drive extension, from the new Strathcona Street/37 Street SW alignment west to the TUC boundary, as shown on Drawing 18-A-03.09SW in Appendix A. The existing connection from the Grey Eagle Casino to 37 Street SW shall be removed when the new access is provided. Safe public access to the Grey Eagle casino must be provided at all times.

Without limitation, the Contractor shall design and construct the following movements at the intersection of the new Strathcona Street/37 Street SW extension and Grey Eagle Drive:

- NB and SB 37 Street SW;
- EB Grey Eagle Drive to NB 37 Street SW;
- EB Grey Eagle Drive to SB 37 Street SW;
- WB Grey Eagle Drive to NB 37 Street SW;
- WB Grey Eagle Drive to SB 37 Street SW;
- WB Grey Eagle Drive to NB 37 Street SW;
- WB Grey Eagle Drive to SB 37 Street SW;
- SB 37 Street SW to WB Grey Eagle Drive;
- SB 37 Street SW to EB Grey Eagle Drive;
- NB 37 Street SW to WB Grey Eagle Drive;
- NB 37 Street SW to EB Grey Eagle Drive;
- NB 37 Street SW to WB Grey Eagle Drive; and
- SB 37 Street SW to WB Grey Eagle Drive.

The Grey Eagle Drive extension shall be designed for a speed of 50 km/h and constructed in accordance with the typical section on Drawing 18-A-04.04SW in Appendix A. The TTN are responsible for the design and construction of Grey Eagle Drive west of the TUC boundary. The Contractor shall ensure the design and construction of the Grey Eagle Drive extension is coordinated with the TTN's design of Grey Eagle Drive. The TTN plan to construct the portion of Grey Eagle Drive west of the TUC boundary and have it open to traffic by December 31, 2017.

200.2.3.6.5 Strathcona Street Interchange

Strathcona Street is to be an arterial roadway with design speed of 70 km/h. There is currently no crossroad that intersects with the TUC at this location. The Contractor shall design and construct a grade-separated service interchange at Strathcona Street with laning as shown on Drawing 18-A-03.08SW in Appendix A. The work includes the design and construction of the bridge structure at Strathcona Street to span the Ultimate Stage Calgary Ring Road configuration, including the Outer Ring Road.

Without limitation, the Contractor shall design and construct the new service interchange as part of the Priority New Infrastructure to provide the following movements:

- WB and EB Strathcona Street across Calgary Ring Road;
- NB and SB Calgary Ring Road across Strathcona Street;
- NB Calgary Ring Road to EB Strathcona Street;
- NB Calgary Ring Road to WB Strathcona Street;
- EB Strathcona Street to SB Calgary Ring Road;
- WB Strathcona Street to SB Calgary Ring Road;
- SB Sarcee Trail to EB Strathcona Street;
- SB Sarcee Trail to WB Strathcona Street;
- WB Strathcona Street to NB Sarcee Trail;
- EB Strathcona Street to NB Sarcee Trail;
- WB Strathcona Street to EB Glenmore Trail via direct ramp; and
- EB Strathcona Street to EB Glenmore Trail via direct ramp.

The Contractor shall design and construct the interchange at Strathcona Street to meet the requirements of the Stage 1 configuration as shown on Drawings 18-A-03.08SW in Appendix A. Construction of the bridge for Stage 1 shall be as shown on Drawing 18-A-05.32SW in Appendix A. Grading for the interchange shall be to the Ultimate Stage configuration. The design and construction of the bridge structure shall include a 2.5 m wide sidewalk on the south side of the bridge structure as shown on Drawing 18-A-05.32SW in Appendix A. The Contractor shall ensure that the Stage 1 design does not negatively affect the upgrading of the bridge to the Ultimate Stage.

The Contractor may design and construct signalized intersections instead of roundabouts at the ramp terminals provided that the traffic simulation analysis illustrates an equivalent or better operation than roundabouts in Stage 1 and accommodates the Ultimate Stage without impacts to

the bridge structure.

The design and construction of the east roundabout shall include an NB Calgary Ring Road to EB Strathcona Street bypass lane as shown on Drawing 18-A-03.08SW in Appendix A.

The Contractor shall design and construct a 2.5 m wide sidewalk along the south side of Strathcona Street SW within the Project Limits as shown on Drawing 18-A-03.09SW in Appendix A.

The Local Authority is responsible for connecting Strathcona Street outside of the Project Limits. If the Local Authority has constructed the connecting roadways prior to July 1, 2020, the Contractor shall tie into the connecting roadway at the Project Limits. If the Local Authority has not constructed the connecting roadways by July 1, 2020, the Contractor shall design and construct the crossroad to the Project Limits to be compatible with the Local Authority's plans and supply and install temporary concrete barriers until the tie-ins are complete.

The Contractor shall ensure that a reasonable replacement access is available for residential, agricultural, recreational and traditional uses of the TTN to TTN land lying north of the Elbow River in section 35-23-2-W5M.

200.2.3.6.6 90 Avenue SW Interchange

90 Avenue SW is classified as an arterial roadway with design speed of 70 km/h. There is currently no crossroad that intersects with the TUC at this location. The Contractor shall design and construct a grade-separated service interchange at 90 Avenue SW to meet the requirements of Stage 1 as shown on Drawing 18-A-03.07SW and bridge Drawing 18-A-05.27SW in Appendix A. Without limitation, the Contractor shall design and construct the new service interchange as part of the Priority New Infrastructure providing the following movements:

- SB and NB Calgary Ring Road across 90 Avenue SW;
- SB Calgary Ring Road to 90 Avenue SW EB;
- NB Calgary Ring Road to 90 Avenue SW EB;
- WB 90 Avenue SW to Calgary Ring Road NB; and
- WB 90 Avenue SW to Calgary Ring Road SB.

The work includes the design and construction of a bridge structure at 90 Avenue SW that spans the Ultimate Stage Calgary Ring Road configuration, including the Outer Ring Road. Grading for the interchange shall be to the Ultimate Stage configuration and includes grading of the future EB to NB loop ramp and stub fill for the extension of 90 Avenue SW to the west TUC limit. The Priority New Infrastructure shall be designed to tie into the City's connecting roadways near the east boundary of the TUC and the TTN's future connecting roadway at the west boundary of the TUC. Both the east and west Project Limits will be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be considered to be within the Project Limits.

The Contractor shall design and construct the Stage 1 infrastructure to ensure that the future expansion of the interchange and bridge structure to the Ultimate Stage configuration is not negatively affected. Pier locations for the bridge structure must accommodate all collector, express and transfer lanes for the Ultimate Stage and Outer Ring Road. A 2.5 m sidewalk located on the south side of the Ultimate Stage bridge structure shall be included in the design for Ultimate Stage. The Contractor shall design the Stage 1 interchange to be compatible with the Ultimate Stage interchange, which will provide a future connection to the west (built by others). Without limitation the Ultimate Stage movements to and from the west Project Limit shall include:

- 90 Avenue SW WB;
- 90 Avenue SW EB;
- Calgary Ring Road SB to 90 Avenue SW WB;
- Calgary Ring Road NB to 90 Avenue SW WB;
- 90 Avenue SW EB to Calgary Ring NB; and
- 90 Avenue SW EB to Calgary Ring Road SB.

Southland Drive SW is classified as an arterial roadway in the *City of Calgary Street Network Plan*. The Ultimate Stage roadway is a divided, four lane urban arterial roadway, with a design speed of 70 km/h as shown on Drawing 18-A-03.07SW in Appendix A. Stage 1 shall include the construction of two lanes located on the future SB lanes of the Ultimate Stage four-lane arterial and the 2.5 m sidewalk on the west side of Southland Drive SW within the Project Limits. The profile shall be designed and constructed as shown on Drawing 18-A-04.08SW in Appendix A.

The intersection at 90 Avenue SW and Southland Drive SW shall be signalized. Without limitation, the Contractor shall design and construct Southland Drive SW as part of the Priority New Infrastructure providing the following movements at the intersections:

- EB and WB 90 Avenue SW;
- NB and SB Southland Drive SW
- NB Southland Drive SW to WB 90 Avenue SW;
- NB Southland Drive SW to EB 90 Avenue SW;
- SB Southland Drive SW to WB 90 Avenue SW;
- SB Southland Drive SW to EB 90 Avenue SW;
- EB 90 Avenue SW to SB Southland Drive SW;
- WB 90 Avenue SW to SB Southland Drive SW;
- EB 90 Avenue SW to NB Southland Drive SW; and
- WB 90 Avenue SW to NB Southland Drive SW.

The Contractor shall ensure that a reasonable replacement access is available for residential, agricultural, recreational and traditional uses of the TTN to TTN land east of the Calgary Ring Road, which includes portions of NE 13, SE and N1/2 24, and S1/2 25-23-2-W5M.

The Local Authority is responsible for connecting Southland Drive SW and 90 Avenue SW outside of the Project Limits. If the Local Authority has constructed the connecting roadways prior to July 1, 2020, the Contractor shall tie into the connecting roadway at the Project Limits.

If the Local authority has not constructed the connecting roadways by July 1, 2020, the Contractor shall design and construct the crossroad to the Project Limits to be compatible with the Local Authority's plans and supply and install temporary concrete barriers until the tie-ins are complete.

200.2.3.6.7 Anderson Road SW

The existing at-grade intersection of Anderson Road SW, 37 Street SW and Bullhead Road shall be replaced in its entirety with a free-flow Systems Interchange as shown on Drawing 18-A-03.06SW and bridge Drawings 18-A-05.24SW to 18-A-05.26SW inclusive in Appendix A. Anderson Road SW is classified as an expressway with a 90 km/h design speed east of the Calgary Ring Road. Within the TUC, Anderson Road SW is classified as an expressway with an 80 km/h design speed. West of the Calgary Ring Road, Anderson Road SW becomes Buffalo Run Boulevard and is classified as a local road with a design speed of 60 km/h. Without limitation, the Contractor shall design and construct a new Systems Interchange as part of the Priority New Infrastructure providing the following movements

- SB Calgary Ring Road across Anderson Road SW/Buffalo Run Boulevard;
- NB Calgary Ring Road across Anderson Road SW/Buffalo Run Boulevard;
- SB Calgary Ring Road to SB Buffalo Run Boulevard;
- SB Calgary Ring Road to EB Anderson Road SW;
- NB Calgary Ring Road to EB Anderson Road SW;
- NB Buffalo Run Boulevard to NB Calgary Ring Road;
- NB Buffalo Run Boulevard to SB Calgary Ring Road;
- NB Buffalo Run Boulevard to EB Anderson Road SW;
- EB Anderson Road SW to NB Calgary Ring Road;
- WB Anderson Road SW to SB Buffalo Run Boulevard;
- WB Anderson Road SW to NB Calgary Ring Road; and
- WB Anderson Road SW to SB Calgary Ring Road.

As part of Stage 1 construction, all bridge structures shall be constructed to their Ultimate Stage and shall be designed such that the construction of the Ultimate Stage of the Calgary Ring Road and Outer Ring Road are not negatively affected.

The Contractor shall design and construct a 3.0 m wide multi-use trail on the north and south side of Anderson Road SW within the Project Limits as shown on Drawing 18-A-03.06SW in Appendix A.

The Contractor is permitted to design and construct a signalized ramp terminal intersection for the EB to NB movement.

The City owns an existing berm and pathway between the residential area and the existing roadway that is located between 130 Avenue SW and Anderson Road SW. If the Contractor's design and construction requires impacts to the existing berm, the existing elevation at the top of the berm shall be retained either through an impermeable noise wall or earth berm/retaining wall

combination. The pathway shall also be retained or replaced with a pathway of equal dimensions and materials.

The City, as part of its improvements to Anderson Road SW, will be constructing a noise attenuation wall along the top of berm on the north side of Anderson Road SW from 24 Street SW to the TUC boundary. The design geodetic elevation of the top of the City's noise attenuation wall at the TUC boundary is 1127.9 m. The Contractor shall design and construct a noise attenuation wall from the TUC boundary to southeastern limit of Cedardale Mews SW. The Contractor shall match the horizontal location and the elevation of the top of the City's noise attenuation wall at the TUC boundary. The Contractor shall maintain the elevation of 1127.9 m until approximately the lane immediately west of Cedardale Rise SW at which point the noise attenuation wall may be stepped down to an elevation of 1125.7 in four equal increments of approximately 0.6 m each.

In the event that the Contractor's designs differ from those presented in the drawings in Appendix A or the Functional Plan, the Contractor shall prepare a noise analysis using the Department's noise attenuation criteria for the same section of noise attenuation wall noted above using traffic volumes provided by the Department. Upon completion of the analysis the Contractor shall be required to design and construct a noise attenuation wall to elevations that are the higher of, the elevations previously noted or the elevations calculated in the noise analysis based on the Contractor's Designs and the Department's noise attenuation criteria.

The Contractor shall design and construct Anderson Road SW/Buffalo Run Boulevard from the Calgary Ring Road to the traffic circle at the intersection of Buffalo Run Boulevard and Chiila Boulevard as shown on Drawing 18-A-03.06SW and typical section as shown on Drawing 18-A-04-03SW "Buffalo Run Boulevard". The Local Authority is responsible for the design and construction of the traffic circle at the intersection of Buffalo Run Boulevard and Chiila Boulevard. If the Local Authority has constructed the traffic circle at the intersection of Buffalo Run Boulevard and Chiila Boulevard prior to July 1, 2020, the Contractor shall tie into the traffic circle at the Project Limits. If the Local Authority has not constructed the traffic circle at the intersection of Buffalo Run Boulevard and Chiila Boulevard by July 1, 2020, the Contractor shall design and construct Anderson Road SW/Buffalo Run Boulevard to the Project Limits, such that the design and construction is compatible with the Local Authority's plans and shall supply and install temporary concrete barriers at the Project Limits until the tie ins are complete.

The Contractor shall design and construct the ramp connection from NB Buffalo Run Boulevard to SB Calgary Ring Road as shown on Drawing 18-A-03.06SW and typical section Drawing 18-A-04.06SW "One Lane Ramp".

The Contractor shall ensure that all currently provided traffic movements for the public are retained throughout the Construction Period in accordance with Section 200.2.3.23 (Detours).

The Contractor shall ensure that the access to Buffalo Run Boulevard is maintained and in operation for public use throughout the Construction Period.

200.2.3.6.8 130 Avenue SW Interchange

The intersection of 37 Street SW and 130 Avenue SW currently operates as a signalized, three-legged intersection. The Contractor shall replace the existing intersection with a service interchange as shown on Drawing 18-A-03.06SW and bridge Drawing 18-A-05.23SW in Appendix A. 130 Avenue SW is classified as an arterial road with a 70 km/h design speed. The Contractor shall design and construct an Ultimate Stage grade-separated service interchange at 130 Avenue SW as part of the Priority New Infrastructure. Without limitation, the Contractor shall design and construct the service interchange, as part of the Priority New Infrastructure, providing the following movements:

- NB and SB Calgary Ring Road across 130 Avenue SW;
- EB and WB 130 Avenue SW across the Calgary Ring Road;
- NB Calgary Ring Road to WB 130 Avenue SW;
- NB Calgary Ring Road to EB 130 Avenue SW;
- EB 130 Avenue SW to SB Calgary Ring Road; and
- WB 130 Avenue SW to SB Calgary Ring Road.

The Contractor shall design and construct the bridge structure at 130 Avenue SW in its Ultimate Stage configuration with a 2.5 m wide sidewalk on the north side of the bridge as shown on Drawing 18-A-05.23SW in Appendix A. The Contractor shall design and construct a 2.5 m wide sidewalk along the north side of 130 Avenue SW and a 3.0 m wide multi-use trail on the south side within the Project Limits as shown on Drawing 18-A-03.06SW in Appendix A. As part of Stage 1 construction, the bridge structure shall be designed such that the construction of the Ultimate Stage of the Calgary Ring Road and Outer Ring Road are not negatively affected. The Contractor shall provide written notice to the Department 60 days prior to the closure of the following movements:

- SB 37 Street SW to EB 130 Avenue SW; and
- WB 130 Avenue SW to NB 37 Street.

The City owns an existing berm and pathway between the residential area and the roadway that runs between 130 Avenue SW and Anderson Road SW. If the Contractor's design and construction requires impacts to the existing berm, the existing elevation at the top of the berm shall be retained either through an impermeable noise wall or earth berm/retaining wall combination. The pathway shall also be retained or replaced with a pathway of equal dimensions and materials.

130 Avenue SW, as part of the Priority New Infrastructure, shall be designed and constructed to tie into existing 130 Avenue SW at the east boundary of the TUC, and to the TTN's connecting roadways at the west boundary of the TUC. Both the east and west Project Limits will be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits.

There is currently no west extension of 130 Avenue SW into TTN lands. At the west Project Limit, the Contractor shall design and construct a four-lane arterial roadway to align and tie-in

with the future west extension of Buffalo Run Boulevard that will be designed and constructed by the TTN. If Buffalo Run Boulevard is not constructed by July 1, 2020, the Contractor shall design and construct 130 Avenue SW to the west boundary of the TUC, such that the design and construction is compatible with the TTN's plans communicated by that date, and shall supply and install temporary concrete barriers until the tie-ins are complete.

200.2.3.6.9 146 Avenue SW/Fish Creek Boulevard SW Interchange

The intersection of 146 Avenue SW and 37 Street SW/Fish Creek Boulevard currently operates as a signalized, three-legged intersection. The Contractor shall replace the existing intersection with a fully directional service interchange as shown on Drawing 18-A-03.05SW and bridge Drawing 18-A-05.21SW in Appendix A as part of the Priority New Infrastructure.

The Contractor shall design and construct a bridge structure at 146 Avenue SW/Fish Creek Boulevard SW in its Ultimate Stage configuration with a 4.2 m wide multi-use trail on the north side of the bridge structure as shown on bridge Drawing 18-A-05.21SW in Appendix A. As part of Stage 1, the bridge structure shall be designed and constructed to its Ultimate Stage and shall be designed such that the construction of the Ultimate Stage of the Calgary Ring Road and Outer Ring Road are not negatively affected.

146 Avenue SW/Fish Creek Boulevard SW is classified as an arterial road with a 70 km/h design speed. The Contractor shall construct a 3.0 m wide multi-use trail on the south side of Fish Creek Boulevard SW from the east boundary of the TUC to the east ramp terminal intersection of the Calgary Ring Road and Fish Creek Boulevard SW. The multi-use trail shall cross Fish Creek Boulevard SW at the intersection and continue on the north side of 146 Avenue SW/Fish Creek Boulevard SW to the intersection on the west side and cross 146 Avenue SW to continue on the south side to the west TUC boundary. Where the multi-use trail crosses Fish Creek Boulevard SW, a new 3.0 m multi-use trail shall be constructed to cross Fish Creek Boulevard SW and continue north along the east TUC boundary, inside the TUC to connect to the existing Fish Creek trail.

146 Avenue SW/Fish Creek Boulevard SW, as part of the Priority New Infrastructure, shall be designed to tie into the City's connecting roadway at the east boundary of the TUC. The east Project Limits will be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits. The west Project Limits will be at 37 Street SW. The Contractor shall design and construct a Service Road from the west TUC boundary to 37 Street SW as shown on Drawing 18-03-05SW in Appendix A and further described in Section 200.2.3.18.5 (Fish Creek Boulevard/146 Avenue Service Road).

The Contractor shall ensure that a reasonable replacement access is available for residential, agricultural, recreational and traditional uses of the TTN to 146 Avenue SW at all times.

To achieve PNI Traffic Availability, the Contractor shall construct, and have open to public traffic, the Mainline lanes to the crossing of 146 Avenue SW and provide the following movements:

- SB Calgary Ring Road to WB and EB 146 Avenue; and
- EB and WB 146 Avenue to NB Calgary Ring Road.

200.2.3.6.10 162 Avenue SW Interchange

Currently, there is no connection of 162 Avenue SW and the Calgary Ring Road within the TUC. 162 Avenue SW is classified as an arterial road with a future bus rapid transit facility within a 14 m wide median with a 70 km/h design speed. The Contractor shall design and construct the Ultimate Stage grade-separated fully directional service interchange to carry 162 Avenue SW over the Calgary Ring Road, as shown on Drawing 18-A-03.05SW and bridge Drawing 18-A-05.20SW in Appendix A as part of the Remaining New Infrastructure.

The Contractor shall design and construct 2.5 m wide sidewalks along the north and south side of the bridge structure. The Contractor shall design and construct a 2.5 m wide sidewalk along the north side of 162 Avenue SW within the TUC boundaries off of the bridge structure and a 3.0 m wide multi-use trail on the south side of 162 Avenue SW within the TUC boundaries off of the bridge structure. As part of Stage 1 the bridge structure shall be designed and constructed such that the construction of the Ultimate Stage of the Calgary Ring Road and Outer Ring Road are not negatively affected.

Currently, there is no connection of 162 Avenue SW within the TUC. The Local Authority is responsible for the design and construction of the extension to the existing 162 Avenue SW to the west and east boundaries of the TUC. The Contractor shall design and construct the arterial road to align with the east and west extensions to be constructed by the Local Authority. If the Local Authority's extensions of 162 Avenue SW are not constructed by July 1, 2020, the Contractor shall design and construct 162 Avenue SW to the Project Limits compatible with the Local Authority's plans and supply and install temporary concrete barriers until the tie-ins are complete.

Both the east and west Project Limits will generally be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits.

200.2.3.6.11 Highway 22X Interchange

The existing Highway 22X is a divided highway running east-west. The design speed of Highway 22X is 110 km/h. The Contractor shall design and construct a three-legged Systems Interchange generally as shown on Drawing 18-A-3.03SW and bridge Drawings 18-A-05.17SW to 18A-05.19SW inclusive in Appendix A as part of the Remaining New Infrastructure.

As part of the Remaining New Infrastructure the Contractor shall design and construct a new section of EB and WB Highway 22X west of the Systems Interchange which will tie into the existing highway at the west Project Limit (immediately east of the intersection of 69 Street SW/128 Street W and Highway 22X). The Contractor shall maintain access to 112 Street W and

53 Street SW during construction. The Contractor shall remove any existing median crossovers in consultation with the Department.

The Contractor shall design and construct the Systems Interchange to the Stage 1 requirement as shown on Drawing 18-A-3.03SW and bridge Drawings 18-A-05.17SW to 18A-05.19SW inclusive in Appendix A. All bridge structures shall be designed and constructed to coordinate with the future expansion and construction of the Ultimate Stage bridges. The structures shall be designed such that the construction of the Outer Ring Road as shown on Drawing 18-A-3.03SW in Appendix A is not negatively affected.

On the south side of the Calgary Ring Road, the Contractor shall reconfigure Tournament Lane, 80 Street W, 96 Street W, and 112 Street W as shown on Drawings 18-A-03.03SW and 18-A-03.04SW in Appendix A. The Contractor shall design and construct a Service Road referred to as the 188 Avenue SW connector that is further described and detailed in Section 200.2.3.18.6 (188 Avenue SW Service Road). The Tournament Lane, 80 Street W, 96 Street W/37 Street SW, and 112 Street W connections with Highway 22X shall not be closed until the replacement accesses are open to public traffic. The driveway accesses along Highway 22X shall not be closed until the replacement access along the new Service Road are open.

On the north side of Highway 22X east of the existing 96 Street W/37 Street SW intersection, the Contractor shall be required to grade the portion of the Chevra Kadisha of Calgary exchange area property (approximately 2.01 ha) in coordination with the Chevra Kadisha of Calgary as shown on Drawing 18-A-03.03SW in Appendix A. The grading shall be generally a 3% cross fall from the south to the north. Work will include but not be limited to site grading, topsoil removal and replacement and seeding and overland drainage. Seed mix and method of application shall be as required by Chevra Kadisha of Calgary. Seeded areas shall show a uniform stand of grass during the calendar year following the year of initial seeding. Areas which do not show a uniform stand of grass shall be reseeded. A uniform stand of grass shall show no bare spots greater than 0.1 square metres in area and shall provide a minimum of 80% ground cover.

200.2.3.6.12 James McKeivitt Road/Spruce Meadows Way Interchange

Currently, James McKeivitt Road/Spruce Meadows Way currently intersects with Highway 22X at an at-grade intersection. James McKeivitt Road and Spruce Meadows Way are classified as arterial roads with a 70 km/h design speed. The Contractor shall design and construct the Ultimate Stage grade-separated fully directional service interchange as shown on Drawing 18-A-03.02SW and bridge Drawing 18-A-05.16SW in Appendix A as part of the Remaining New Infrastructure.

The work includes the design and construction of the bridge structure at James McKeivitt Road/Spruce Meadows Way in its Ultimate Stage configuration with a 4.2 m wide multi-use trail along the west side of the bridge structure as shown on Drawing 18-A-05.16SW in Appendix A. The Contractor shall construct a 3.0 m wide multi-use trail along the west side of James McKeivitt Road SW/Spruce Meadows Way within the Project Limits.

The Contractor shall design and construct an access/intersection on Spruce Meadows Way SW at

the existing entrance to the Spruce Meadows facility. Public access must be maintained at all times.

James McKeivitt Road/Spruce Meadows Way, as part of the Remaining New Infrastructure, shall be designed and constructed to tie into the Local Authority's connecting roadways at the Project Limits. Both the north and south Project Limits will generally be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits. If the Local Authority's extension of Spruce Meadows Way SW is not constructed by July 1, 2020, the Contractor shall design and construct Spruce Meadows Way SW to the Project Limits compatible with the Local Authority's plans and supply and install temporary concrete barriers as required to effect the transition from the TUC to the existing roadway.

200.2.3.6.13 6 Street SW/Sheriff King Street Interchange

Currently, 6 Street SW/Sheriff King Street SW intersects with Highway 22X as an at-grade intersection. Sheriff King Street SW and 6 Street SW are classified as arterial roads with a 70 km/h design speed. The Contractor shall replace the intersection with a service interchange as shown on Drawing 18-A-03.02SW and bridge Drawings 18-A-05.14SW and 18-A-05.15SW in Appendix A as part of the Remaining New Infrastructure. The service interchange will include a basketweave structure to facilitate the merging of 6 Street SW/Sheriff King Street SW traffic on to WB Calgary Ring Road. The basketweave configuration will also include a bypass or slip ramp to facilitate the movement of WB traffic from 6 Street SW/Sheriff King Street SW to James McKeivitt Road/Spruce Meadows Way.

As part of the Remaining New Infrastructure, the Contractor shall design and construct the partially directional service interchange to its Ultimate Stage configuration. Stage 1 includes the design and construction of the bridge structure at 6 Street SW/Sheriff King Street SW in its Ultimate Stage configuration with a 4.2 m wide multi-use trail along the west side of the bridge structure as shown on Drawing 18-A-03.02SW in Appendix A. The Contractor shall construct a 3.0 m wide multi-use trail along the west side of 6 Street SW/Sheriff King Street SW within the Project Limits.

6 Street SW/Sheriff King Street SW, as part of the Remaining New Infrastructure, shall be designed and constructed to tie into the Local Authority's connecting roadways at the Project Limits. Both the north and south Project Limits will generally be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits.

The Contractor shall ensure that all existing movements at the intersection of 6 Street SW/Sheriff King Street SW and Highway 22X are provided until such time that the 194 Avenue SW connector from Macleod Trail SE to Sheriff King Street SW is open to public traffic.

200.2.3.6.14 Macleod Trail SE Interchange

Currently, the movement of traffic at Macleod Trail and Highway 22X is facilitated by a service interchange that carries Highway 22X over Macleod Trail. The Contractor shall design and construct a new major, free-flow Systems Interchange at Macleod Trail SE to replace the

existing interchange in its entirety as shown on Drawing 18-A-03.02SW and bridge Drawings 18-A-05.01SW to 18-A-05.11SW in Appendix A inclusive as part of the Remaining New Infrastructure. Construction shall be to the Project Limit leaving stubs for others to tie into as shown on Drawing 18-A-04 in Appendix A.

Macleod Trail is considered an expressway with a design speed of 90 km/h north of the Calgary Ring Road and a design speed of 110 km/h south of the Calgary Ring Road.

All bridge structures shall be designed and constructed to their Ultimate Stage. The Contractor is required to construct the Ultimate Stage grading for all ramps and roadways. The Contractor's design shall accommodate the future basket-weave directional ramps between Macleod Trail and Chaparral Boulevard, however, the grading of these ramps will not be part of Stage 1 construction.

The Contractor is responsible for the demolition and removal of the existing bridge structure carrying Highway 22X over Macleod Trail at this location (Department's Bridge File Number 77546-1). The Contractor shall complete the demolition of the bridge structure in accordance with Section 200.2.3.24 (Demolition).

Macleod Trail SE, as part of the Remaining New Infrastructure, shall be designed and constructed to tie into the Local Authority's connecting roadways at the Project Limits. Both the north and south Project Limits will generally be at the TUC boundary, except where the vertical or horizontal ramp geometry extends beyond the TUC boundary, in which case the roadway extending beyond the TUC will be included in the Project Limits.

200.2.3.7 Other Crossings

Stage 1 construction shall include Ultimate Stage subgrade for all other crossings unless noted otherwise in this Section 200.2.3 (Design Specifics). Stage 1 paving shall include lane configurations as shown on Drawings 18-A-03.01SW to 18-A-03.11SW inclusive in Appendix A.

The Contractor shall ensure that traffic on existing roadways at other crossings operates at the standards as defined in Section 200.2.3.23 (Detours) through the Project Limits throughout the Construction Period.

- **Paving**
The surface of all pavement structures in the New Infrastructure shall tie smoothly to the existing pavement structures at the Project Limits. In the event that the pavement structure for the New Infrastructure differs from that of the existing pavement, grading surfaces shall be transitioned to match seamlessly at the Project Limits ensuring that base course drainage is maintained.
- **Retaining Structures**
The Contractor is responsible for all retaining structures necessary for grading of all New Infrastructure within the Project Limits, including those associated with the Contractor's bridge designs.

All retaining wall structures shall have barriers or railings along the top edge. Barrier placement and construction shall be in accordance with safe roadside design practices as established in the Roadside Design Guide and in Section 300.5 (Bridge Structures). Where a situation is not covered by the Roadside Design Guide or Section 300.5 (Bridge Structures), provisions in the TAC Geometric Design Guide shall be used.

- **Bridges**
All bridge structures shall be designed and constructed to the Ultimate Stage bridge opening, lane arrangement, clearance box, clear zone requirements and grading, unless shown otherwise in Drawings 18-A-05.01SW to 18-A-05.47SW inclusive in Appendix A. The Contractor is responsible for the design and construction of all bridge structures associated with interchanges and grade separations.
- **Hazard Protection**
The Contractor is responsible for the design and construction of all required hazard protection for the Contractor's constructed roadway and bridge structure elements.
- **Signage**
The Contractor is responsible for the design, supply, and installation of all required signage for the Contractor's constructed roadway and bridge structure elements.
- **Roadway Lighting**
The Contractor is responsible for design and installation of all required roadway lighting for the Contractor's constructed roadway and bridge structure elements.

The Contractor shall design and construct the power feeds to provide separate circuits to the street lights and traffic signals that are part of the Service Roads or outside the Project Limits, in order to clearly demarcate areas of responsibility between the Local Authority and the Province.

All existing roadway lighting, located at the proposed interchanges that are part of Stage 1 construction, shall be removed and salvaged. The Contractor shall provide written notice to the appropriate Local Authority that existing roadway lighting hardware has been removed and salvaged and will be available for pick up for a period of three months. The Contractor shall be responsible for disposal of salvaged roadway lighting components that have not been removed by the appropriate Local Authority once the three month period has ended.

The Contractor shall verify that the design and construction of the New Infrastructure will not compromise the integrity of the operation of the existing roadway lighting infrastructure outside the Project Limits. All non-permanent lighting used during the Construction Period shall be equal to or better than the existing roadway lighting and shall be pole mounted.

- **Pavement Markings**
The Contractor is responsible for design and construction of all required pavement markings for the New Infrastructure roadway and bridge structure elements.

On roadways with design speed less than or equal to 70 km/h, urban pavement marking arrows shall be used in accordance with Figures TCS-C-401.1, TCS-C-405 and TCS-C-405.1 of the Department's *Highway Pavement Marking Guide* (March 2003). On roadways with a design speed greater than 70 km/h, rural pavement marking arrows shall be used in accordance with Figure TCS-C-401 of the Department's *Highway Pavement Marking Guide* (March 2003).

- Walks and multi-use trails
The Contractor is responsible for the design and construction of all walks and multi-use trails such that they are in accordance with the requirements of the Local Authority
- Ramp Terminal Intersections
The Contractor is responsible for the design and construction of ramp terminal intersections as part of the interchange design and construction. Where possible and not prohibited in the Technical Requirements, the Contractor may design and construct roundabouts at the ramp terminals provided that the traffic simulation analysis demonstrates that an equivalent or better level of service is achieved in Stage 1, and accommodates the Ultimate Stage.

200.2.3.7.1 Cullen Creek

The Contractor shall design and construct a single bridge size culvert or collinear bridge size culverts underneath Highway 8 westbound and eastbound lanes as illustrated on Drawing 18-A-05.45SW in Appendix A as part of the Remaining New Infrastructure. The culvert will replace the existing culvert underneath the existing Highway 8 alignment (Department's Bridge File #71710E). The culvert is to be designed in a manner to accommodate the Ultimate Stage eastbound carriageway as well as the Ultimate Stage westbound carriageway and shall be sized based on the following for a bank-full flow condition in Cullen Creek:

- Bank-full design flow rate of maximum 10.9 m³/s;
- Channel flow depth 1.5 m above the channel invert with corresponding natural flow water surface profile elevations of:
 - Approximately 1103.9 m at a location 30 m upstream of the existing culvert inlet;
 - Approximately 1104.0 m at a location 150 m upstream of the existing culvert inlet; and
- Flow conditions for fish passage shall comply with those required by Federal Fisheries and Oceans Canada and Alberta Environment.

The design requirement for freeboard as described in Section 300.5.2.3.1 (Minimum Freeboard for Stream Crossings) shall apply for the above noted Cullen Creek bank-full design flow rate condition.

The Department requires the existing channel over the extent of the realignment to be infilled subsequent to realignment in all locations where current or future highway lanes are indicated on Drawing 18-A-05.45SW in Appendix A. The channel infill shall have sufficient coverage to accommodate the entire footprint of the supporting highway lane embankments. The Contractor shall ensure infilling and culvert design meets all regulatory requirements and the Technical

Requirements.

200.2.3.7.2 Weaselhead Road Underpass

The Contractor shall design and construct a grade separation to provide access on a revised alignment for the Weaselhead Road. The grade separation structure will be part of the Priority New Infrastructure and shall be a single continuous structure as shown on Drawing 18-A-05.31SW in Appendix A. The Contractor shall design and construct the continuous structure to be compliant with the National Fire Protection Association “NFPA 502 Standard for Road Tunnels, Bridges, and Other Limited Access Highways” for “Mandatory Requirements” for the appropriate “Tunnel Category”. The design of the grade separation shall take into consideration that the transportation of dangerous goods and the movement of vehicles transporting dangerous goods will not be permitted through the underpass. The Contractor shall ensure that public access remains uninterrupted on Weaselhead Road throughout the Construction Period. Weaselhead Road will be a Service Road as further described in Section 200.2.3.18.3 (Weaselhead Road Service Road).

The Contractor shall remove and demolish the existing Weaselhead Road bridge structure in accordance with Section 200.2.3.24 (Demolition). The existing roadways shall be obliterated in accordance with Section 200.4.12 (Roadway Obliteration).

200.2.3.7.3 Weaselhead Road Bridge over Elbow River

The Contractor shall design and construct the Ultimate Stage bridge structure to carry the realigned Weaselhead Road over the realigned Elbow River as shown on bridge Drawing 18-A-05.30SW in Appendix A as part of the Priority New Infrastructure. The bridge structure shall be designed similar to the Mainline bridges over the realigned Elbow River having the same bridge opening, height, and meet the same environmental requirements as noted in Sections 200.2.3.7.4 (Elbow River Crossing at Weaselhead) and Section 200.2.13 (Environmental). The Contractor is required to provide the minimum wildlife passage corridor clearance boxes as shown in Drawing 18-A-05.30SW in Appendix A.

The bridge design shall meet the following requirements:

- Minimum freeboard to underside of superstructure between the toe of abutment; embankment slopes as measured from high water level shall be 2 m;
- Minimum design high water elevation shall be 1083.0 m;
- Substructure design ice loading shall be determined in accordance with section 3.12 of the Bridge Design Code;
- The minimum ice loading condition that shall be considered to have an effective ice strength based on situation (b) (700kPa) (as described in section 3.12.2.1 of the Bridge Design Code) with a thickness of 1.0 m and a design high ice elevation of 1082.8 m;
- Minimum longitudinal grade on the bridge shall be 1.0%;
- Minimum Elbow River flow rate of 954 cms; and
- Piers shall not be located within the edges of the water of the realigned Elbow River stream under normal flow.

The Elbow River is to be realigned beneath the bridge structure as illustrated in Drawings 18-A-05.28SW to 18-A-05.30SW inclusive in Appendix A. The Contractor shall undertake the realignment of the Elbow River ensuring all regulatory requirements and the Technical Requirements, including those in Section 200.13 (Environmental), are met.

The Elbow River valley through which the Elbow River traverses acts as a corridor for the passage of wildlife in both an upstream and downstream direction. The Contractor's design and construction execution shall not inhibit wildlife passage along this corridor. Permanent dedicated large wildlife passage shall be provided beneath the bridges at both the north and south bridge abutments as well as a dedicated small wildlife passage at the north bridge abutment. The small wildlife passage shall be above the high water level. The Contractor shall extend the wildlife passage corridors on either side of the bridge to provide a contiguous corridor of varying width through the disturbed area. Temporary passageways shall be available during construction to maintain ability for wildlife passage during construction. The ground surface of the passageways shall be approximately level (allowing for appropriate drainage) and shall have a generally smooth walking surface that closely matches the natural river valley substrate (e.g. no riprap or large boulders) and vegetated to meet the requirements of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Elbow River Bridge Crossing Wildlife Planting Concept Drawing (Figure 3.5-17a) and Section 200.2.8 (Landscaping). The minimum wildlife passage corridor clearance boxes should meet the requirements shown in Drawings 18-A-05.28SW to 18-A-05.30SW inclusive in Appendix A.

The realignment of the Elbow River and the construction of the Calgary Ring Road north embankment will impact the existing Water Survey of Canada gauge station located at the southeast corner of the existing Weaselhead Road bridge over the Elbow River. The existing Water Survey of Canada gauge station shall be removed and transported by the Contractor to the Water Survey of Canada warehouse located at 4415 Manhattan Road SE, Calgary. Prior to its removal the Contractor shall contact Water Survey of Canada to arrange for the removal of any equipment within or on the building. The Contractor shall design and construct a new gauge station on the north bank of the realigned Elbow River between Weaselhead Road and southbound Calgary Ring Road at a location agreed to with the Water Survey of Canada. The Contractor shall design and construct the gauge station in accordance with Water Survey of Canada requirements. The Contractor shall contact the Water Survey of Canada to coordinate the design and construction of the gauge station. The Water Survey of Canada contact is:

Curtis Waiting, Hydrometric Supervisor
Water Survey Canada / Environment Canada
854, 220 - 4 Avenue SE
Calgary, AB T2G 4X3
Telephone: (403) 292-5471
Cell: (403) 880-8565
Email: curtis.waiting@ec.gc.ca

In addition to the Water Survey of Canada's design and construction requirements the Contractor shall:

- (a) design and construct gauge station such that the elevation of the building floor is set at or above 1.0 m above the 954 m³ per second design flow;
- (b) provide an all-weather gravel surfaced access road to the gauge station suitable for use by a SU9 design vehicle. The access road shall not be lower than the building floor elevation of the gauge station;
- (c) for the purposes of powering the gauge station, provide a separate, metered, single phase 120/240 V power source to the gauge station; and
- (d) The Contractor shall warranty the gauge station construction for a period of two years from the date of acceptance from the Water Survey of Canada. The Contractor shall repair, at its own expense, any such defect or failure which occurs in the work prior to the expiry of the warranty period.

200.2.3.7.4 Elbow River Crossing at Weaselhead

The Contractor shall construct two bridge structures to carry the Calgary Ring Road across the Elbow River, with five northbound lanes and five southbound lanes as illustrated on Drawings 18-A-05.28SW and 18-A-05.29SW in Appendix A as part of the Priority New Infrastructure. The Contractor shall produce a complete design for Stage 1 construction that fully accommodates Ultimate Stage requirements.

The bridge design shall meet the following requirements:

- Minimum freeboard to underside of superstructure between the toe of abutment embankment slopes as measured from high water level shall be 2 m;
- Minimum design high water elevation shall be 1082.8 m;
- Substructure design ice loading shall be determined in accordance with section 3.12 of the Bridge Design Code;
- The minimum ice loading condition that shall be considered to have an effective ice strength based on situation (b) (700kPa) (as described in section 3.12.2.1 of the Bridge Design Code) with a thickness of 1.0 m and a design high ice elevation of 1082.8 m;
- Minimum longitudinal grade on the bridge shall be 1.0%;
- Minimum Elbow River flow rate of 954 cms;
- Piers shall not be located within the edges of the water of the realigned Elbow River stream under normal flow;
- The roadway surface elevation of the bridge shall be at a similar elevation to the northbound/southbound roadway bridge; and
- The northbound and southbound bridges shall have matching aesthetic properties.

The Elbow River is to be realigned beneath the bridge structures as illustrated in Drawings 18-A-05-28SW and 18-A-05-29SW in Appendix A. The Contractor shall undertake the realignment of the Elbow River ensuring all regulatory requirements and the Technical Requirements, including Section 200.2.13 (Environmental), are met.

The Elbow River valley through which the Elbow River transverses acts as a corridor for the

passage of wildlife in both an upstream and downstream direction. The Contractor's design and construction execution shall not inhibit wildlife passage along this corridor. Permanent dedicated large wildlife passage shall be provided beneath the bridges at both the north and south bridge abutments as well as a dedicated small wildlife passage at the north bridge abutment. The small wildlife passage shall be above the high water level. The Contractor shall extend the wildlife passage corridors on either side of the bridge to provide a contiguous corridor of varying width through the disturbed area. Temporary passageways shall be available during construction to maintain ability for wildlife passage during construction. The ground surface of the passageways shall be approximately level (allowing for appropriate drainage) and shall have a generally smooth walking surface that closely matches the natural valley substrate (e.g. no riprap or large boulders) and vegetated to meet the requirements of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Elbow River Bridge Crossing Wildlife Planting Concept Drawing (Figure 3.5-17a) and Section 200.2.8 (Landscaping). The minimum wildlife passage corridor clearance boxes should meet the requirements shown in Drawings 18-A-05.28SW and 18-A-05.29SW in Appendix A.

Wildlife fencing shall be provided as noted in Section 200.2.15 (Fencing).

The Contractor shall design and construct any retaining wall required within the Elbow River valley as a vegetated terraced walls. The vegetation must conform with the Technical Requirements.

The Contractor's design shall ensure that no errant vehicle and/or contaminant can leave the Calgary Ring Road and enter the Glenmore Reservoir or Elbow River valley. The Contractor shall design and construct a single slope concrete TL-5 roadside barrier along the east side of the northbound carriage way of the Calgary Ring Road from the top of the south escarpment of the Elbow River valley to the top of the north escarpment of the Elbow River valley as shown on Drawings 18-A-03.07SW and 18-A-03.08SW in Appendix A. For this section of barrier only, the TL-5 barrier shall be 1270 mm tall as measured from the top of pavement to the top of barrier, except where lamp poles or other potential obstacles extending above the top of the barrier exist behind the barrier, then the height of the barrier shall be increased to 1370 mm for a distance extending to 2000 mm on either side of the obstacle, with vertical transitions at a 10H to IV slope. The thickness of the barrier at the base of the barrier shall not be less than 700 mm and the slope of the barrier faces above the top of pavement shall be 0.165H to 1.00V. For the entire length of the Elbow River bridge structure a custom TL-5 bridge barrier shall be designed and constructed in favour of the Department's standard TL-5 bridge barrier described in Section 300.5.2.19 (Barriers). The custom TL-5 bridge barrier shall match the geometric shape of the single slope concrete TL-5 roadside barrier used on the approach and departure roads, and shall comply with the requirements of the Bridge Design Code and Section 300.5.2.2 (Design Load).

200.2.3.7.5 Elbow River Crossing at Highway 8 Westbound

The Contractor shall design and construct one bridge structure to carry the westbound lanes of Highway 8 across the realigned Elbow River. The Contractor shall design the bridge structure to accommodate the Ultimate Stage four lanes as illustrated on Bridge Drawing 18-A-05.44SW in Appendix A as part of the Remaining New Infrastructure.

The Contractor shall produce complete but separate designs for both Stage 1 and Ultimate Stage construction, but Stage 1 designs shall include bridge piers and pier caps to accommodate the Ultimate Stage superstructure as presented on Bridge Drawing 18-A-05.44SW in Appendix A. The Ultimate Stage shall be designed as a widening of Stage 1 such that the widening can be achieved without any future in-channel construction and without closing down more than one lane of traffic. In the event that the design necessitates the Stage 1 superstructure being strengthened to accommodate the Ultimate Stage widening, all measures that will be required for this future strengthening shall be incorporated into Stage 1, including all measures that are required for future post-tensioning. Both Stage 1 and Ultimate Stage designs shall include drainage details.

The bridge design shall meet the following requirements:

- Minimum freeboard to underside of superstructure between the toe of abutment embankment slopes as measured from high water level shall be 1.5 m;
- Minimum design high water elevation shall be 1105.7 m;
- Substructure design ice loading shall be determined in accordance with section 3.12 of the Bridge Design Code;
- The minimum ice loading condition that shall be considered to have an effective ice strength based on situation (b) (700kPa) (as described in section 3.12.2.1 of the Bridge Design Code) with a thickness of 1.0 m and a design high ice elevation of 1105.7 m;
- Minimum longitudinal grade on the bridge shall be 1.0%;
- Minimum Elbow River flow rate of 954 cms; and
- Piers shall not be located within the edges of the water of the realigned Elbow River stream under normal flow.

The Elbow River is to be realigned beneath the bridge structure as illustrated in Drawing 18-A-05.44SW in Appendix A. The Contractor shall undertake the realignment of the Elbow River in conformance with all regulatory requirements and the Technical Requirements.

The Elbow River Valley through which the Elbow River transverses acts as a corridor for the passage of wildlife in both an upstream and downstream direction. The Contractor's design and construction execution shall not inhibit wildlife passage along this corridor. Permanent dedicated large wildlife passage shall be provided beneath the bridges at both the east and west bridge abutments. The Contractor shall extend the wildlife passage corridors on either side of the bridge to provide a contiguous corridor of varying width through the disturbed area. Temporary passageways shall be available during construction to maintain ability for wildlife passage during construction. The ground surface of the passageways shall be approximately level (allowing for appropriate drainage) and shall have a generally smooth walking surface that closely matches the

natural river valley substrate (e.g. no riprap or large boulders) and vegetated to reflect and be compatible with vegetation cover types in surrounding undisturbed areas and meet the requirements of Section 200.2.8 (Landscaping). The minimum wildlife passage corridor clearance boxes should meet the requirements shown in Drawing 18-A-05.44SW in Appendix A.

Wildlife fencing shall be provided as noted in Section 200.2.15 (Fencing).

200.2.3.7.6 Elbow River Crossing at Highway 8 Eastbound

The Province constructed bridge structure BF02143 in 1970 to carry Highway 8 over the Elbow River. The bridge structure is approximately 83 m long and 10.6 m wide and includes 3 spans of precast FC type girders with a cast-in-place deck. Record drawings are available in the Electronic Data Room (as defined in the RFP).

Notwithstanding that the Stage 1 eastbound bridge carrying Highway 8 over Elbow River is defined as part of the Existing Infrastructure, the Contractor shall modify this existing bridge structure from its current arrangement, which consists of one westbound traffic lane and one eastbound traffic lane with two shoulders, to operate with two eastbound traffic lanes and two shoulders. The traffic lanes shall each be 3.7 m in width and the shoulders shall be 1.64 m in width.

At least two months prior to commencing with the modifications required for the existing Elbow River Bridge (the “**Highway 8/Elbow River Bridge**”), the Contractor shall submit a detailed inspection and testing plan complete with identified Witness Points. The Contractor shall not proceed with any modifications until the inspection and testing plan and identified Witness Points have been reviewed and accepted by the Department. The Contractor shall provide the Department with one week written notice prior to a Witness Point inspection and shall provide the Department with all documentation addressed in the Contractor’s inspection and testing plan. The Contractor shall provide the Department with as much time as the Department indicates is required to inspect and accept the modifications to the Department’s full satisfaction. The Contractor shall not proceed past a Witness Point until acceptance is given in writing by the Department.

Unless noted otherwise all modifications to the Highway 8/Elbow River Bridge shall be completed in accordance with the Technical Requirements as if the Highway 8/Elbow River Bridge was part of the New Infrastructure. Removal of the existing wearing surface, partial/full depth repairs, surface preparations, and deck overlay material and placement shall be completed in accordance with section 20 of Alberta Transportation’s *Standard Specifications for Bridge Construction Edition 15*, with all references to “Consultant” replaced with “the Department”, and shall be addressed in the Contractor’s inspection and testing plan.

Modifications to the existing bridge structure shall be completed by the Contractor as follows:

- Upgrade/modification of the existing curb, barrier system and supporting girders and substrate as necessary to satisfy the Bridge Design Code requirements for permanent traffic barriers;

- Removal and disposal of the existing fibre reinforced silica fume (“**FRSF**”) wearing surface in its entirety;
- Removal and disposal of the existing steel fingerplate expansion joints including cover plates and the expansion joint reinforced concrete anchorage zone;
- Design and construct modified expansion joint reinforced concrete anchorage zones to accommodate new abutment expansion joint assemblies;
- Supply and installation of new cover Type 1 strip seal deck joint expansion joint assemblies at abutments;
- Undertake all necessary concrete girder repairs to eliminate pop-outs, spalls, delaminated and cracked sections of the existing girders;
- Supply and installation of a new Class HPC with steel fibres wearing surface;
- Undertake all necessary concrete curb repairs to eliminate pop-outs, spalls, delaminated and cracked sections of the existing concrete curbs;
- Undertake all necessary concrete slope protection repairs to eliminate pop-outs, spalls, delaminated and cracked sections of the existing concrete slope protection, and grout completely to fill any existing voids situated beneath the concrete slope protection sections that are retained;
- Supply and install Class 2 heavy rock riprap at the east head slope to address degradation of bank armouring and restore substructure and bank protection to a level sufficient to resist channel design flows at the bridge;
- Undertake all necessary concrete substructure repairs to eliminate pop-outs, spalls, delaminated and cracked sections of the existing concrete substructure elements;
- Supply and installation of new expansion joint cover plates for pier expansion joints maintaining equivalent to existing curb plate joint details but that suit the change from two directional to one directional traffic flow;
- Removal and disposal of existing pier expansion joint seals and supply and installation of new seals into existing joint extrusions;
- All barrier transitions from the bridge barriers to the approach road barriers shall comply with Department standards and shall be replaced and or modified as required to achieve this requirement;
- Seal all cracks with a width greater than or equal to 0.2 mm in concrete superstructure and substructure elements. The cracks shall be sealed in accordance with section 4.25.8 (b) of Alberta Transportation’s *Standard Specifications for Bridge Construction Edition 15*, with all references to “Consultant” replaced with the Department, and shall be addressed in the Contractor’s inspection and testing plan;
- Apply concrete sealers in accordance with the Technical Requirements and as indicated on Drawing SK-1; and
- Supply and installation of all lane markings including the obliteration of any existing lane markings using a Department approved method.

All new abutment expansion joint assemblies shall comply with Standard Drawings S-1810 through S-1812 for Type 1 Deck Joint expansion joints. Any new expansion joint cover plates for pier joints shall be compatible with the existing joint systems and shall comply with current Department Standard Drawings S-1810 through S-1812 for expansion joints that are most similar to those located at this bridge. Where incompatibility of current Department standards with the

existing joints exist, the Contractor shall modify details to suit existing conditions and address the intent of the current Department standards.

All barrier transitions from the bridge barriers to the approach road barriers shall comply with Standard Drawings S-1643-00 (TL-4 Double Tube Type Bridgerail Approach Rail Transition Details). The Contractor shall upgrade and modify the existing bridge barrier ends as necessary so that transitions shown on the Standard Drawing S-1643-00 in Appendix B are achieved.

The Contractor shall undertake the modifications to the Highway 8/Elbow River Bridge in such a manner that an equivalent level of service of traffic is maintained and number of lanes and shoulders are in accordance with Section 200.2.3.23 (Detours).

The Contractor shall warranty the Highway 8/Elbow River Bridge modifications, as described in this Section, for a period of two years from RNI Traffic Availability. During the warranty period, the Contractor shall warrant the work to be free from any defect or failure and to withstand climatic, maintenance and normal operational conditions. Warranty repairs are a performance requirement of the Technical Requirements. The Contractor shall repair, at its own expense, any such defect or failure which occurs in the work prior to the expiry of the Highway 8/Elbow River Bridge modifications warranty period. The Department will notify the Contractor, in writing, of repairs required during the warranty period and the Contractor shall promptly make the necessary repairs. If the Contractor fails to carry out repairs promptly or to the satisfaction of the Department, the Department may then make other arrangements to have the repairs done, the cost of which shall be a debt due and owing by the Contractor to the Department. Upon completion of the warranty period, the Contractor shall invite the Department to attend the final project inspection for all infrastructure that will become the Department's responsibility. The final inspection will be undertaken with the Contractor and the Department present and any outstanding issues shall be addressed by the Contractor prior to the issuance of final acceptance certificate for the Highway 8/Elbow River Bridge to the Contractor. The Contractor shall provide the Department with written notice 14 days in advance of the final inspection.

The Contractor shall have the necessary access and use of the applicable portion of the Road Right of Way in order to carry out the modifications and warranty work required by this Section 200.2.3.7.6.

200.2.3.7.7 Anderson Road Pedestrian Bridge

A new pedestrian bridge structure will be required to cross over the Calgary Ring Road south of Anderson Road as shown in Drawing 18-A-03.06SW in Appendix A as part of the Priority New Infrastructure. The new pedestrian bridge crossing over the Calgary Ring Road along an east west alignment shall align with the coordinate N 5,645,444 E-9,832. The pedestrian bridge shall be designed and constructed as shown on Drawing 18-A-05.46SW in Appendix A. The bridge shall be designed based on the anticipated degree of pedestrian use as defined in the Clause 3.4.4 (Serviceability limit states) of the CAN/CSA-S6 CODE, as 'frequent pedestrian use'. The approaches to the bridge shall be designed and constructed as a 3.0 m wide multi-use trail. The multi-use trail design shall meet the requirements of the TAC Geometric Design Guide, section 3.3 (Streetscaping) and section 3.4 (Bikeways). The multi-use trail shall connect the existing trail located along and just west of the east boundary of the TUC to the east end of the new pedestrian

bridge and the multi-use trail shall extend from the west end of the new pedestrian bridge to the west boundary of the TUC boundary as shown on Drawing 18-A-03.06SW in Appendix A. The location for the pathway tie-in point shall be N 5,645,406 E-10,133 at the west TUC boundary and shall be coordinated with the Local Authority.

Public security shall be a consideration in the design of the pedestrian bridge.

The Contractor's design shall include lighting in accordance with Illuminating Engineering Society of North America document RP-8-00 based on high pedestrian conflict level on the bridge and at the openings. The Contractor shall also ensure that sightlines are unobstructed on the bridge and at both ends.

At each end of the bridge the Contractor shall fabricate and install a well illuminated and clearly visible sign with the text:

“CALGARY RING ROAD
SOUTHWEST
ANDERSON ROAD
PEDESTRIAN BRIDGE”

The text shall be in 50 mm high black letters in Helvetica style on white high intensity grade reflective background. The sign shall be 1220 mm wide by 610 mm long on treated timber posts set with bottom of sign 1600 mm above grade.

200.2.3.7.8 Fish Creek Northbound

The City constructed bridge structure BF 00375 to carry 37 Street SW over Fish Creek in 2004. The Contractor shall use the existing bridge structure to carry the northbound Calgary Ring Road traffic over Fish Creek. The bridge structure is approximately 281 m long and 20 m wide and includes 5 spans of precast NU girders with a cast-in-place concrete deck. Record drawings are available for this bridge structure which is part of the Existing Infrastructure.

Notwithstanding that the northbound bridge carrying the Calgary Ring Road over Fish Creek is defined as part of the Existing Infrastructure, the Contractor shall modify this existing bridge structure from its current arrangement, which consists of two northbound traffic lanes and two southbound traffic lanes each, median barrier, and two shoulders. The modified structure shall operate with four northbound through lanes and two shoulders. The four through lanes shall each be 3.7 m in width, the inside shoulder shall be 2.2 m in width and the outside shoulder shall be 3.0 m in width. These modifications shall be completed prior to PNI Traffic Availability.

At least two months prior to commencing with the modifications required for the existing Fish Creek Bridge (the “**Fish Creek Northbound Bridge**”), the Contractor shall submit a detailed inspection and testing plan complete with identified Witness Points. The Contractor shall not proceed with any modifications until the inspection and testing plan and identified Witness Points have been reviewed and accepted by the Department. The Contractor shall provide the Department with one week written notice prior to a Witness Point inspection and shall provide the Department with all documentation addressed in the Contractor's inspection and testing plan.

The Contractor shall provide the Department five business days to inspect and accept the modifications to the Department's full satisfaction. The Contractor shall not proceed past a Witness Point until acceptance is given in writing by the Department.

Unless noted otherwise all modifications to the Fish Creek Northbound Bridge shall be completed in accordance with the Technical Requirements as if the Fish Creek Northbound Bridge was part of the New Infrastructure. Removal of the existing wearing surface, partial/full depth repairs, and surface sandblasting shall be completed in accordance with section 20 of Alberta Transportation's *Standard Specifications for Bridge Construction Edition 15* with all references to "Consultant" replaced with the "Department", with all references to "Special Provisions" replaced with the "Technical Requirements", and shall be addressed in the Contractor's inspection and testing plan.

Modifications to the existing bridge structure shall be completed by the Contractor as follows:

- removal and disposal of the existing concrete median barrier;
- removal and disposal of the existing 50 mm nominal PMA wearing surface and up to 5 mm of the underlying concrete. PMA and deck concrete removals shall be completed using a small milling machine having a maximum removal width of 1.2 m. After all removals and all deck concrete repairs are complete, preparation of the deck concrete surface shall further proceed in accordance with section 16.4.3.3 (Bridge Deck Waterproofing) of Alberta Transportation's *Standard Specifications for Bridge Construction Edition 15* with all references to "Consultant" replaced with the "Department". If a HAPAS issued BBA certified liquid applied bridge deck waterproofing system and a 50 mm nominal thickness asphalt concrete pavement wearing surface is selected by the Contractor as the replacement for the existing PMA, the method for further preparation of the underlying concrete surface, required in section 16.4.3.3, shall ensure 100% removal of existing tack coat and PMA remnants from the concrete surface prior to sandblasting or shotblasting;
- partial and full depth concrete repairs of all concrete bridge elements where delamination, pop-outs, spalling, or other damage is present, including but not limited to the bridge deck, pier diaphragms, concrete slope protection, approach slabs, wingwalls, abutments, piers, and approach barriers;
- seal all cracks with a width greater than or equal to 0.2 mm in concrete superstructure and substructure elements. The cracks shall be sealed in accordance with Section 4.25.8 (b) of Alberta Transportation's *Standard Specifications for Bridge Construction Edition 15*, with all references to "Consultant" replaced with the "Department", and shall be addressed in the Contractor's inspection and testing plan;
- removal, disposal, and replacement of the existing exterior barriers, and embedded utilities and attachments. The Contractor shall coordinate with the utility company to facilitate work;
- removal and replacement of light poles complete with illumination;
- removal and replacement of existing bridge deck concrete sufficient to provide for suitable details and adequate structural capacity to support new TL-5 barriers along both sides of the bridge deck;

- removal, replacement, modification and/or supplementation of existing deck reinforcement sufficient to provide adequate structural capacity to support new TL-5 barriers along both sides of the bridge deck. The design and construction shall take into consideration the potential for corrosion inducement by the “halo effect” near the interface of the repairs and shall incorporate passive corrosion mitigation technology to mitigate the development of the “halo effect”. The mitigation technology shall result in corrosion probability in the bridge that is equivalent to or less likely to occur than what the probability of corrosion would have been in the bridge if left unrepaired;
- modifications to wingwalls, approach slabs, and abutments, sufficient to provide adequate structural capacity to support new TL-5 barriers on the abutments, including removal, replacement and modification of existing concrete and reinforcement, deck joints and other elements. The design and construction shall take into consideration the potential for corrosion inducement by the “halo effect” near the interface of the repairs and shall incorporate passive corrosion mitigation technology to mitigate the development of the “halo effect”. The mitigation technology shall result in corrosion probability in the bridge that is equivalent to or less likely to occur than what the probability of corrosion would have been in the bridge if left unrepaired;
- supply and installation of TL-5 exterior concrete barriers along both sides of the bridge;
- all barrier transitions from or to the bridge barriers to or from the approach road barriers shall comply with the Technical Requirements for the New Infrastructure and shall be replaced and or modified as required to achieve this requirement;
- surface preparation and/or deck sandblasting of all surfaces to receive a bridge deck waterproofing system, including the bridge deck, approach slabs and portion of barrier faces up to top of wearing surface;
- supply and installation of a bridge deck waterproofing and wearing surface system that consists of a waterproofing membrane and asphalt concrete pavement;
- remove, plug and patch existing deck median deck drains with an Approved Product ensuring repairs match the existing;
- remove, plug and patch existing approach roadway median drain and appurtenances with grout, new sub-grade and pavement structure;
- removal and replacing of existing deck drain down pipe brackets with new galvanized pipe brackets;
- provision of new bridge and approach road drainage components to accommodate necessary roadway and bridge deck drainage requirements;
- upgrade all headslope drain troughs, and install lateral drains at the north end of the bridge to accommodate roadway drainage;
- all existing surface coatings shall be completely removed prior to preparing and completing concrete surface finishes;
- apply concrete sealers in accordance with SK-1 in Appendix B of the Technical Requirements; and
- removal, disposal and replacement of the existing chain link gates and supporting posts/frames at the north east and south west corners of the bridge. The new gates and posts/frames shall be fabricated using galvanized steel materials to suit the geometry of

the resulting opening in the incorporating fences. The new gates and post/frames shall provide for secure lockable closures that prevent passage below or around the perimeter of the gates when closed with a 50 mm gap between the perimeter and the adjacent ground or structure. The gates shall be provided with hinges, latches and locking hardware complete with padlocks/keys acceptable to the Department. The materials, fabrication and construction shall comply with Alberta Transportation's *Standard Specifications for Highway Construction* (section 2.12 (Fencing) and section 5.14 (Supply of Fence Material)), with all references to "Consultant" replaced with the "Department".

For the Fish Creek Northbound Bridge only, the Contractor may choose to replace the existing PMA wearing surface with the Department's standard bridge deck waterproofing and asphalt concrete pavement system in accordance with Section 300.5.15 or a liquid applied bridge deck waterproofing system having a current British Board of Agrément ("BBA") certificate issued under the Highway Authorities Product Approval Scheme ("HAPAS") and a 50 mm nominal asphalt concrete pavement wearing surface. The use of a HAPAS issued BBA certified product, if selected by the Contractor, will only be permitted on the Fish Creek Northbound Bridge and not on any New Infrastructure.

If the Contractor elects to use a liquid applied bridge deck waterproofing system with a current BBA certificate issued under HAPAS and 50 mm nominal asphalt concrete pavement, the following additional modifications are required:

- removal and disposal of existing modular expansion joint seals and supply and installation of new seals into existing modular joint extrusions;
- supply and install wick drains connected to deck drain pipes and the liquid applied waterproofing membrane in a similar manner to that shown on Department Standard Drawings S-1838-15 and S-1839-15 in Appendix B;
- supply and install the new TL-5 barriers with consideration of Section 300.5.2.19.3 and in accordance with Department Standard Drawings S-1702-06 to S-1705-06 inclusive in Appendix B except the barrier shall be constructed 40 mm taller than indicated on the Standard Drawings in Appendix B to accommodate a future wearing surface elevation that is 40 mm higher than existing. To account for the additional future wearing surface thickness the height of the concrete portion of the barrier wall above the top of finished wearing surface shall be increased by 40 mm to 640 mm;
- supply and install new expansion joint cover plates compatible with the existing modular joints. These cover plates shall comply with Department Standard Drawing S-1704-06 in Appendix B except where incompatibility with the existing modular joint results, in which case the Contractor shall modify details to suit existing conditions and address the intent of the Drawing S-1704-06 in Appendix B; and
- supply and installation of new lane markings.

If the Contractor elects to use the Department's standard bridge deck water proofing and asphalt concrete pavement system in accordance with Section 300.5.15, the following additional modifications are required:

- supply and install the new TL-5 barriers with consideration of Section 300.5.2.19.3 and in accordance with Department Standard Drawings S-1702-06 to S-1705-06 inclusive in Appendix B;
- complete load rating analyses in accordance with the Department's *Bridge Load Evaluation Manual* to confirm if the existing bridge requires strengthening in order to accommodate the additional dead load resulting from the increased asphalt thickness of 80 mm compared to the existing 50 mm (nominal) thickness. If any components of the bridge do not have adequate strength to accommodate the added dead load, then the Contractor shall design, supply and construct the necessary strengthening;
- removal and disposal of existing steel modular expansion joints, approach slab rotation joints and compression seals, cover plates, and the expansion and rotation joint concrete anchorage zones;
- design and construct modified modular expansion and compression seal joint concrete anchorage zones to accommodate the additional nominal 40 mm thickness resulting from the bridge deck waterproofing and asphalt concrete pavement system;
- supply and install new approach slab rotation joints, expansion joints, and expansion joint cover plates in accordance with Section 300.5.2.18; and
- supply and installation of new lane markings.

The Contractor shall undertake the modifications in such a manner that an equivalent level of service of traffic is maintained and number of lanes and shoulders are in accordance with Section 200.2.3.23 (Detours).

The Contractor shall warranty the Fish Creek Northbound Bridge modifications described in this Section for a period of two years from RNI Traffic Availability. During the warranty period, the Contractor shall warrant the work to be free from any defect or failure and to withstand climatic, maintenance and normal operational conditions. Warranty repairs are a performance requirement of the Technical Requirements. The Contractor shall repair, at its own expense, any such defect or failure which occurs in the work prior to the expiry of the Fish Creek Northbound Bridge modifications warranty period. The Department will notify the Contractor, in writing, of repairs required during the warranty period and the Contractor shall promptly make the necessary repairs. If the Contractor fails to carry out repairs promptly or to the satisfaction of the Department, the Department may then make other arrangements to have the repairs done, the cost of which shall be a debt due and owing by the Contractor to the Department. Upon completion of the warranty period, the Contractor shall invite the Department to attend the final project inspection for all infrastructure that will become the Departments' responsibility. The final inspection will be undertaken with the Contractor and the Department present and any outstanding issues shall be addressed by the Contractor prior to the issuance of final acceptance certificate for the Fish Creek Northbound Bridge to the Contractor. The Contractor shall provide the Department written notice 14 days in advance of the final inspection.

The Contractor shall have the necessary access and use of the applicable portion of the Road Right of Way in order to carry out the modifications and warranty work required by this Section 200.2.3.7.8.

200.2.3.7.9 Fish Creek Southbound

The Contractor shall design and construct one new bridge structure to carry the southbound Calgary Ring Road over the realigned Fish Creek as illustrated on Drawing 18-A-05.22SW in Appendix A. The new bridge structure is part of the Priority New Infrastructure.

The Contractor shall produce a complete design for Stage 1 construction, which is the same as for Ultimate Stage at this bridge location.

The bridge design shall meet the following requirements:

- Minimum freeboard to underside of superstructure between the toe of abutment embankment slopes as measured from high water level shall be 12 m;
- Minimum design high water elevation shall be 1073.4 m;
- Substructure design ice loading shall be determined in accordance with section 3.12 of the Bridge Design Code;
- The minimum ice loading condition that shall be considered to have an effective ice strength based on situation (b) (700kPa) (as described in section 3.12.2.1 of the Bridge Design Code) with a thickness of 1.0 m and a design high ice elevation of 1073.4 m;
- Minimum longitudinal grade on the bridge shall be 1.0%;
- Piers shall not be located within the edges of the water of the realigned Fish Creek stream under normal flow;
- The roadway surface elevation of the bridge shall be at a similar elevation to the existing (northbound) roadway bridge;
- The overall profile of the bridge shall match that of the existing Fish Creek bridge (northbound Mainline), including the total length of the superstructure; and
- Four piers shall be provided that match the pier shapes and aesthetic finishes of the existing Fish Creek bridge (northbound Mainline). The pier positions relative to the ends of the bridge shall match the existing Fish Creek bridge (northbound Mainline).

Fish Creek is to be realigned beneath the Existing Infrastructure bridge structure carrying the four northbound Mainline lanes and the Priority New Infrastructure bridge carrying the four southbound Mainline lanes as illustrated in Drawing 18-A-05.22SW in Appendix A. The Contractor shall undertake the realignment of the Fish Creek in conformance with all regulatory requirements and the Technical Requirements. As part of the re-alignment of Fish Creek, the Contractor shall install bank protection (rip rap), as a means of erosion control, along the south bank of Fish Creek in order to protect burial sites in SE 1-23-2-W5M. The Contractor shall consult with representatives of the TTN with regard to the exact location of the required bank protection.

Fish Creek valley through which Fish Creek traverses acts as a corridor for the passage of wildlife in both an upstream and downstream direction. The Contractor's design and construction execution shall not inhibit wildlife passage along this corridor. Permanent dedicated large wildlife passage shall be provided beneath the bridge at both the north and south bridge abutments. Temporary passageways shall be available during construction to maintain

ability for wildlife passage during construction. The ground surface of the passageways shall be approximately level (allowing for appropriate drainage) and shall have a generally smooth walking surface that closely matches the natural river valley substrate (e.g. no riprap or large boulders) and vegetated to meet the requirements of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Fish Creek Bridge Crossing Wildlife Planting Concept Drawing (Figure 3.5-17b) and Section 200.2.8 (Landscaping). The minimum wildlife passage corridor clearance boxes should meet the requirements shown in Drawing 18-A-05.22SW in Appendix A.

Wildlife fencing shall be provided as noted in Section 200.2.15 (Fencing).

200.2.3.7.10 CPR Rail Crossing – Mile 10.75, CPR Macleod Subdivision

An existing bridge structure carries Highway 22X over the CPR line. The Contractor shall design and construct new grade separations for EB and WB Mainline over the existing CPR line as shown on Drawings 18-A-05.12SW and 18-A-05.13SW in Appendix A as part of the Remaining New Infrastructure. The new grade separation shall be designed and constructed to accommodate the construction of the future LRT and future roadway as shown on Drawings 18-A-05.12SW and 18-A-05.13SW in Appendix A. The future opening of the grade separation shall be achieved through the replacement of bridge head slopes constructed by the Contractor with future retaining walls constructed by others.

The Contractor is responsible for the demolition and removal of the existing bridge structure carrying Highway 22X over the CPR at this location (Department’s Bridge File Number 77545-1). The Contractor shall complete the demolition of the bridge structure in accordance with Section 200.2.3.24 (Demolition).

The Contractor shall design and construct a 6.0 m wide gravel access road from the intersection of Sheriff King Street SW and Sheriff King Road SW to the existing level crossing at Mile 10.75 of the CPR Macleod Subdivision as described in Section 200.2.3.18.7 (Sheriff King Street).

The Contractor shall coordinate with CPR regarding the design and construction of the grade separation and the access road.

The main contact for CPR is:

Pete Bayerle
7550 Ogdendale Rd SE,
Calgary , Alberta T2C 4X9
Telephone: 403-319-7488
Cell: 403-835-9372
Email: pete_bayerle@cpr.ca

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200.2.3.18	Service Roads

The Contractor shall design and construct the service roads as set out in this Section 200.2.3.18 and as detailed in the applicable Drawing in Appendix A (the “**Service Roads**”). Unless specified otherwise, all Service Roads shall have a asphalt concrete pavement wearing surface. The Service Roads are roadways and intersections to be designed and constructed by the Contractor and turned over to the Local Authority for operation and maintenance. The Contractor shall match the relevant Local Authority’s standards for such Service Road construction. The Contractor shall coordinate the design and construction of Service Roads with the Local Authority. Service Road works that are within Local Authority Lands require permission from the Local Authority to construct. When proposed Service Road works are within the TUC but encroach beyond the available right of way, a cross-section with revised ditching requirements will be considered.

The Contractor shall ensure that traffic on existing roadways and intersections continues to operate at the existing standards and level of service throughout construction. The Contractor shall ensure that all currently provided accesses and traffic movements for the public are retained throughout the Construction Period in accordance with Section 200.2.3.23 (Detours). Any Service Roads required to replace an existing access shall be completed and open to public traffic prior to removing existing access roads from service. The Contractor shall be responsible for removal, and coordination of any required road removals and closures in the TUC and within the Project Limits with the Local Authority. All existing accesses replaced by Service Roads shall be removed and obliterated in accordance with Section 200.4.12 (Roadway Obliteration), such obliteration only being allowed following the opening of the replacement access to public traffic.

The Contractor is responsible for the design and construction of all permanent signage, pavement markings, lighting and signalization of the Service Roads, but for all traffic signals associated with the Service Roads, the Contractor shall contract with the Local Authority for the design and construction of such traffic signals.

Prior to opening of a particular Service Road to traffic in accordance with section 5.18 (Service Roads) of the DBFO Agreement and the resulting hand-over of the particular Service Road to the Local Authority, the Contractor shall invite the Local Authority to attend the final project inspection for all infrastructure that will become the Local Authority's responsibility.

200.2.3.18.1 Highway 8 Interchange Service Roads

The Contractor shall design and construct the 85 Street SW connector from the TUC boundary to connect to Lower Springbank Road SW as shown on Drawing 18-A-03.10SW in Appendix A. The existing connection to Lower Springbank Road SW shall be removed when the new access is provided. The connection to 85 Street SW is classified as a Service Road. The Local Authority responsible for this Service Road is the City. The Service Road shall be designed for a speed of 50 km/h with a WB-21 design vehicle and constructed in accordance with the typical section "Paved Service Road, Local Residential (2 Lanes)" shown on Drawing 18-A-04.06SW in Appendix A.

Currently, the intersection of 101 Street SW and Highway 8 is a three-legged, un-signalized intersection; this intersection will be replaced with a three-legged intersection with signalization for the westbound direction only. The Contractor shall design and construct the 101 Street SW/Highway 8 intersection as shown on Drawing 18-A-03.11SW in Appendix A. 101 Street SW is classified as a Service Road. The Local Authority responsible for this Service Road is the City. The Service Road shall be designed for a speed of 50 km/h with a WB-21 design vehicle and constructed in accordance with the typical section "Paved Service Road, Local Residential (2 Lanes)" shown on Drawing 18-A-04.06SW in Appendix A.

Currently the intersection of Highway 8/Range Road 25/Lott Creek Blvd is a signalized at-grade intersection. The Contractor shall design and reconstruct the intersection shown on Drawing 18-A-03.11SW in Appendix A.

The Contractor shall design and construct a 6.0 m wide gravel surfaced restricted, gated emergency access road on the south side of Highway 8 immediately west of the new Highway 8/101 Street SW intersection as shown on Drawing 18-A-03.11SW in Appendix A. The gated emergency access road shall be constructed and safe for use by September 30, 2017. The Local Authority responsible for this access road is the City.

The Contractor shall design and construct a private gravel access road on the west side of 101 Street SW north of the new intersection of Highway 8/101 Street SW as shown on Drawings 18-A-03.11SW and 18-A-04.09SW in Appendix A. The new private access road will replace the existing private access road that provides access from the north side of Highway 8, west of 101 Street SW. The Contractor shall obliterate the existing private access road after the new private gravel access road has been opened for safe use by the landowner. The obliteration of the existing access road shall be in accordance with the requirements of Section 200.4.12 (Roadway Obliteration) of the Technical Requirements. The Contractor shall also install a new 6.1 m wide livestock guard (refer to Alberta Transportation drawing CB6-2.17M6). Notwithstanding the aforementioned gravel surfacing noted for the private gravel access road, the Contractor shall provide surfacing as shown on Drawing 18-A-04.09SW. Notwithstanding the Contractor's drainage design, the minimum culvert diameter beneath the permanent access gravel road at

approximately 0+260 as shown on Drawing 18-A-04.09SW shall be 800 mm.

The existing Rocky View County sign west of 101 Street SW along the north side of Highway 8 is to be removed by Rocky View County. The Contractor shall coordinate activities with Rocky View County to ensure the removal of the existing sign occurs prior to any construction in the vicinity.

200.2.3.18.2 37 Street SW Service Roads

Prior to PNI Traffic Availability, the Contractor shall design and construct a new single lane roundabout just west of the existing 37 Street SW to connect existing 37 Street SW northbound and southbound to the new Strathcona Street/37 Street SW/Grey Eagle Drive intersection as illustrated on Drawing 18-A-03.09SW in Appendix A. The new roundabout shall be designed to accommodate a WB-21 design vehicle. The connecting roadway between the new roundabout and the new Strathcona Street/37 Street SW/Grey Eagle Drive shall be a two lane roadway. The Contractor shall provide right-in, right-out from the realigned 37 Street SW northbound and southbound to the existing properties along existing 37 Street SW immediately to the east of the new single lane roundabout as illustrated on Drawing 18-A-03.09SW in Appendix A.

The Contractor shall reconstruct the intersection of existing 37 Street SW and Lakeview Drive SW to remove the north leg of the intersection and provide a corner that accommodates a SU9 design vehicle.

The Local Authority responsible for these Service Roads is the City.

200.2.3.18.3 Weaselhead Road Service Road

Prior to PNI Traffic Availability, the Contractor shall design and construct a Service Road to replace the portion of existing Weaselhead Road that will be impacted by the construction of the Calgary Ring Road. The new roadway is designated a Service Road and will extend from the intersection of the existing Weaselhead Road and the east boundary of the TUC, across/under the Calgary Ring Road, and will continue south along the west side of the Calgary Ring Road until tying in with the existing Weaselhead Road, as shown on Drawing 18-A-03.07SW in Appendix A. No deviations from the alignment shown on Drawing 18-A-03.07SW in Appendix A will be allowed.

The design speed of the Service Road shall be 60 km/h. The Service Road shall be designed and constructed in accordance with the typical section for “Weaselhead Road” as shown on Drawing 18-A-04.03SW in Appendix A. The Local Authority responsible for this Service Road is the TTN.

The Contractor shall ensure that public access remains uninterrupted on Weaselhead Road throughout the Construction Period. The Contractor shall ensure that access is maintained at the connection with the old Priddis Trail, located at SE 26-23-2-W5M at all times during the construction and after PNI Traffic Availability.

200.2.3.18.4 Anderson Road/Buffalo Run Boulevard Service Road

Intentionally Deleted

200.2.3.18.5 Fish Creek Boulevard/146 Avenue Service Road

The Contractor shall construct a two lane undivided Service Road on the westbound lanes of the future four-lane divided 146 Avenue SW from the west TUC limit to the intersection of existing 37 Street SW as shown on Drawing 18-A-03.05SW in Appendix A. The Service Road west of TUC limits shall be designed and constructed in accordance with the typical section for “146 Ave SW” as shown on Drawing 18-A-4.03SW in Appendix A. The Local Authority responsible for this Service Road is the City

The Contractor shall design and construct a cul-de-sac with a gated access road to accommodate a WB-21 design vehicle from existing 146 Avenue SW to the Lower Sarcee Reservoir as shown on Drawing 18-A-03.05SW in Appendix A and typical section “Gravel Access Road (9 m)” with a 50 km/h design speed as shown on Drawing 18-A-04.06SW in Appendix A. The Contractor shall ensure reasonable replacement access is available at all times. The Contractor shall construct an access off 37 Street SW to the lands immediately south of 146 Avenue SW and east of 37 Street SW as shown on Drawing 18-A-03.5SW in Appendix A.

The City of Calgary water feedermain located between 146 Avenue SW and Fish Creek may be impacted by the Contractor’s design and construction. The Contractor shall design and construct the alterations for the affected section(s) of the water feedermain. The design and construction shall be coordinated with, and approved by, The City of Calgary Water Resources. All work shall conform to *City of Calgary Standard Specifications Waterworks Construction*. The Contractor shall prepare record drawings that meet the City’s approval and requirements no later than six months after construction completion and acceptance by the City.

200.2.3.18.6 188 Avenue SW Service Road

Prior to RNI Traffic Availability, the Contractor shall design and construct a Service Road located on the south side of the Calgary Ring Road from Spruce Meadows Way SW to an existing driveway approximately 800 m west of 112 Street W, as shown on Drawing 18-A-03.02SW, Drawing 18-A-03.03SW and Drawing 18-A-03.04SW in Appendix A. The Service Road intersects with Tournament Lane, 80 Street W, 96 Street W, and 112 Street W. The Contractor shall design and construct intersections at these locations.

The Service Road east of Tournament Lane shall be a four lane undivided roadway designed and constructed in accordance with the typical section for a “188 Avenue east of Tournament Lane” as shown on Drawing 18-A-4.02SW in Appendix A. The design speed east of Tournament Lane shall be 70 km/h. The Service Road west of Tournament Lane shall be a two lane undivided roadway designed and constructed in accordance with the typical section for a “188 Avenue SW West of Tournament Lane” as shown on Drawing 18-A-4.02SW in Appendix A. The design speed west of Tournament Lane shall be 60 km/h. The Contractor may utilize the existing vertical geometry of the eastbound carriageway of Highway 22X west of 96 Street W. A

minimum 50 mm thick asphalt overlay shall be required on the extent of the eastbound carriageway to be utilized.

The existing connections of 112 Street W, 96 Street W, 80 Street W and Tournament Lane to Highway 22X shall remain open until the replacement Service Road is completed and open to public traffic, at which time the existing median cross-overs shall be removed. The driveway accesses along Highway 22X shall not be closed until the replacement accesses along the new Service Road are open. The Contractor shall construct a median cable fence (refer to Alberta Transportation drawing CB6-2.12M12) between Highway 22X and the Service Road from the intersection of the re-aligned 96 Street W to the cul-de-sac located west of 112 Street W.

The Local Authority responsible for this Service Road is the City.

200.2.3.18.7 Sheriff King Street

Prior to RNI Traffic Availability, the Contractor shall design and construct a Service Road connection on the south side of the Calgary Ring Road. The Service Road shall extend from the south side of the cul-de-sac at existing Sheriff King Place SW to the intersection of Silverado Boulevard and Sheriff King Street SW as shown on Drawing 18-A-03.02SW in Appendix A and typical section “Paved Service Road Local Residential (2 Lanes)” as shown on Drawing 18-A-4.06SW in Appendix A. The Service Road shall have a design speed of 60 km/h.

A Service Road is also required to access the City storm ponds and CPR right-of-way. The City storm ponds are located immediately west of the CPR tracks and southeast of the Sheriff King Street SW interchange. The access road to the CPR right-of-way shall extend from the City storm ponds access road. This access road shall be provided from Sheriff King Street SW as shown on Drawing 18-A-03.02SW in Appendix A. The access road shall be a 6.0 metre wide gravel road as shown on Drawing 18-A-4.06SW “Gravel Access Road” in Appendix A, complete with the City’s *Standard Emergency Vehicle Gate for Roads* at the aforementioned cul-de-sac at existing Sheriff King Place SW. Another *Standard Emergency Vehicle Gate for Roads* shall be constructed immediately east of the access to the City storm ponds.

A Service Road to the ATCO facilities in the southwest section of this interchange shall be established from Silverado Skies Way as shown on Drawing 18-A-03.02W in Appendix A. The access road shall be a 6.0 metre wide gravel road as shown on Drawing 18-A-4.06SW “Gravel Access Road” in Appendix A, complete with the City’s *Standard Emergency Vehicle Gate for Roads*.

The Local Authority for these Service Roads is the City.

200.2.3.18.8 Macleod Trail

Prior to RNI Traffic Availability, the Contractor shall design and construct a Service Road connection on the south side of the Calgary Ring Road, west of Macleod Trail SE to connect to existing roads as shown on Drawing 18-A-03.02SW in Appendix A. The Service Road will provide access to two private accesses to residential homes currently utilizing Sheriff King Street

SW. Access to existing Sheriff King Street SW shall be maintained until the Service Road is open to traffic.

The Service Road connection shall have a design speed of 60 km/h. The Service Road shall be a 9.0 metre wide gravel road designed and constructed in accordance with the typical section for a “Gravel Access Road (9 m)” as shown on Drawing 18-A-04.06SW in Appendix A. The Local Authority for this Service Road is the City.

200.2.3.19 Excavation of Materials

The TTN may excavate up to 1,000 cubic metres of clay from a location within the TUC and prior to a deadline jointly agreed upon by the Department and the Contractor. If the excavation of clay does not occur prior to the agreed upon deadline, the Contractor shall stockpile, at a location selected by the TTN in SE 26-23-2-W5M, 1,000 cubic metres of good quality clay for the use by the TTN.

If the Contractor has surplus excavated materials, the Department and the Department of Infrastructure may consider a request from the Contractor to allow stockpiling within the TUC at locations pre-approved by the Department.

200.2.3.20 Road Closures

The Contractor is responsible for the physical closure and removal of existing roads at locations shown on Drawings 18-A-03.01SW through 18-A-03.11SW in Appendix A.

The Contractor is responsible for obtaining all permits and approvals for the physical road closures and removals, construction of the required turnarounds/cul-de-sacs, installation of appropriate signage, installation of barricades and disposal of all materials and restoration of the closed road to a natural landscaped area, including the restoration of drainage to its original lines. The roadway structure shall be obliterated in accordance with Section 200.4.12 (Roadway Obliteration) then topsoiled and seeded in accordance with Section 200.2.9 (Topsoil and Seeding).

The Contractor is responsible for coordination of all closures and removals with the Local Authority. The Contractor shall apply to the Local Authority for road closure permits a minimum of three months prior to the planned date of the road closure. The Department will be responsible for obtaining legal road closure and the Contractor shall cooperate with the Department in the supply of information for legal road closure.

The Contractor shall not close any road prior to the date stipulated in the Technical Requirements, if applicable. In addition, the Contractor shall not close any road until such time as safe, permanent alternative access to affected properties is available and in full operation for the public.

The Contractor shall construct turnarounds/cul-de-sacs as shown on Drawing 18-A-04.06SW at locations shown on Drawings 18-A-03.01SW through 18-A-03.11SW in Appendix A. Unless otherwise specified, turnarounds/cul-de-sacs shall be designed and constructed to accommodate

a WB-21 design vehicle.

200.2.3.21 Traffic Signals

The Contractor is responsible for design and installation of all necessary traffic signals on the specified interchange ramps and intersections. The Contractor shall verify that design and installation of the new signals will not compromise the integrity of the operation of the existing signals outside the Project Limits.

All signal systems shall be reasonably similar to those used by the Local Authority. The signal timing shall be coordinated with the Local Authority. The signal electronics shall meet NEMA standards. All poles and hardware shall be galvanized. Further details regarding the requirements for traffic signals can be found in Appendix J (Traffic Modelling and Traffic Signal Guidelines), Package F (Traffic Signals).

Traffic signal systems shall include an emergency vehicle override system that is compatible with the Local Authority's emergency equipment, vehicle detection, and traffic signal communication interconnection systems.

All existing traffic signals at the proposed interchanges in Stage 1 shall be replaced as part of the New Infrastructure.

The Contractor is responsible for the removal of the following existing traffic signals:

- Macleod Trail SB to Hwy 22X EB;
- Macleod Trail NB to Hwy 22X WB;
- Sheriff King Street/6 Street SW at Hwy 22X;
- James McKeivitt Road at Hwy 22X WB;
- Fish Creek Blvd/146 Avenue SW at 37 Street SW;
- 130 Avenue SW at 37 Street SW;
- Anderson Rd/37 Street SW at Bullhead Road; and
- Glenmore Trail at Sarcee Trail.

The Contractor is responsible for coordination of all traffic signal removals with the Local Authority. The Contractor shall apply to the Local Authority for permit to remove traffic signals a minimum three months prior to the planned date of the removal. On the scheduled removal date, the Contractor shall remove existing traffic signals and provide written notice to the appropriate Local Authority that the existing traffic signal hardware has been removed and is available for pick up for a period of 30 days. The Contractor shall store signal hardware in a secure location and protect it against theft, vandalism or damages. The Contractor shall be responsible for the disposal of remaining components after this 30 day period has lapsed.

200.2.3.22 Intentionally Deleted

200.2.3.23 Detours

The Contractor is responsible for maintaining existing traffic on all roadways and for providing access to all properties affected by the construction. The extent of all detours shall be constructed entirely within the Project Limits and shall be of a reasonably equivalent length to the existing movement. As required by Section 100.2.8 (Construction Management Plan), all detour plans shall be submitted to the Department for review in accordance with section 5.5 (Contractor’s Designs, Plans and Schedules) of the DBFO Agreement. Traffic accommodation plans and detour plans shall be prepared in accordance with Alberta Transportation’s *Traffic Accommodation in Work Zones* (2008) manual and the Roadside Design Guide. Horizontal geometry and barrier placement for all Mainline detours shall be in accordance with Exhibit 200.2.3.23-1 (Typical Mainline Detour) in Part 2 of Appendix B. The Highway Geometric Design Guide shall form the basis for the horizontal and vertical geometry of all detours.

The Contractor is responsible for ensuring proper detour signage, barriers, drainage, pavement markings, lighting, safety devices, and other appurtenances are installed and maintained for the duration that the detour is in use. Any existing overhead or ground-mount guide signs that display information contrary to the intended operation of the detours shall be covered up or removed for the duration that the detour is in place. The duration of any detour plans shall be reviewed and approved by the Department and the Local Authority including emergency services providers.

Detours, if required, shall maintain safe passage of traffic, and shall allow for the minimum number of specified lanes and shoulders open in each direction at all times. All detours must be constructed with a surface type equal to or better than the surface type on the connecting roadways at either end of the detour, and shall meet specified minimum design and posted speeds. Detours shall be illuminated such that there is no discernible difference, in the opinion of the Department, in the illumination level between the existing roadway and the detour. All detour luminaires shall be pole mounted. Light plants/towers shall not be used for roadway lighting purposes unless approved by the Department. Concrete barriers that are compliant with MASH are required for construction work zones while traffic detours are in use.

The lane width of detours shall be 3.5 m unless otherwise specified in this Section. Detour standards (minimum lanes and minimum design and posted speeds) are stated in the following table:

Roadway(s)	Min. Number of Lanes (Each Direction)	Min. Shoulder Width (m) (Each Direction)	Minimum Design Speed	Minimum Posted Speed
Glenmore Trail east of Sarcee Trail	2 @ 3.7 m	2.0	70	60
Sarcee Trail	2	2.0	70	60
Glenmore Trail west of Sarcee Trail	2- EB @ 3.7 m 1- WB @ 3.7 m	2.0	70	60

Roadway(s)	Min. Number of Lanes (Each Direction)	Min. Shoulder Width (m) (Each Direction)	Minimum Design Speed	Minimum Posted Speed
Highway 8	1 @ 3.7 m	2.0	70	60
69 Street SW	2	1.0	60	50
37 Street (north of Glenmore Trail)	2	1.0	60	50
37 Street (south of Glenmore Trail)	1	1.0	60	50
Grey Eagle Drive	1	1.0	60	50
Weaselhead Road	1	1.0	60	50
Bullhead Road	1	1.0	60	50
Anderson Road	2	2.0	70	60
37 Street (Anderson Road to Fish Creek Blvd)	2	2.0	70	60
Fish Creek Boulevard	2	1.0	60	50
146 Avenue	1	2.0	60	50
Highway 22X	2 @ 3.7 m	2.0	80	70
24 Street	1	1.0	50	40
James McKeivitt Road SW/Spruce Meadows Way (south of HWY 22X WB)	1	1.0	60	50
James McKeivitt Road SW (north of HWY 22X WB)	2	1.0	60	50
6 Street SW/Sheriff King Street	2	1.0	60	50
Macleod Trail SE	2 @ 3.7 m	2.0	80	70

Detour standards (minimum lanes, minimum lane width, minimum design speed and posted speeds) for existing or temporary bridge crossings are stated in the following table:

Existing or Temporary Bridge Crossing(s)	Min. # Lanes (Each Direction)	Min. Lane Width (m)	Minimum Design Speed	Minimum Posted Speed
Highway 22X over Macleod Trail SE	1	3.7	80	70
37 Street over Fish Creek	2	3.3	70	60
Highway 8 over Elbow River	1	3.3	70	60

The Department may consider reduced shoulder widths for existing or temporary bridge crossings on a case by case basis. The Department may also consider reduced shoulder widths on sections of urban road that have existing curb and gutter on a case by case basis. The Contractor shall submit detailed plans showing the proposed lane and shoulder widths for each detour to the Department for review.

Notwithstanding the minimum lane requirements in the preceding tables, the Contractor shall maintain existing traffic movements throughout the Construction Period at all ramps, all movements at at-grade intersections, and accesses to properties affected by construction activities until the access is replaced, where applicable. The Contractor shall ensure, at all times, that all detours and intersections provide the appropriate laning and intersection treatment to provide a level of service equal to or better than to the existing condition prior to the implementation of the detour. The Contractor shall provide traffic simulation analyses at least 30 days prior to the implementation of any detour.

The Department may permit short-term, local detours to re-route traffic at crossroads or interchanges to accommodate short-term construction activities such as girder erection. A minimum of 14 days prior to the implementation of a short-term, local detour the Contractor shall submit, to the Department for review and written acceptance, a detailed detour plan, and other material to comply with the Local Authority's processes for incorporation into the Contractor's Traffic Management Plan under Section 100.2.5, and an updated Traffic Management Plan identifying the number of lanes, all horizontal and vertical detour geometry, anticipated traffic volumes relative to peak traffic volumes, traffic management and traffic control devices, and hours of operation. A single lane detour may be used for short-term, local detours wherever the traffic can be safely accommodated on a single lane. The Contractor shall ensure that multiple site, short-term, local detours are not implemented simultaneously on adjacent routes serving the same communities. The Contractor shall provide the Local Authority and emergency service providers with notification of the implementation of short-term, local detours, with a copy of all such notices provided concurrently to the Department, a minimum of one week prior to the implementation of the short-term, local detour. Implementation and use of short-term, local detours shall be limited to the hours of 10:00 p.m. to 6:00 a.m. local time.

The Contractor shall notify 511 Alberta of all traffic impacts including but not limited to lane closures, traffic detours, and road closures. A construction activity notification shall be submitted to 511 Alberta a minimum of three days prior the scheduled traffic impact. Construction notifications shall be sent to the following email address trans.511@gov.ab.ca. In addition to 511 Alberta the Contractor shall notify the City of Calgary's 311 online services at the following email address trafficinfo@calgary.ca to notify the City of upcoming traffic disruptions related to the Project within the City.

If the Contractor's detour requires the alteration of traffic signals or traffic signal timing on signals owned by the Local Authority, the Contractor shall coordinate any changes with the Local Authority, and shall hire the Local Authority to make the necessary signal revisions to the applicable traffic signals owned by the Local Authority. The Contractor shall confirm that the traffic signal alterations will not result in a reduction of capacity or change in level of service

during the a.m. and p.m. peak periods.

The following requirements, including without limitation, Payment Adjustments (unless expressly stated otherwise), shall apply during the Construction Period (with such modifications as necessary) to all detours (the “**Deemed New Infrastructure**”) as if all detours were New Infrastructure:

- (a) Section 400.1.5 (Imminent Danger Repairs);
- (b) Section 400.1.6 (Lane Closure) applied to any reduction of the minimum lane requirements for the Deemed New Infrastructure as set out in Section 200.2.3.23 (Detours). The provisions applicable to the Schedule of Lane Closures and telephone service shall not apply. Except with the prior written approval of the Department, acting reasonably, and except for an Excepted Lane Closure, the Contractor shall not close all lanes in either direction or close any lanes for an extended period of time (as determined by the Department, acting reasonably). For planned maintenance activities on the Deemed New Infrastructure with two lanes in each direction the Contractor must have at least one lane in each direction open to traffic at all times, unless otherwise approved in writing and in advance by the Province, acting reasonably. For the purposes of the second bullet of the definition of Lane Closure in the third last paragraph of Section 400.1.6 (Lane Closure), the Minimum Posted Speed in the fifth column of the above tables in this Section 200.2.3.23 are deemed to be 75% of the normal posted speed for the applicable detour;
- (c) Section 400.2.1 (Roadway Inspection Requirements);
- (d) Section 400.2.2 (Emergency Maintenance);
- (e) Section 400.2.3 (Routine Maintenance);
- (f) Section 400.2.4 (Measuring for Compliance);
- (g) Section 400.3.1 (General). For the Winter Maintenance Standards table in Section 400.3.1, Highway 201 is deemed a Class AA roadway, and all other crossroads are deemed Class A roadways;
- (h) Section 400.3.2 (Equipment and Materials);
- (i) Section 400.3.3 (Snow Clearing and Ice Control Operations);
- (j) Section 400.4.1 (Roadway Maintenance Requirements), except for the requirements in the third bullet under Section 400.4.1.2 (Completing Repairs);
- (k) Sections 400.4.4 (Rutting Performance Requirement (New Infrastructure Only)) and 400.4.6 (General Pavement Maintenance Requirements). Detours shall be designed to accommodate the anticipated traffic and to meet the requirements of “\$/Isolated Deficiency” column of Section 400.4.4.2 (Payment Adjustments) of Section 400.4.4

(Rutting Performance Requirement (New Infrastructure Only)) and Section 400.4.6 (General Pavement Maintenance Requirements), except the requirements in Section 400.4.6.3 and 400.4.6.4 and that the definition of localized roughness in Section 400.4.6.2 shall be modified to be any abrupt deviation in excess of 12 mm when measured with a 1.2 m straight edge;

- (l) Section 400.4.7 (Miscellaneous - Operation and Performance Requirements), except for the requirements in Section 400.4.7.9 and for any Payment Adjustments set out in Section 400.4.7.1, 400.4.7.3 through 400.4.7.9 inclusive; and
- (m) Section 400.4.8 (Traffic Control Devices - Operation and Performance Requirements), except for any Payment Adjustments set out in Section 400.4.8.

The Contractor is expected to act reasonably and professionally throughout the Construction Period and shall take all reasonable precautions to prevent damage to existing infrastructure.

The Contractor, subject to the Department receiving prior written sign-off from the structural engineer of record to put a bridge into service and receiving a pre-opening road safety audit prepared by the road safety auditor in accordance with TAC guidelines stating that the bridge and related approaches are safe to open to traffic, will be permitted to detour traffic onto a bridge included with the New Infrastructure prior to Traffic Availability.

200.2.3.24 Demolition

The Contractor shall demolish, remove and dispose (the “**Demolition**”) of all buildings, associated works (wells, poles, etc.), other structures or installations located on the Affected Areas (as defined below), and all existing fences and above ground constructed features within the crossroads rights-of-way described in the City Agreement (as defined in Section 200.4.1). The Contractor shall obtain all required permits and approvals for the Demolition. The Province shall ensure the Affected Areas have been vacated by the Affected Areas’ tenants so as to enable the Contractor to carry-out the Demolition. The Contractor shall remove and dispose of all rubbish from the Affected Areas after tenants have vacated. All building demolitions must be completed by December 31, 2017. The Contractor is responsible for security on vacated Affected Areas until such time that Demolition is complete. The Contractor shall restore the Affected Areas after the Demolition to a landscaped state consistent with the surrounding area, including the restoration of existing drainage. Burial of the demolition materials within the Lands is not allowed. The “**Affected Areas**” means:

- (a) those lease areas set out in Appendix G (Alberta Infrastructure Land Lease Summary and Drawings);
- (b) sanitary lift station south of Anderson Road; and
- (c) buildings or residences in the TUC within the Lands applicable to the Priority New Infrastructure.

The Contractor shall demolish all retaining walls and existing bridge structures identified in Section 200.2.3 (Design Specifics) in accordance with the referenced restoration and disposal requirements. Burial of the demolition materials within the Lands is not allowed.

The Contractor shall be responsible for Demolition of retaining walls and existing bridge structures indicated in Section 200.2.3 (Design Specifics). The Contractor shall obtain all required permits and approvals for demolition from the Local Authority and railway company, as applicable. All components of the structure and substructure shall be removed to a minimum depth of 1 m below final grade. The Contractor shall supply the Department and the Department of Infrastructure with plans showing all bridge components left below grade, together with a description of the components, approximate dimensions and depths as extracted from Department “as-built” drawings, and surveyed coordinates. Where remnant components of demolished structures are within 20 m of any bridge that forms part of the New Infrastructure, this shall be noted on an information sheet in the “C” drawing set for that bridge, together with the number of the drawing that provides detailed descriptions and locations. Burial of the demolished materials within the Lands is not allowed.

The Contractor shall submit the following information, in respect of a Demolition, to the Department:

- Proposed demolition sequence and schedule;
- Construction limits;
- Demolition methods;
- Depth of removal;
- Traffic Accommodation Plan;
- Safety Plan; and
- Protective measures for existing infrastructure and environment.

All removed asphalt, soil cement and concrete pavement shall be the property of the Contractor. All operations necessary for the removal of any structures that might endanger the new construction shall be completed prior to the construction of the new work.

Prior to demolition of existing railway bridge structures as indicated in Section 200.2.3 (Design Specifics) the Contractor shall invite CPR to attend an inspection of the existing structure to be removed to identify what portions, if any, of the existing structure are to be salvaged for CPR. The salvaged components shall be stored outside the limits of construction and in a manner satisfactory to CPR for a period of three months for pick up by CPR. The Contractor shall dispose of any remaining components after the expiry of the three month period.

The Contractor acknowledges that the description of the buildings, associated works, other structures or installations listed in Appendix G (Alberta Infrastructure Land Lease Summary and Drawings) under the “Demolition Requirements” column is provided for information only and must be confirmed by the Contractor. The Province makes no representation as to the completeness or accuracy of the description therein and no error or omission shall relieve the Contractor of its obligations under this Section.

200.2.4 INTENTIONALLY DELETED

200.2.5 DRAINAGE

The basis for drainage design shall be generally as outlined in the Functional Plan except where noted below. Drainage works shall be designed in accordance with *Alberta Transportation's Design Bulletin #16 - Drainage Guidelines for Highways Under Provincial Jurisdiction in Urban Areas*, *Alberta Transportation's Best Practice Guidelines for Culvert Selection*, Section 200.2.17 (Miscellaneous Environmental Concerns), and the requirements of Alberta Environment and the Local Authority. The drainage design shall include erosion control installations necessary for the in-situ conditions of the drainage works. The Department's *Design Guidelines for Erosion and Sediment Control for Highways* may be considered for such designs.

The following exceptions to the design criteria as stated in Design Bulletin #16 shall apply:

- notwithstanding what is stated in Page 3 of 7 of the Design Bulletin #16 regarding highway ditches, the highway ditches should maintain a minimum slope of 0.2% to prevent standing water and also be designed to minimize velocities to avoid excessive erosion;
- notwithstanding what is stated in Page 4 of 7 of the Design Bulletin #16 regarding dry ponds, the maximum allowable fluctuation of the 1:100 year event is 2.5 m and the minimum bottom slope is 1.0% for dry ponds located outside the Mainline carriageways or ramps; and
- notwithstanding what is stated in Page 4 of 7 of the Design Bulletin #16 regarding wetlands, the allowable fluctuation depth above the permanent pool is 2.5 m.

Stormwater management facilities shall be sized to accommodate stormwater from within the Road Right of Way, remaining areas of the TUC, and flow volumes from areas outside the TUC within the natural drainage basin. The Contractor shall consider both existing land development conditions and future development planning for those areas, as described in the Functional Plan. The Contractor may contact the City of Calgary Water Resources Department for additional information. As part of the functional planning for the Project, the following reports were prepared:

- *Southwest Ring Road Stormwater Drainage Master Plan* - prepared by Operational Solutions Ltd. (April 2007);
- *South Calgary Ring Road Stormwater Functional Planning Study* – prepared by AMEC Earth & Environmental/Focus Corporation (November 2009); and
- *West Calgary Ring Road Stormwater Functional Planning Study* - prepared by AMEC Earth & Environmental/Focus Corporation (March 2010).

Wet ponds are not permitted within loop ramps, between ramps and the Mainline, or between the Mainline carriageways.

Dry ponds are permitted within loop ramps and between ramps and the Mainline provided they meet the following design criteria:

- Maximum allowable fluctuation depth for the 1:100 year event is 1.5m;
- Minimum bottom slope is 1%;
- Pond side slopes must not be steeper than side slopes of adjacent road elements;

- Dry ponds must completely drain within 48 hours from the time of initial flow into the dry pond. Computer simulation is required to demonstrate conformance with this requirement;
- Dry ponds must discharge through a downstream wet pond that meets water quality improvement requirements including all the dry pond flows; and
- Maximum water level under 1:100 year event conditions shall not be higher than 1 m below the lowest adjacent road subgrade elevation.

The facilities shall be designed and operated to regulate all runoff discharge to receiving water bodies at the general locations and in quantities outlined in the Functional Plan, and as noted herein. All permanent drainage systems and facilities shall be designed and constructed as gravity flow. The use of pumping systems or forcemains is not permitted. Standing water in ditches is not permitted.

The Contractor shall remove and replace all existing culvert structures within the Project Limits, except as otherwise noted in Section 200.2.3 (Design Specifics). All stormwater management facilities and minor conveyance systems shall be designed for the Ultimate Stage. All other drainage components shall be designed to be consistent with the grading in the general vicinity of the individual drainage components. Urban style drainage is not permitted for the Mainline.

Stormwater management facility locations shall be determined by the Contractor. For the purpose of minimizing encumbrances to future pipeline construction, stormwater management wetlands and wet ponds shall not be located on TUC lands that are designated for pipelines. Any proposed use of lands outside the Road Right of Way and within the TUC for stormwater management facilities shall require the Contractor to obtain the prior written agreement from the Department of Infrastructure.

Access roads are required to all pond inlet and outlet works. Access must also be provided to remove sediment accumulation on the pond bottom. Maintenance vehicle access shall conform to the requirements of the Local Authority.

Stormwater management facilities placed adjacent to power transmission towers shall be designed and constructed to allow overland access to the tower and a surrounding work area for power company maintenance equipment at the time water levels in the ponds are at design high water levels. Specific details of the access and work area requirements will be developed jointly by the Contractor and the affected power company.

The stormwater management facilities shall be enclosed by fences. The stormwater management facilities and fences shall be maintained by the Contractor.

The Calgary Ring Road, Highway 22X and Macleod Trail are classified as dangerous goods truck routes and the provision for hazardous spill containment measures shall be included in the Contractor's stormwater management design.

If the Contractor enters into an agreement to handle stormwater from outside the TUC or provincial road right-of-way with any party, then the Contractor shall ensure such agreements indemnify the Department from any future liability. Any such agreements shall require the prior written approval of the Department.

Agreements for stormwater management facilities, ditch easements or other agreements which the Contractor may enter into shall not provide for any payments from the Department without the Department's prior written consent. Such agreements must transfer to the Department at the end of the Term, at no cost to the Department, and must be enforceable in perpetuity.

The Contractor shall not sell drainage capacity in the stormwater management facilities to any third party.

The following miscellaneous drainage requirements shall be met:

- use of smooth wall steel pipes shall require the prior written agreement of the Department for the intended use;
- manholes shall not be located within the paved area of the roadway, except for catch basin/manholes in the urban section of crossroads;
- all manholes in excess of 1.0 m depth shall have galvanized metal ladder rungs;
- traversable grates are required on all ends of culverts where the top of the inverts are within the required clear zone;
- permanent drainage systems and facilities shall be designed for gravity flow;
- existing wetlands and their current overflow routes, as well as the potential that they are filled in future, must be considered in the design of the stormwater management systems for the Project;
- all conveyance elements, including culverts not conveying pond discharges, are to be designed to pass the 1:100 year, 4-hour Chicago event;
- for areas identified in the Functional Plan to flow through the Project Limits with no additional controls, the Contractor is to design the conveyance piping and channels to the design flows that are the greater of the flows between the Functional Plan and available development planning reports;
- ponds are to be designed to prevent backflow from downstream creeks during high flow events; the use of backflow prevention devices may be accepted only if other design options are exhausted;
- any lands currently contributing to the TUC, not recognized in the Functional Plan, must be accommodated within the Calgary Ring Road drainage systems; in future, when the adjacent lands develop, it is expected that their drainage will be directed elsewhere, or at least be limited to predevelopment rates;
- contributing areas with controlled discharges are expected to flow through proposed TUC ponds without impacting pond volumes to any extent;
- wetland outlet structure designs are the responsibility of the Contractor, with consideration given to the design features described in the Functional Plan and the following:
 - submerged outlet design with outlet controls contained within a structure adjacent

- to the downstream end of the wetland and with manhole access above the high water level;
 - a small diameter orifice to pass low flows, with invert at normal water level, sized to retain 1:2 year runoff volumes for 24 hours;
 - a larger diameter orifice to pass higher flows, with invert at the 1:2 year pond level and sized such that maximum allowable pond discharges are achieved at pond high water level from the combined discharges through both orifices; and
 - an emergency overflow weir at pond high water level for increased discharge capacity in the case where a storm event larger than the design event occurs;
- dry pond outlet structure designs are to be the responsibility of the Contractor. Subject to dry pond design criteria noted above, consideration shall be given to the design features described in the Functional Plan and the following:
 - outlet controls contained within a structure adjacent to the downstream end of the dry pond and with manhole access above the high water level;
 - an orifice sized to pass the maximum allowable pond discharges at pond high water level; and
 - an emergency overflow weir at pond high water level for increased discharge capacity in the case where a storm event larger than the design event occurs;
- the water treatment and spill containment features of the wetlands are to be designed by the Contractor, with consideration given to the design features described in the Functional Plan and the following:
 - a deeper open water area at the inlet end for collection of sediments from the incoming flows;
 - a deeper open water area at the outlet to provide for a submerged outlet that will allow floatable materials to be contained in the facility and not washed downstream; and
 - a large, circuitous, shallow section between the inlet and outlet pools in which normally occurring low flows can be routed through emergent and submergent vegetation that can provide filtering and plant uptake to remove contaminants;
- deep drop structures must be designed for energy dissipation;
- river outfall structures must be designed for river ice scour forces; and
- All oil/grit separator (“OGS”) units must be supplied by one of the following City of Calgary approved suppliers:

Type of Oil-Grit Separator	Manufacturer/Supplier
Stormceptor	Imbrium Systems
Vortechs	CONTECH Stormwater Solutions
CDS	CONTECH Stormwater Solutions
Downstream Defender	Hydro International
AFC (Oil-Water Interceptor	American Forcecrete of Canada
* Catchbasin-types of Oil-Grit Separators are not approved	

In addition to other utility diversions, the Contractor is required to complete the following alterations and additions to the City existing drainage infrastructure as noted in the Sections

below. Prior to the transfer of operations and maintenance of a particular piece of drainage infrastructure to the Local Authority, the Contractor shall invite the Local Authority to attend the final project inspection for the drainage infrastructure that will become the Local Authority's responsibility. The Contractor shall warranty all drainage infrastructure work that will be transferred to the Local Authority for a period of two years from RNI Traffic Availability.

200.2.5.1 SOUTH RICHMOND STORM TRUNK DIVERSION

The existing South Richmond Storm Trunk is a double 1500 mm W x 1650 mm H box culvert located between 46 Avenue SW and Glenmore Trail SW to the east of Galbraith Drive SW in the community of Glamorgan. The existing trunk must be modified as follows:

- At existing manhole 520, or other suitable location, a new 2400 mm diameter storm trunk must be constructed going to the southeast to 37 Street SW and then south adjacent to 37 Street SW through the Glenmore Trail/37 Street interchange. The new trunk must divert all the South Richmond storm trunk peak flow of 14.5 m³/s to a new tie-in point at the upstream end of the new 37 Street SW storm trunk located in the vicinity of the intersection of Lakeview Drive SW and 37 Street SW, constructed by City. The approximate tie-in data is as follows:
 - Approximate box culvert invert at MH 520 1116.30 m
 - Approximate box culvert crown at MH 520 1117.95 m
 - Approximate trunk invert at 37 Street SW 1114.30 m
- Once constructed and tied in, one of the existing double box culverts downstream of MH 520 must be plugged and abandoned for a minimum distance of 10 m downstream of the plug. A portion of the other box culvert north of Glenmore Trail SW is to be retained to convey storm runoff flow from the existing connection from the Galbraith Drive SW collection system at MH 532 and from the condominium development on the east side of the existing trunk. To enable this flow reversal back to MH 520, the invert of the box culvert must be raised at the south end and concrete benching added to the bottom of the culvert after cleaning to create a south to north invert slope of minimum 0.1% gradient. The existing box culvert downstream of the existing connection at MH 532 must be plugged and abandoned for a minimum distance of 10 m downstream of the plug.

200.2.5.2 SOUTH RICHMOND STORM TRUNK TIE-IN TO 37 STREET SW STORM TRUNK

The City installed the new 37 Street SW Storm Trunk. The upstream end of this trunk is located south of Lakeview Drive SW and terminates at approximate centerline coordinates of N 5652249.51, E -9906.33 and an invert elevation of 1114.30m.

As part of this installation, the City has constructed a receiving shaft (North Tunnel Shaft) north of the above termination point and a temporary bypass of the Lakeview Drive SW storm line around the North Tunnel Shaft. The Lakeview Drive SW storm line flows west to manhole 504 in 37 Street SW where the line turns south and continues south along 37 Street SW. The bypass consists of a new connection to manhole 504, two new manholes 201 and 202 offset to the east of the existing storm line, to divert storm flows in a 525 mm diameter concrete pipe south from Lakeview Drive SW to reconnect approximately 30 m downstream to the existing storm line in 37 Street SW at a new manhole 203.

The North Tunnel Shaft is 10.4m internal diameter caisson with a 900 mm thick concrete wall and centre coordinates of N 5652255.61, E -9906.33. The shaft is available for the Contractor's use for the South Richmond Storm Trunk.

As part of the South Richmond Storm Trunk Diversion, the following additional work is required.

- Extend the 37 Street SW Storm Trunk north from its current termination through the North Tunnel Shaft to a point approximately due west of the intersection of Lakeview Drive SW and 37 Street SW;
- Install a manhole on the 37 Street SW Storm Trunk. Tie in the south end of the South Richmond Storm Trunk Diversion to this new manhole;
- Remove and dispose of the building cover and fencing, and the caisson of the North Tunnel Shaft to a depth of 3m below ground surface;
- Backfill the North Tunnel Shaft to the elevation of the surrounding existing ground surface;
- Provide a storm line extension of the Lakeview Drive SW storm line, with a capacity of 0.217 m³/s, from manhole 504 to direct flow to the new 37 Street SW Storm Trunk. The new manhole at the north end of the 37 Street Storm Trunk may be used for this connection if required. A drop pipe inside the manhole may be required to convey the Lakeview Drive storm flows into the 37 Street SW Storm Trunk;
- Remove the pipe and manholes in the temporary bypass. Reinstall the wall of manhole 504 if required. Plug the upstream end of the storm line at removed manhole 203; and
- Re-instate 37 Street SW.

All work must conform to City of Calgary Standard Specifications for applicable types of construction. All work must be approved by City before and during installation.

Record drawings meeting City requirements and approval must be submitted no later than six months after tie-in and acceptance by City of the South Richmond Storm Trunk.

Stormwater flows into the new 37 Street SW Storm Trunk are not permitted until January 2018.

200.2.5.3 ELBOW RIVER STORMWATER PONDS SPILL CONTROL

Any discharges from TUC drainage facilities to the Elbow River, including the North and South Elbow River stormwater ponds, require spill control features that have the capability for remote control from a City continuously-operated facility such as the Glenmore Water Treatment Plant.

The capability for remote control must be compatible with the City's SCADA system. The remote control system must meet the following requirements:

- Motorized/actuated control gates in the outlet structures with a manual override, suitable for all-weather operation (Rotork electric actuator with local display and control);

- Weatherproof, insulated, humidity-resistant control panel at each structure complete with:
 - PLC (Allen-Bradley MicroLogic1400) compatible with City of Calgary SCADA system for Modbus TCP protocol;
 - local / remote control selector switch. Remote for SCADA telemetry control and local for open/close from actuator local buttons;
 - momentary push button for detection of cabinet door open/close with door switch;
 - internal LED lighting, activated only when panel door is open;
 - heater to maintain adequate internal temperature;
 - vapour and insect barriers; and
 - four spare electrical outlets.
- Cellular modem telemetry system, Chameleon CTM-200; and
- Power supply to control panels and gates with a UPS to maintain power during a power outage.

The Contractor shall develop an emergency response plan for spill control specific to the Elbow River Stormwater Ponds.

200.2.5.4 SARCEE STORM TRUNK

The existing Sarcee Storm Trunk through the Glenmore Trail/Sarcee Trail interchange is a combination of a piped and ditch system. The existing main storm trunk upstream of the ditch section flows from north to south in a 1800 mm square box culvert, with twin 1800 mm diameter pipes flowing to the existing outfall (G20) to the south, downstream of the ditch section. A short length of the ditch section lies outside the TUC and is to be left undisturbed. The ditch section within the TUC must be filled to match existing grades adjacent to the ditch. Upstream of the ditch section there is an existing 1050 mm diameter pipe from the east of the TUC that connects to the existing trunk. The Contractor must provide a new piped system to replace the existing system to convey the required storm runoff flows through the interchange area, including the main trunk and a new section of the east sewer. A conveyance capacity of 13.83 m³/s is required in the main trunk from the north end of the TUC to the new connection point with the new east sewer. The main trunk from the connection point to the south end of the TUC must be a piped system sized to convey 19.73 m³/s and connected to the existing twin 1800 diameter pipes at the downstream end of the TUC. The existing east sewer must be re-routed around the inside of the TUC to connect to the existing storm sewer at the edge of the TUC from the community of Glamorgan and sized to convey a peak flow of 3.0 m³/s. A new east sewer connection from the edge of the TUC to the new main trunk is required to convey a peak flow of 5.66 m³/s. Connection manholes are required at each end and at required offsets and connection points and at maximum manhole spacings. All existing storm manholes and sewers within the TUC that are no longer required must be removed or excavated to a minimum depth of 1m below future subgrade and abandoned. All work must conform to City of Calgary Standard Specifications, for

applicable types of construction. All work must be approved by City before and during installation. Record drawings meeting City requirements and approval must be submitted no later than six months after tie-in and acceptance by the City of the Sarcee Storm Trunk.

200.2.5.5 162 AVENUE SE AND MACLEOD TRAIL

The interchange at 162 Avenue SE and Macleod Trail will contribute additional runoff to the Macleod Trail/Calgary Ring Road interchange area from additional paved surfaces as shown in sketch “SK-U307_DrainageToTUC-SK-U307 DrainageToTUC” posted in the Electronic Data Room (as defined in the RFP). The Contractor’s designs shall accommodate this additional runoff.

200.2.5.6 HIGHWAY 8 DRAINAGE TO CLEARWATER PARK WETLAND

The City is developing a stormwater management wetland in the proposed Clearwater Park east of Range Road 25 and north of the Highway 8. As part of the Highway 8 twinning, stormwater runoff from the highpoint along Highway 8 at approximately Range Road 32 to approximately 50 m east of Range Road 25 is to be conveyed and discharged to the proposed wetland. Before discharge, the flow must be treated in an Oil/Grit Separator (“OGS”) which shall be supplied and installed by the Contractor. Preliminary design parameters for the catchment discharging to the OGS are as follows:

TUC drainage area	58.0 ha
Drainage area imperviousness	20.8%

The discharge point downstream of the OGS unit for the Highway 8 drainage is located at coordinates N5653466.47, E-17964.50, with an invert elevation of 1107.5 m.

Sizing of the OGS must be based on the Ultimate Stage Highway 8 design and runoff flow rates. Treatment in the OGS must meet the lowest value of net-zero increase in average annual TSS loadings or 85% TSS removal for particles ≥ 50 microns.

Runoff from the remaining area of Highway 8 from approximately 50 m east of Range Road 25 to the Elbow River shall be collected in an evaporation/infiltration pond to be located between the mainline carriageways. Preliminary design parameters for this catchment are:

TUC drainage area	14.95 ha
Drainage area imperviousness	22.7%

The evaporation/infiltration pond shall have the following design criteria:

- Maximum allowable fluctuation depth for the 1:100 year event is 1.5 m;
- Pond side slopes must not be steeper than side slopes of adjacent road elements; and
- Maximum water level under 1:100 year event conditions shall not be higher than within 1 m below the lowest adjacent road subgrade elevation.

200.2.5.7 37 STREET SW AND FISH CREEK PONDS

As noted in the table of Stormwater Requirements below, the Fish Creek ponds are sized for the ultimate 8-lane road layout proposed in 2003, including drainage areas inside and outside the TUC.

Runoff from the TUC south of Fish Creek is currently conveyed under Fish Creek to SWMF 86WLA in a 900 mm diameter polyethylene pipe siphon. The existing pipe downstream of the siphon is a 675 mm diameter concrete pipe. This existing 675 mm diameter pipe must be replaced by the Contractor with a 1350 mm diameter pipe between existing manholes at following approximate coordinates N5643778, E-9856 and N5643955, E-9850.

All work related to the siphon and connection to SWMF 86WLA must conform to City of Calgary Standard Specifications, for applicable types of construction. All work must be approved by City before and during installation.

Record drawings meeting City requirements and approval must be submitted no later than six months after tie-in and acceptance by City of the tie-in to SWMF 86WLA.

Immediately following construction of the roadway, including seeding of the side slopes and ditches, the Contractor shall inspect all components of the drainage systems for sediment accumulation and remove any sediment found, including at the following locations:

- the inlet ends of the dry ponds and inlet sedimentation bays of the wetlands;
- along the erosion control check dams in the ditches of the roadway approaching the Elbow River and Fish Creek;
- along the sedimentation check dams on the bottom of the dry ponds; and
- in any culverts or sewer systems.

Stormwater Requirements for the Project, to be confirmed by hydrologic analysis using most-current rainfall data up to and including 2014, are provided in the table below:

SWCRR Catchment	Watershed and Receiving Stream	Allowable Release Rate	Annual Target Control Volume	Target Water Quality Control	Spill Control
Part 2-2 Highway 8 from Elbow River to interchange with SWCRR, SWCRR from north of 17 Avenue SW to approx. 93 Street SW	Elbow River	<ul style="list-style-type: none"> • Pre-development release rate of 1.0 L/s/ha 	<ul style="list-style-type: none"> • Net-zero increase in annual volume or 40 mm as per lower limit of 10–20% imperviousness, whichever is less. See Note 1 below. 	<ul style="list-style-type: none"> • 90% TSS removal for particles \geq 50μm, upstream of Glenmore Reservoir • Net-zero increase in pollutant loading 	Required
Part 2-3 Highway 8 from approx. 93 Street SW to 69 Street SW	Elbow River	<ul style="list-style-type: none"> • Drainage is through the existing Montreux Ph 1 facility is sized to accept 22.1 ha of TUC drainage. Allowable release rate of Montreux Ph1 facility is 	<ul style="list-style-type: none"> • Included in Montreux Ph 1 facility 	<ul style="list-style-type: none"> • Oil/Grit separator required upstream of pond for TUC flows 	Already included in Montreux Ph 1 facility

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SWCRR Catchment	Watershed and Receiving Stream	Allowable Release Rate	Annual Target Control Volume	Target Water Quality Control	Spill Control
		5.0 L/s/ha			
Part 2-4 69 Street SW to existing gravel access road to the 69 Street Pond before Sarcee Trail SW	Elbow River	<ul style="list-style-type: none"> No available capacity in the Strathcona Pond (69 Street SW Pond). No TUC runoff shall be directed to the Strathcona (69 Street) Pond 	<ul style="list-style-type: none"> Net-zero increase in annual volume or 40 mm as per lower limit of 10–20% imperviousness, whichever is less. See Note 1 below. 	<ul style="list-style-type: none"> 90% TSS removal for particles $\geq 50\mu\text{m}$ Net-zero increase in pollutant loading 	Required
Part 2-5 Existing gravel access road to the 69 Street Pond to Sarcee Trail SW and high point west of 37 Street SW	Elbow River	<ul style="list-style-type: none"> Pre development release rate of 3.4 L/s/ha for Proposed <i>Elbow River North Pond</i>, Pre development release rate of 2.0 L/s/ha for Proposed Elbow River South Pond, 	<ul style="list-style-type: none"> Net-zero increase in annual volume or 40 mm as per lower limit of 10–20% imperviousness, whichever is less. See Note 1 below. 	<ul style="list-style-type: none"> 90% TSS removal for particles $\geq 50\mu\text{m}$ Net-zero increase in pollutant loading 	Required
Part 2-6 Sarcee Trail SW to north of Anderson Road SW	Elbow River	<ul style="list-style-type: none"> Drainage from Glenmore Trail/37 Street SW interchange can be directed to the City’s new 37 Street SW Storm Trunk. The maximum discharge rate into the new 37 Street SW Storm Trunk shall not exceed 3.1 m³/s. The connection point shall be at the upstream end of the City’s new 37 Street SW Storm Trunk Phase 1. The catchment area is shown on drawing 115-RD-SK05 in the Electronic Data Room (as defined in the RFP). 	<ul style="list-style-type: none"> Net-zero increase in annual volume or 40 mm as per lower limit of 10–20% imperviousness, whichever is less. See Note 1 below. 	<ul style="list-style-type: none"> 90% TSS removal for particles $\geq 50\mu\text{m}$ Net-zero increase in pollutant loading Treatment for water quality improvement of the Glenmore Trail/37 Street SW interchange flow is not required before discharge into the 37 Street SW Storm Trunk. 	Required at both North and South Elbow River ponds
Part 3 North of Anderson Road SW to 162 Avenue SW	Fish Creek	<ul style="list-style-type: none"> Pre development release rate of 0.35 L/s/ha for 1-in-5 year and 2.42 L/s/ha for 1-in-100 year, storm event, (Operational Solutions (April 2007)). The ponds in the 3-cell stormwater facility (86WLA) were sized for the ultimate 8-lane road layout proposed in 2003, for a total contributing drainage area of 786.2 ha of which 50.3 ha was taken to be paved. 	<ul style="list-style-type: none"> Net-zero increase in annual volume or 40 mm as per lower limit of 10–20% imperviousness, whichever is less. See Note 1 below. Implement source control 	<ul style="list-style-type: none"> 85% TSS removal for particles $\geq 50\mu\text{m}$, Net-zero increase in pollutant loading 	Required

SWCRR Catchment	Watershed and Receiving Stream	Allowable Release Rate	Annual Target Control Volume	Target Water Quality Control	Spill Control
Part 4-1 162 Avenue SW to East of Spruce Meadows Way SW. See Note 2 below	Pine Creek	<ul style="list-style-type: none"> Pre development release rate of 0.08 L/s/ha for a 1-in-2 year, 0.27 L/s/ha for 1-in-5 year and 1.05 L/s/ha for 1-in-100 year storm events 	<ul style="list-style-type: none"> Net-zero increase in pre-development runoff rates and volumes or an average annual runoff volume target of 17 mm whichever is less. See Note 3 below. Implement source control 	<ul style="list-style-type: none"> 85% TSS removal for particles \geq 50μm, Net-zero increase in pollutant loading 	Required
Part 4-2 East of Spruce Meadows Way SW to Macleod Trail SE	Pine Creek	<ul style="list-style-type: none"> Pre development release rate of 0.08 L/s/ha for a 1-in-2 year, 0.27 L/s/ha for 1-in-5 year and 1.05 L/s/ha for 1-in-100 year, storm events for the Radio Tower Creek Wetland. Pre-development release rate of 11.0 L/s/ha for the proposed 4 Street SW Pond. Pre-development release rate of 9.6 L/s/ha for the Existing Pond C, AMEC (2009) 	<ul style="list-style-type: none"> Net-zero increase in pre-development runoff rates and volumes or an average annual runoff volume target of 17 mm whichever is less. See Note 3 below. Implement source control 	<ul style="list-style-type: none"> 85% TSS removal for particles \geq 50μm, Net-zero increase in pollutant loading 	Required

Note 1: The annual volume of runoff must be the lesser of the existing annual volume or the runoff volume equivalent of 40 mm rainfall across the catchment.

Note 2: All stormwater facilities required for the Project on Highway 22X west of 37 Street SW to the Project Limit shall be contained within the Project Limits. Any stormwater discharges directed to watercourses outside the Project Limits shall be limited to release rates of 0.08 L/s/ha for a 1-in-2 year, 0.27 L/s/ha for 1-in-5 year and 1.05 L/s/ha for 1-in-100 year storm events if the watercourse forms part of the Pine Creek watershed.

Note 3: If the pre-development runoff volume exceeds the equivalent of 17 mm, reduction to no more than the equivalent of 17 mm is required

The following table summarizes the ownership and operations and maintenance responsibilities for the existing and proposed stormwater infrastructure:

Facility	Related Infrastructure	Constructed by	Status	Responsible for O&M
Pond C near Hwy 22X	Inlet and outlet piping	City	Existing	Contractor
	Pond	City	Existing	Contractor

Priddis Slough	Inlet piping from Pond C and existing Hwy 22X runoff	City	Existing	City
Radio Tower Creek	Existing creek through Silverado	Developer/ City	Existing/in progress	City
Fish Creek Pond	Inlet piping to ponds	City	Existing	City
	Siphon across Fish Creek	City	Existing	Contractor
	Second siphon (if activated), existing pipe	City	Existing	Contractor
	Second siphon (if activated), new connection to existing pipe	Contractor	Future	Contractor
	3-cell wet pond	City	Existing	City
	Upsized pipe from siphon to Inlet MH	Contractor	Future	Contractor
69 Street Pond	Inlet and outlet piping	City	Existing	City
	Pond (no contribution from TUC allowed)	City	Existing	City
Montreux Ph 1 Pond	Inlet and outlet piping	City	Existing	City
	Pond (22.1 ha contribution from TUC allowed)	City	Existing	City
	Inlet and OGS from TUC	Contractor	Future	Contractor
S Richmond Storm Trunk Diversion	New Storm Trunk from existing S Richmond Trunk to new 37 Street SW Trunk	Contractor	Future	City
	Laterals, CBs, CB Leads	Contractor	Future	Contractor
Sarcee Storm Trunk replacement	New piped Storm Trunk through Sarcee/SWCRR interchange	Contractor	Future	City
Clearwater Park/Wetland	Stub pipe and OGS from Highway 8 system	Contractor	Future	Contractor

200.2.6 ROADWAY LIGHTING

200.2.6.1 GENERAL

This Section includes the standards to be applied for the design of roadway lighting. It shall be read in conjunction with Section 300.4.1.6 (Roadway Lighting) describing lighting functionality requirements, Section 300.4.1.6.4 (Lighting Equipment) material requirements and Section 300.4.1.6.4.4 (LED Luminaires).

The Contractor has the option of using LED luminaires provided they are used throughout the New Infrastructure and all of the design, performance and functionality requirements listed below and in the Sections noted above are achieved. Mixing of LED and HPS luminaires is not permitted.

200.2.6.2 Design Standards

The roadway lighting system shall seamlessly tie into other adjacent provincial or Local Authority systems. Transitions shall be gradual, in both colour and intensity. The lighting system shall meet or exceed the following requirements:

- Compliance with the *Alberta Transportation Highway Lighting Guide* (2006) as amended by Design Bulletin #35 (“**HLG**”). The Project shall be considered an urban freeway for the purposes of applying HLG requirements;
- Continuous lighting shall be provided on all roads within the Project Limits unless otherwise specified in this Section;
- Continuous lighting along Highway 22X west of 37 Street SW/96 Street W is not required, however all intersections shall be illuminated in accordance with the requirements for rural intersections as detailed in the *Alberta Transportation Highway Lighting Guide* (2006) as amended by Design Bulletin #35;
- Light standards shall be located in the centerline median or off the right side of the roadways for the Mainline illumination and off the right side of the roadway for illumination of connectors, ramps, C-D roads and crossroads;
- Minimum maintained average luminance levels for each category of road shall be as follows:
 - 0.6 cd/m² for Mainline,
 - 0.6 cd/m² throughout systems interchanges,
 - 0.6 cd/m² for all C-D roads,
 - 0.6 cd/m² for crossroads, flyovers and service interchanges,
 - 0.8 cd/m² for ramps,
 - Underpasses and under bridges: at least equal to, but not more than twice the level on adjacent roadways;
- The minimum maintained average luminance levels shall be achieved on all roads throughout the Construction Period. Mezopic multiplier factors shall not be used in designs using LED luminaires;
- The minimum maintained average luminance levels shall not be exceeded by more than 10% on 90% of the length of roadway, assessed in metres;
- Intersection conflict area illuminance designs shall use the low pedestrian value in table 10-1

of the *TAC Guide for the Design of Roadway Lighting*;

- Dirt depreciation shall be derived from the ‘Very Clean’ curve shown in Figure 2 of IES DG-4-14. The dirt factor for HPS lamps shall reflect the HLG requirement for group re-lamping every four years. The Contractor shall show any extrapolation used for scheduled LED luminaire cleaning periods up to, but not exceeding 10 years;
- Electrical cables - All electrical cables and communications/signals wiring shall be underground;
- Continuous lighting is required on Mainline, all ramps, connector roads, crossroads, and C-D roads;
- Light poles located within the clear zone, as determined to be the highest value of the range given in Table H3.1 of Roadside Design Guide, shall be on break-away bases;
- All breakaway bases shall meet the requirements of section 12 (Breakaway Supports) of *AASHTO-Standard Specifications For Structural Supports For Highway Signs, Luminaries, and Traffic Signals (5th edition)*;
- All light poles and bases shall be designed in accordance with the Bridge Design Code and/or *AASHTO-Standard Specifications For Structural Supports For Highway Signs, Luminaries, and Traffic Signals (5th edition)*, whichever governs. If AASHTO equation 3-1, Clause 3.8.1 is used to adjust wind pressures then the equation should be modified as follows:

$$P_z = 2.5 q K_z C_d$$

where q shall be taken from CAN/CSA S6, Table A3.1.7 for a return period of 50 years;

- At the Project Limit where crossroad lighting interfaces with roadway lighting provided by the Local Authority, the Contractor shall, using luminance design practices, determine if transition lighting arrangements are required. If the difference in light level between the two systems is numerically equal to, or less than the average predicted for the lower of the two systems and the lower light level is $<0.6 \text{ cd/m}^2$, transition lighting is not required. If the lower light level is $>0.6 \text{ cd/m}^2$ and/or the numerical difference between the two systems is >2 , transition lighting is required. The length of transition lighting required shall be determined from Table 9.4 of the *TAC Guide for the Design of Roadway Lighting (2006)*; and
- Lighting requirements for Service Roads shall be governed by the Local Authority in which the Service Roads exist.

200.2.6.3 High Mast Lighting

High Mast lighting systems comprised of poles greater than 30 m in height with multiple luminaires may only be installed in locations 600 m or more away from the perimeter of existing or future residential areas. Refer to Section 300.5.2.9 (Overhead Sign Structures and High Mast Lighting Support Structures) and Section 300.4.1.6.2 (Design) for details related to high mast structure design and functional requirements respectively.

The design of high mast structures shall include a complete design of the foundation, pole and luminaire raising mechanism and must be signed off by a structural Professional Engineer with input from a geotechnical Professional Engineer. Refer to Section 300.5.2.9 for the requirements for high mast structure design.

200.2.6.4 Design Verification

The design of roadway lighting shall be conducted according to North American standard luminance design practices as described in Section 9.6.2 and Figure 9.16 of the TAC Guide for the Design of Roadway Lighting (2006).

All other aspects of the lighting design shall be governed by the *Alberta Transportation Highway Lighting Guide* (2006) as amended by Design Bulletin #35. According to Design Bulletin #35, the *TAC Guide for the Design of Roadway Lighting* (2006) is to be used as the source for lighting design parameters not specified in the Technical Requirements (e.g. lighting levels and warrants) while the *Alberta Transportation Highway Lighting Guide* (2006) as amended by Design Bulletin #35 (including general design requirements, constructing and maintenance) is still the primary guideline to be used.

200.2.7 GUIDE SIGNING

Guide signage and guide sign structures for the New Infrastructure shall be designed, installed and maintained by the Contractor. The guide signage for the Project, including all Mainline, interchanges and crossroad components, is identified on guide sign drawings in Appendix E (Guide Signing for New Infrastructure) of this Schedule 18. The location of guide sign structures shown in Appendix E (Guide Signing for New Infrastructure) of this Schedule 18 are for illustrative purposes only. The Contractor is required to design guide sign structures such that barriers are not required. The New Infrastructure guide sign structures shall be designed to accommodate the loadings imposed by the addition of Ultimate Stage guide sign panels at a future time. The guide sign structures shall be designed to span the Ultimate Stage roadway without the need for barrier protection as per the Roadside Design Guide. At gore locations, the guide sign structures shall be placed to suit both the Stage 1 and Ultimate Stage roadway. Structural supports for guide signs shall not be attached to bridge structures or retaining wall structures.

All guide signs for the Project shall comply with the Department's *Highway Guide and Information Sign Manual*, dated October 2006, and any applicable Alberta Transportation Design Bulletins. The Contractor shall submit drawings of ring road signs at a level of detail and to the standards that are compatible with the guide sign drawings in Appendix E. The guide sign panels shown in Appendix E have individually been identified according to the Department's Guide Sign Panel Identification Protocol in the Department's Guide Sign Master Plan (the "**Protocol**"). In general, the principles being followed in the Protocol are as follows:

For example, the designation 52-SW-01-OH-L indicates:

- 52 = Exit 52 and identifies the exit located 52 km originating from Highway 2 (Calgary Trail) and travelling clockwise;
- SW = identifies the location as being in the southwest quadrant of the interchange;
- 01 = Panel number at this location;
- OH = Support Structure Type (OH for Overhead, C for Cantilever, GM for Ground Mounted); and
- L = Panel Position on this structure (L for Left, M for Middle, R for Right).

This Protocol shall apply to all guide sign panels for the New Infrastructure.

The details regarding the location and messaging of all overhead, cantilever and ground-mounted guide signs are set out in Appendix E. The Contractor shall install and maintain all overhead and cantilever signs and ground mounted guide signs required for the New Infrastructure, including without limitation, those signs set out in Appendix E. The Contractor acknowledges that certain overhead, cantilever, and ground-mounted signs set out in Appendix E are located outside the Project Limits (“**Signs Outside the Project Limits**”). For the Signs Outside the Project Limits, the Contractor shall obtain all the necessary permits and approvals from the appropriate authorities in order to install and maintain the Signs Outside the Project Limits. For signs that are within the project limits for the Southeast Stoney Trail project, the Contractor shall coordinate with Chinook Roads Partnership to coordinate and perform sign panel replacement.

The Contractor shall remove all guide signs that contain messaging inconsistent with the requirements set out in Appendix E regarding sign messaging for the New Infrastructure; particularly, such guide signs shall be removed from existing sign structures located on Highway 201 Highway 22X or Highway 8. Existing crossroad guide signs containing messaging inconsistent with requirements set out in Appendix E which are located within the Local Authority shall be removed by the Local Authority. The Contractor shall provide advance notification to, and liaise/coordinate with, the Local Authority for the removal of guide signs that do not conform to the requirements of Appendix E. In all cases, the timing of such guide sign removals shall be coordinated with the Contractor’s schedule for Traffic Availability.

The Clearview Highway font shall be used on all guide signing in accordance with Design Bulletin #36, which is posted on the Department’s web site. Interchange sequence signs shall be designed in accordance with *Design Bulletin #58*. For guide sign structures that incorporate use of truss style cantilever arms, the guide sign panel shall have a minimum height exceeding the height of the truss cantilever arm.

The following font sizes and letter heights shall be used for the Project:

- Mainline, Highway 22X, Highway 8, Glenmore Trail, Sarcee Trail, and Anderson Road Overhead Signage – 406 mm (16 inch) Clearview font.
- Mainline, Highway 22X, Highway 8, Glenmore Trail, Sarcee Trail and Anderson Road Shoulder Mounted Signage – 330 mm (13 inch) Clearview font. In cases where the street name is very long, the letter height may be reduced to 305 mm (12 inch).
- Non-Mainline Overhead Signage – 330 mm (13 inch) Clearview font.
- Non-Mainline Shoulder Mounted Signage – 254 mm (10 inch) Clearview font.

Overhead directional signs shall have reflective sheeting as specified in Section 300.4.2.11 (Permanent Highway Signs, Posts and Bases).

The Contractor shall submit shop drawings to the Department using the “**Clearviewhwy font software**” package for the message content and layout on the major guide signs prior to manufacturing. The Contractor shall obtain the Department’s prior written approval of all guide

sign message content prior to manufacturing the guide signs.

200.2.8 LANDSCAPING

The relocation of trees impacted by the Project shall be done within the Road Right of Way and/or stormwater management facilities if it is safe and technically feasible. These trees shall be relocated to locations where traffic operations, safety, and drainage are not compromised.

The Province shall have the right to allow third parties, such as the Local Authority or community groups, to carry out supplemental planting or enhanced formal landscape plantings (the “**Third Party Landscaping**”) on lands in the TUC but outside the Road Right of Way. The Third Party Landscaping shall be on the following conditions:

- The proposed Third Party Landscaping shall not negatively impact the safety of the roadway or of the O&M;
- The Province shall own the Third Party Landscaping and the applicable third party shall maintain the Third Party Landscaping, and the Province and the applicable third party shall enter into an agreement addressing such ownership, such maintenance and any potential relocation of the Third Party Landscaping; and
- The Third Party Landscaping shall not be used for advertising.

Stormwater management facility wet ponds shall have vegetation for water quality enhancement, and erosion control.

- Shrub staking shall be installed along the disturbed margins of the wetland or around selected constructed wetlands or stormwater ponds to stabilize disturbance, reduce the potential for sediment introduction and restore habitat function where shrubs were present prior to construction and where directed by the environmental inspector.
- It is preferred that plant species selected for revegetation within constructed wetlands be sourced from local materials, either salvaged from naturally occurring wetlands that may be disturbed within the Road Right of Way or from known donor wetlands.
- If salvaged or donor material is not available, the Contractor shall source out native plant species adapted to wetland conditions (bare root stock preferred).
- Sourced plant species shall include:
 - Submerged plant species to be planted within deep pools;
 - Emergent plant species accustomed to fluctuations in water level to be planted just below to partially above the normal water level; and
 - Riparian plant species, both shrub and herbaceous species, accustomed to slightly drier conditions but can tolerate occasional flooding to be planted just above the ordinary high water level.

Stormwater Management Facility Naturalization Enhancements

Layout

The North and South stormwater management facilities at the Elbow River Weaselhead crossing, and the Highway 8 stormwater management facility shall each have a sediment forebay and main pond areas.

The main pond areas shall have perimeter littoral zones and/or wetland zones for naturalization enhancements and water quality improvement. Littoral zones are typically less than 0.3 m in depth at normal water level (“NWL”) and shall be minimum 10 m wide. Wetlands are typically 0.3 to 0.5 m deep at NWL. Wetland zones are required at the downstream ends of the SWMFs upstream of the discharge structures. The wetland zone shall extend for a minimum radius of 50 m from the discharge structure.

Straight shorelines at both NWL and HWL shall not exceed 50 m in length. Curves in the shorelines shall be incorporated to avoid long straight lines.

The ponds shall have a minimum of two curvilinear finger dikes extending from the perimeter dikes to extend flow patterns and provide a longer flow path within the pond. Finger dikes shall have littoral zones on each side along the length of the dikes. Finger dike top elevation shall be 0.5 m above NWL. Littoral and wetland zones shall be planted with native plant species that are tolerant of complete water submergence and inundation for periods of not less than one week. Live dormant stakes/brush shall be planted at a density of 5 to 10 stems per linear metre.

Plant Species

Finger dikes shall be planted with inundation-tolerant native shrubs such as sandbar willow (*Salix exigua*). As sandbar willow is a small plant with fine stems, it is recommended that rooted stock plugs are installed at a density of 2 plugs per square metre.

Native plant species for littoral and wetland zones shall be selected from the following:

Potential Wetland Species for Stormwater Naturalization

Examples: 0.5 m below NWL to 0.5 m above NWL (submerged to emergent)

- Sweet Flag (*Acorus americanus*)
- Water Plantain (*Alisma triviale*)
- Water Sedge (*Carex aquatilis*)
- Awned Seged (*Carex atherodes*)
- Creeping Spike-Rush (*Eleocharis erythropoda/palustis*)
- Tall Manna Grass (*Glyceria grandis*)
- Arrowhead (*Sagittaria latifolia*)
- Hardstem/Great Bulrush (*Scirpus actus/Schoenoplectus acutus*)
- Softstem/Common Great Bulrush (*Schoenoplectus tabernaemontani/Scirpus validus*)
- Three-square Rush (*Scirpus pungens*)
- Common Cattail (*Typha latifolia*)

Examples: NWL to 0.5 m above NWL

- Baltic Rush (*Juncus balticus*)

- Fowl Bluegrass (*Poa palustris*)
- Bluejoint (*Calamagrostis canadensis*)
- Slough Grass (*Beckmannia syzigachne*)
- Tufted Hairgrass (*Deschampsia cespitosa*)
- Nuttall’s Alkali Grass (*Puccinellia nuttalliana*)
- Tall Manna Grass (*Glyceria grandis*)

Examples: 0.5 m above NWL to HWL

- Western Wheatgrass (*Agropyron smithii*)
- Northern Wheatgrass (*Agropyron dasystachyum*)
- Slender Wheatgrass (*Agropyron trachycaulum*)
- Tufted Hairgrass (*Deschampsia cespitosa*)
- Canada Wildrye (*Elymus canadensis*)
- Nuttall’s Alkali Grass (*Puccinellia nuttalliana*)

MSE Wall Naturalization Enhancements

The mechanically stabilized earth (“**MSE**”) wall adjacent to Beaver Pond shall have vegetation for stabilization, filtration of sediment, erosion control and aesthetics. The Contractor shall develop a planting plan for the Department’s review that is consistent with the following requirements.

- Live dormant stakes and brush (multi-branched material) shall be used within terraces of the MSE wall (place plant material in layers horizontally and cover with soil with approximately 30 cm of exposed plant material) at the base and along the lower terraces of the walls and where directed by the environmental inspector to reduce the potential for sediment introduction into Beaver Pond by stabilizing surface soils and filtering sediment. Established vegetation will also provide wildlife habitat and help to maintain the aesthetic value of the area.
- It is preferred that plant species selected for revegetation be sourced from local materials, either salvaged from natural areas that may be disturbed within the Road Right of Way or from known donor areas.
- If salvaged or donor material is not available, the Contractor shall source out native plant species.
- Sourced plant species shall include the following categories of plants (see list of Potential Plant Species below):
 - Riparian plant species, both shrub and herbaceous species, accustomed to moist/wet conditions that can tolerate occasional flooding to be layered in terraces at the base of the MSE wall just above the ordinary high water level;
 - Riparian and upland species, both shrub and herbaceous, accustomed to moist but not flooded conditions to be layered along the lower terraces; and
 - Upland plant species, including tree, shrub and herbaceous species, to be planted along the upper terraces.

- Vegetation shall be planted along the terraces to mimic the natural species profile along the slope in adjacent areas.
- The Contractor is required to water all large tree plantings until they are successfully established.
- The Contractor shall conduct monthly monitoring of planted tree stock for the first year following construction and in May, early July, and mid-August in the second year following construction. Rooted stock plants shall have, at a minimum, a survival rate of 85% - 90% for the first year and the Contractor shall replace stock up to that level.

Potential Plant Species

The base of the MSE wall shall be layered with inundation-tolerant native shrubs such as sandbar willow (*Salix exigua*). The lower terraces which are within 1 m to 1.5 m of the ordinary high water level shall be layered with moisture-tolerant native shrubs such as beaked willow (*Salix bebbiana*), greenleaf willow (*Salix lucida*) or red-osier dogwood (*Cornus stolonifera*). These live dormant stakes or brush should have a minimum diameter of 10 mm with terminal branches intact and should be at least 1 m in length. Live dormant stakes or brush shall be layered at a density of 5 to 10 stems per linear metre. Upper terraces shall be planted with rooted plant stock of upland native shrubs and trees, such as those listed in Table 3.5-19 of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014). If using species from the “Tree” category in Table 3.5-19, obtain rooted stock in a 5 to 7 gallon size for deciduous trees (8’ minimum height) and a 15 to 20 gallon size for coniferous trees (5’ minimum height) and plant an even mixture of deciduous and coniferous stock at a density of 1 plant per 3 linear metres; obtain “Tall Shrub/Small Tree” species in a 2 gallon size and plant at 1 plant per 2 linear metres; obtain “Medium Shrub” species in a 2 gallon size and plant at 1 plant per linear metre; obtain “Short Shrub” species in a 1 gallon size and plant at 1 plant per 0.7 linear metre. Apply Seed Mix C – Riparian Seed Mix – Woody Species Plant Community to the terraces at a rate of 4 kg/ha.

The Contractor shall establish native grass/shrub/tree plantings and seeding on the MSE wall. Plantings shall have, at a minimum, a survival rate of one establishing plant per linear terrace metre in 80% of total linear metres at all times during the Construction Period and for a period of 12 months or longer if required by regulatory approval after RNI Traffic Availability. The Contractor shall conduct monthly inspections that identify the percent survival rate and those areas that need immediate attention in order to achieve the minimum survival rate. Deficiencies with planting survival shall be addressed by the Contractor within a two month period of discovery. All rock and rip rap shall be washed prior to delivery and installation. No rock or rip rap shall be washed within the Elbow River valley or the Fish Creek valley.

Highway Median Plantings

The highway median areas through the Elbow River and Fish Creek valleys shall have vegetation for stabilization, erosion control, aesthetics and wildlife habitat. The Contractor shall develop a highway median planting plan for the Department’s review that is consistent with the following requirements.

Tall tree plantings and shrub plantings shall be provided in linear clusters within the median area as well as on the west and east edges of the Mainline carriageway within the escarpments of the Elbow River valley also known as the Weaselhead and the Fish Creek Valley. Deciduous tree plantings shall have a minimum height of eight feet, white spruce tree plantings shall have a minimum height of five feet, and shrub plantings shall have a minimum height of two feet. A varying mix of tree and shrub species and configurations shall be planted within the planting zone in a randomized natural pattern (see Figure 3.5-17a in the AMEC Environmental Assessment Vol. 1 [December 2014]). Use rooted plant stock of upland native shrubs and trees, such as those listed in Table 3.5-19 of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014). If using species from the “Tree” category in Table 3.5-19, obtain rooted stock in a 5 to 7 gallon size for deciduous trees and a 15 to 20 gallon size for coniferous trees and plant at a density of 1 plant per 3 linear metres; obtain “Tall Shrub/Small Tree” species in a 2 gallon size and plant at 1 plant per 2 linear metres; obtain “Medium Shrub” species in a 2 gallon size and plant at 1 plant per linear metre; obtain “Short Shrub” species in a 1 gallon size and plant at 1 plant per 0.7 linear metre. The Contractor will be required to water all of the large tree plantings until they are successfully established. The Contractor shall conduct monthly monitoring of planted tree stock for the first year following construction and in May, early July and mid-August in the second year following construction. Rooted stock plants shall have, at a minimum, a survival rate of 85% - 90% for the first year and the Contractor shall replace stock up to that level.

Watercourse Realignment Plantings

The Contractor shall develop a watercourse realignment planting plan for the Department’s review that is consistent with the following requirements.

Bioengineering plantings shall be incorporated into the realignments of the Elbow River, Cullen Creek, and Fish Creek. The bioengineering plantings at Fish Creek, Elbow River at Weaselhead and Cullen Creek are to be installed and fully maintained for at least one year prior to channel activation so that the plantings are established. Bioengineering plantings shall have a survival rate compliant with applicable regulatory approvals (e.g., potential FAOC Authorization) and at a minimum of one establishing plant per linear bank metre in 80% of total linear metres at all times during the Construction Period and for a period of 12 months after RNI Traffic Availability. The Contractor shall conduct monthly inspections that identify the percent survival rate and those areas that need immediate attention in order to achieve the minimum survival rate. Deficiencies with bioengineering plantings shall be addressed within a two month period of discovery. All rock and rip rap shall be washed prior to delivery and installation in the new channels. No rock or rip rap shall be washed within the Elbow River valley or the Fish Creek valley.

The Contractor shall establish native grass/shrub/tree plantings and seeding under the structures at Elbow River at Weaselhead, Elbow River at Highway 8 and Fish Creek, along the Elbow River and Fish Creek stream realignments and in the associated Temporary Use Areas to facilitate wildlife movement. The Contractor shall provide detailed planting designs for Department review that meet the requirements of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Elbow River Bridge Crossing Wildlife

Planting Concept (Figure 3.5-17a) and the Fish Creek Bridge Crossing Wildlife Planting Concept (Figure 3.5-17b). Details contained within the planting designs shall include the identification, location and density of the plantings for shrubs and tree species. The designs shall be consistent with the concept drawings provided and the specifications that follow. Use rooted plant stock of upland native shrubs and trees, such as those listed in Table 3.5-19 of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014). If using species from the “Tree” category in Table 3.5-19, obtain rooted stock in a 5 to 7 gallon size for deciduous trees and a 15 to 20 gallon size for coniferous tree and plant at a density of 1 plant per 3 linear metres; obtain “Tall Shrub/Small Tree” species in a 2 gallon size and plant at 1 plant per 2 linear metres; obtain “Medium Shrub” species in a 2 gallon size and plant at 1 plant per linear metre; obtain “Short Shrub” species in a 1 gallon size and plant at 1 plant per 0.7 linear metre. Overall densities of each woody vegetation type above shall not exceed 150% of the density of the same vegetation type in the surrounding natural vegetation. Deciduous tree plantings shall have a minimum height of eight feet, white spruce tree plantings shall have a minimum height of five feet, and shrub plantings shall have a minimum height of two feet. The Contractor will be required to water all of the large tree plantings until they are successfully established. The Contractor shall conduct monthly monitoring of planted tree stock for the first year following construction and in May, early July and mid-August in the second year following construction. Rooted stock shall have, at a minimum, a survival rate of 85% - 90% for the first year and the Contractor shall replace stock up to that level.

The Contractor shall construct the embankments of the Southwest Calgary Ring Road through the Elbow River valley, also known as the Weaselhead, in a contextually sensitive manner that incorporates environmentally sensitive features such as terraced slopes with native plantings as noted previously in this Section and Section 200.2.9 (Topsoil and Seeding).

200.2.9 TOPSOIL AND SEEDING

Cleanup operation shall be undertaken promptly after completion of construction activities, during non-frozen conditions. Topsoil material shall be uniformly spread to a depth of 200 mm over the prepared areas to facilitate the required seeding and landscaping, including areas of shrub and tree planting. Under no circumstances shall any topsoil be buried, wasted or otherwise disposed of. In the case of large amounts of surplus topsoil, the Contractor shall indicate how the material will be handled and stored in a manner compliant with relevant regulatory requirements. The procedures for the handling and storage of topsoil shall be included in the Contractor’s Environmental Management System (Section 100.2.2) operational procedures.

Conventional seeding and/or hydro-seeding shall be carried out by the Contractor in conformance with the relevant sections of Schedule 18 (Technical Requirements) related to drainage and erosion. Drainage and erosion control measures should be installed as specified in the Contractor’s ECO Plan, per the Contractor’s permanent erosion and sediment control design and elsewhere as warranted to ensure soil stability, facilitate adequate surface drainage and to promote revegetation.

Seeded areas shall show a uniform stand of grass during the calendar year following the year of initial seeding. Areas which do not show a uniform stand of grass shall be reseeded. A uniform

stand of grass shall show no bare spots greater than 0.5 square metres in area and shall provide a minimum of 80% ground cover. Vegetation shall be mowed to a maximum height of 100 mm within the TUC during the Construction Period a minimum of twice throughout the growing season. Mowing of riparian areas is not permitted.

All seed supplied by the Contractor shall be certified free of all prohibited noxious weed varieties listed in the *Weed Control Act* (Alberta). Only certified Canada No. 1 seed should be used, or, in the event that it is not available, the highest grade of seed available, with the prior written approval of the Department.

In order to maintain consistency in vegetation within the TUC, the Contractor shall utilize seed mixtures for the New Infrastructure that are similar to those used in the existing portions of the Calgary Ring Road.

Below are the seed mix specifications for revegetation of disturbed areas. The Contractor may propose alternate grass species for the Department’s consideration. All broadcast seeded areas shall be harrowed following seeding. If drill seeding is used, seeded areas shall not be harrowed.

Banks and approach slopes of all water crossings shall be hand-seeded immediately following construction to ensure rapid soil stabilization. If seeding cannot occur until the following spring, a cover crop of fall rye should be seeded to the banks in conjunction with biodegradable geotextile fabric or other appropriate erosion control method implemented to provide short-term ground cover. Disturbed areas shall be reclaimed and revegetated within one month following the completion of construction activity for each segment of the Project. All topsoil and subsoil stockpiles that are to remain in place for a period of more than one month shall be seeded with a rapid establishing cover crop species within a 30 day period of placement of the stockpile. Seeding is not expected to occur between November and February.

Due to water quality concerns in the Elbow River, Fish Creek, and Cullen Creek no fertilizers are to be used within the Elbow River and Fish Creek valleys. Fertilizer cannot be used in areas where native grass seed is utilized.

A preconstruction assessment shall be conducted by the Contractor to identify the species and distribution of native grasses. All predisturbance areas containing native grasses shall be reseeded with native grass seed mixtures. No agronomic seed mixtures are approved for use in areas where native grass existed prior to the disturbance.

Seed Mix A – Native Upland Mix

For revegetating ditches, medians and embankment slopes, and to be applied to portions of the Road Right of Way where the Road Right of Way crosses native or grassland or improved pasture.

Species	Latin Species	% of Mix by Dry Weight
Slender Wheatgrass	<i>Agropyron dasystachyum, smithii or trachycaulum</i>	30

Hairy Wild Rye	<i>Elymus innovatus</i>	15
Mountain Brome	<i>Bromus carinatus</i>	15
Alkali Grass or June Grass	<i>Puccinellia nuttaliana</i> or <i>P. distans</i> or <i>Koeleria micrantha</i>	10
Needle and Thread Grass or Porcupine Grass	<i>Stipa curtisetata</i> or <i>S. comata</i>	10
Idaho Fescue	<i>Festuca idahoensis</i>	5
Rough Fescue	<i>Festuca campestris</i>	5
Rocky Mountain Fescue	<i>Festuca saximontana</i>	5
Indian Ricegrass	<i>Orzyopsis hymenoides</i>	5
Total		100%

Seeding considerations are as follows:

- Application Rate (drill seeding) = 25 kg/ha.
- If hydroseeding, increase application rate as advised by a qualified vegetation specialist, based on hydroseeding method and mixture.
- The application rate can be increased in areas that will be mowed where weed introduction or spread is expected to be an issue.
- No fertilizer shall be used with Seed Mix A.
- Choice between species (indicated above) can be based on availability of seed.

Seed Mix B – Agronomic Upland Mix

For ditches, medians and upper embankment slopes, and to be applied to portions of the Road Right of Way outside of riparian zones, where the Road Right of Way crosses cultivated lands. No agronomic mixtures are to be used within the Elbow River floodplain and Fish Creek valley.

Species	Latin Species	% of Mix by Dry Weight
Pubescent Wheatgrass	<i>Agropyron trichophorum</i>	32
Dahurian Wildrye	<i>Elymus dahuricus</i>	30
Sheep Fescue	<i>Festuca ovina</i>	30
Cereal Rye	<i>Secale cereale</i>	8
Total		100%

Seeding considerations are as follows:

- Application Rate (drill seeding) = 50 kg/ha.
- If hydroseeding, increase application rate as advised by a qualified vegetation specialist, based on hydroseeding method and mixture.
- Topsoil will be analysed for nutrient status as part of the pre-construction topsoil assessment, to determine fertilizer application requirements (per the Department’s Design Bulletin # 25).

Seed Mix C – Riparian Mix to Allow Tree Ingrowth

For revegetating disturbed low-lying areas in the Elbow River and Fish Creek floodplains as well

as disturbed areas adjacent to wetlands where it is desirable to have native tree/shrub ingrowth.

Species	Latin Species	% of Mix by Dry Weight
Rocky Mountain Fescue	<i>Festuca saximontana</i>	40
Slender Wheatgrass	<i>Agropyron trachycaulum</i>	20
Canada Wild Rye	<i>Elymus canadensis</i>	20
Mountain brome	<i>Bromus carinatus</i>	15
Tufted Hairgrass	<i>Deschampsia caespitosa</i>	5
Total		100%

Seeding considerations are as follows:

- Application Rate (drill seeding) = 5 kg/ha. Broadcast seed rate = 10 kg/ha.
- Cover crop of fall rye recommended, broadcast seed rate = 20 kg/ha.
- If hydroseeding, increase application rate as advised by a qualified vegetation specialist, based on hydroseeding method and mixture.
- No fertilizer shall be used with Seed Mix C.

Seed Mix D – Riparian Mix for Where Tree Growth is Not Desired

For revegetating disturbed low-lying areas in the Elbow River and Fish Creek floodplains as well as disturbed areas adjacent to wetlands, where the re-establishment of native trees/shrubs is not a priority.

Species	Latin Species	% of Mix by Dry Weight
Western Wheatgrass	<i>Agropyron smithii</i>	30
Rough Hair Grass	<i>Agrostis scabra</i>	20
Tall Mannagrass	<i>Glyceria grandis</i>	20
Tufted Hairgrass	<i>Deschampsia caespitosa</i>	15
Fowl Bluegrass	<i>Poa palustris</i>	10
Bluejoint Reed Grass	<i>Calamagrostis canadensis</i>	5
Total		100%

Seeding considerations are as follows:

- Application Rate (drill seeding) = 5 kg/ha. Broadcast seed rate = 10 kg/ha.
- Cover crop of fall rye recommended, broadcast seed rate = 20 kg/ha.
- If hydroseeding, increase application rate as advised by a qualified vegetation specialist, based on hydroseeding method and mixture.
- No fertilizer shall be used with Seed Mix D.

Seed Mix E – Wetland Mix

The following seed mix shall be used in wetter areas of wetlands where disturbance has occurred and natural regeneration has been identified to need remediation or within constructed wetlands around the normal water level.

Species	Latin Species	% of Mix by Dry Weight
Western Wheatgrass	<i>Agropyron smithii</i>	20
Slender Wheatgrass	<i>Agropyron trachycaulum</i>	20
Canada Wildrye	<i>Elymus canadensis</i>	20
Tall Mannagrass	<i>Glyceria grandis</i>	10
Slough Grass	<i>Beckmannia syzigachne</i>	15
Tufted Hairgrass	<i>Deschampsia caespitosa</i>	5
Alkali Grass	<i>Puccinellia nuttalliana</i> or <i>P. distans</i>	5
Fowl Bluegrass	<i>Poa palustris</i>	5
Total		100%

Seeding considerations are as follows:

- Application Rate (drill seeding) = 5 kg/ha.
- No hydroseeding within wetland areas.
- No fertilizer shall be used with Seed Mix E.
- Choice between species (indicated above) can be based on availability of seed.

200.2.10 UTILITIES

This Section 200.2.10 is subject to section 4.8 (Utility, Railway and Drainage Agreements) of the DBFO Agreement. The Contractor shall locate all utility rights of way, easements, or similar interests (whether registered against title to the land or not) affected by the Project. The Contractor shall deal with existing utilities in a manner that is consistent with the Department’s approach throughout the Province.

- If no depth is specified by the Department, Local Authority, or utility, the top of pipe elevation is to be a minimum of 1.8 m below the lowest elevation of the Ultimate Stage road cross-section within the road crossing zone;
- The Contractor shall coordinate the design of utility crossings with the affected utility company such that the maximum allowable load over the utility does not exceed the requirements of the utility company;
- The Contractor shall receive written approval from the utility company for type of soil backfill material to be placed and construction methods to be used over the buried powerline facilities. All material placed in the vicinity of buried powerlines shall meet the utility company’s thermal resistivity requirements. The Contractor shall provide the utility company with thermal resistivity testing data as part of the approval process;
- The Department will consider permitting the use of insulation in lieu of the minimum depth requirement listed above with prior written consent from both the Department and the affected utility company;
- The pipe shall not have bends or kinks within the road crossing zone, that zone being described as from the top of the backslope of the outer ditch on one side of the road to top of the backslope on the other side of the road. The length of pipe to be free of

- bends or kinks will vary depending on the Ultimate Stage and Outer Ring Road roadway plans and protection needed to accommodate any further construction. The profile of the pipe within the road crossing zone shall be flat or at minimum grade in the case of gravity pipes;
- Top of pipe elevation is to be labelled on the cross-section and profile;
 - Heavy wall pipe or casing is to be utilized throughout the road crossing zone;
 - No open cuts are permitted across roadways to be incorporated into the New Infrastructure;
 - Pipeline/utility crossing signs are to be installed on both sides of the roadway at property (fence) line;
 - Roadway centreline profile information for 200 m in either direction from the proposed crossing location is required to be submitted to the Department for review and acceptance to confirm minimum crossing elevations as compared to future profile improvements; and
 - All elevations are to be geodetic.

The Contractor shall apply the information outlined in the *Alberta Transportation Utility Guidance Manual* (2001) when entering into an agreement with a utility company on behalf of the Department. The Contractor may use one of the sample agreements provided in Appendix H of the *Engineering Consultant Guidelines for Highway and Bridge Projects - Volume 1, Design and Tender, 2011*. Prior to the agreements being signed by the utility company and the Contractor, they are to be sent to the Department for review. In the event that changes to the wording of the sample agreements are required, the changes will require the prior written approval by the Department. A period of two weeks will be required by the Department to review the proposed revisions after which the Department will provide comments on the suitability of the proposed revisions.

The Contractor shall provide copies of all signed utility agreements to the Department and the Contractor shall also provide the Department with Detailed Design drawings for review. The drawings shall be submitted four weeks prior to commencement of the applicable construction.

For any utility work done for the Local Authority, the Contractor shall provide record drawings to the Local Authority consistent with its requirements (e.g. block profile requirement by the City).

There may be cases in which a utility company consents to enter into an agreement with the Contractor, where such utility company does not require its utility pipeline to have any casing protection. Notwithstanding the requirements of the utility company, the Department requires that all pipelines constructed of jointed pipe shall require continuous casing (i.e. casing with welded joints) as a protective measure for containment of a ruptured pipeline. Cured in place pipe linings are not an acceptable alternative. The casing requirement shall apply when jointed pipelines are crossed by the new construction of a highway or by the new construction of its associated interchanges. For the Project, highways and associated interchanges shall include locations in which there are newly constructed or reconstructed infrastructure as part of the Project. These locations are:

- Calgary Ring Road;
- Highway 8;
- Glenmore Trail; and
- Highway 22X (collectively, the “**Listed Highways**”).

The casings shall extend a minimum of 5 m beyond the back of the outer roadside ditch as required for the Ultimate Stage grading. Pipelines crossing the Listed Highways and associated interchange locations or other roadways within the influence of the interchange shall be installed in accordance with the *Alberta Transportation Utility Guidance Manual* (2001). Pipeline crossings within the influence of the interchange shall be avoided for the long term benefit of reducing future highway disruptions in critical areas unless otherwise approved by the Department in writing. A pipeline is considered to be within the interchange if it is located within the footprint of the interchange extents of which are defined by the painted gore points of all connecting roadways.

No bends or kinks will be permitted for new or relocated pipeline installations within the road crossing zone, except for pipelines installed within the existing pipeline component of the TUC or as otherwise approved in advance and in writing by the Province, acting reasonably. In considering its approval, the Province shall consider all factors including the following: (a) the commercially feasible options for relocation; (b) the written rationale and support for the request from the pipeline designer; (c) potential risks to highway operations; (d) potential future highway expansion; (e) approval by the utility owner; and (f) approval by applicable regulatory agencies (for example the National Energy Board and the Alberta Energy Regulator).

The Contractor will not be required to replace existing pipelines within the Road Right of Way that have kinks or bends and that are not affected by the Project.

In the event that the Contractor’s designs require the abandonment of an existing utility, the existing utility shall be removed in its entirety. On a case by case basis, with the prior written approval of the Department and the Department of Infrastructure, the abandoned existing utility may be allowed to remain in place. If allowed to remain in place all infrastructure (e.g. manholes) shall be removed to 1 m below design subgrade for Stage 1 and Ultimate Stage of the Calgary Ring Road and shall be grouted in its entirety to prevent the possibility of future collapse or settlement.

Municipal utilities including water, wastewater and stormwater pipelines constructed of a jointed pipe shall be continuously cased when crossing the Listed Highways and associated interchange locations if the pipelines are jointed and of a size of 1050 mm in diameter or less. Larger diameter jointed pipes do not require casing. Existing casings crossing the Southwest Calgary Ring Road or municipal roadways within the influence of an interchange associated with the Southwest Calgary Ring Road shall be extended or replaced to meet the casing requirements for Ultimate Stage grading.

Storm pipelines forming part of the roadside drainage collection system are not required to meet casing and/or continuous pipe requirements. Storm pipelines from one stormwater

management facility (“**SWMF**”) to another or from a SWMF to a natural water body crossing the Listed Highways and associated interchange locations require casing if jointed and equal to or less than 1050 mm in diameter and jointed.

In lieu of casing jointed pipes, continuous pipe sections may be used for the crossing. Continuous piping may be either HDPE fused pipe with a minimum SDR rating of 11 or a welded continuous steel line. No casing will be required for “heavy wall welded steel pipe”. ‘Heavy wall’ pipe is considered, as one wall thickness above what is used, for the size of pressure rating, installed outside of the Road Right of Way or the TUC. The continuous pipe sections shall be of sufficient strength to withstand expected loadings. Use of cured in place pipe lining is not permitted. Continuous steel casings shall include cathodic protection to meet a minimum design life of 50 years. The Department may consider the use of fusible PVC as an alternative to casing on a case by case basis with the written approval of the impacted utility.

In situations where buried utilities are in the vicinity of MSE walls, the Contractor shall conform to the requirements of Section 300.5.2.22.2 (Waterways, Water Carrying Appurtenances and Utilities).

The direct out-of-pocket costs that are incurred by the Contractor pursuant to this casing requirement in relation to the Project are subject to the cost-sharing arrangement between the Contractor and the Province as set forth in section 15.4 (Assistance with Permits and Utility Agreements) of the DBFO Agreement.

There may be cases in which a utility company consents to enter into a utility agreement with the Contractor, where such utility company does not require its powerline facilities to be buried. Notwithstanding the previous statement, the Department requires that all powerline facilities rated at 25 kV or less shall be buried when crossed by the new construction of a highway or by the new construction of its associated flyovers and interchanges. The buried powerline facilities shall extend to a minimum of 5 m beyond the backslope of the outer roadside ditches as required for the Ultimate Stage grading and be installed at 1.8 m below the lowest ditch at a flat or minimum grade. The location of the first power pole and/or first pole anchors in any direction from the roadway shall be a minimum of 15 m from the edge of pavement but in no case shall be closer than the back of the normal 4 m wide outside road ditch unless in an area that is protected by a guardrail or barrier.

The direct out-of-pocket costs that are incurred by the Contractor pursuant to the requirement to bury powerline facilities in relation to the Project shall be subject to the cost-sharing arrangement between the Contractor and the Province as set forth in section 15.4 (Assistance with Permits and Utility Agreements) of the DBFO Agreement.

The Contractor shall allow Local Authorities and other utility companies to have access to the Lands for utility work.

The Contractor shall design and construct the relocation of the existing sanitary forcemain and watermain located in NE12-23-02-W5M. The Contractor shall be required to upgrade the existing 150 mm sanitary forcemain located in NE12-23-02-W5M to a 300 mm sanitary

forcemain. The design of the relocated sanitary forcemain and watermain shall be coordinated with the Local Authority. Record drawings shall be prepared in accordance with the Local Authority's requirements and submitted no later than six months after completion and acceptance of the relocation by the Local Authority.

The Department has established utility contacts with the following utility companies, which are not all the relevant utility companies:

ATCO Gas
Contact: Adam Claude
Senior Engineer, Calgary Region Engineering
South
Floor 5, 909-11 Avenue SW
Calgary Alberta T2R 1L8
adam.claude@atcogas.com

ATCO Pipelines
Contact: Frederic De Caigny
Senior Engineering Technical Leader, Major
Projects
ATCO Pipelines
Suite 1300, 909 – 11 Avenue SW
Calgary, Alberta T2R 1L8
Frederic.DeCaigny@atcopipelines.com

AltaLink
Contact: Jeffrey Johnson
Project Manager
AltaLink Management Ltd.
2611 - 3rd Avenue SE
Calgary, AB T2A 7W7
Jeffrey.Johnson@altalink.ca

The City of Calgary, Water Resources (Storm
and Sanitary)
Contact: Ian Morley
Manager - Infrastructure Delivery
City of Calgary Water Resources
625 - 25 Avenue SE
Calgary Alberta T2G 4K8
Ian.Morley@calgary.ca

The City of Calgary, Water Services
(Feeder mains)
Contact: Jim Buker, P.Eng.
Project Engineering - Underground
Infrastructure Delivery
625 - 25 Avenue SE
Calgary, Alberta T2G 4K8
jbuker@calgary.ca

City of Calgary, Water Resources
(Infrastructure Planning)
Contact: Zhong Xiang, Development
Engineering Coordinator, Development
Approvals
625 - 25 Avenue SE
Calgary, Alberta T2G 4K8
Zhong.Xiang@calgary.ca

ENMAX Power Corporation
Contact: Willem du Toit
Manager, Major projects
141 – 50 Avenue SE
Calgary, Alberta T2G 4S7
wdutoit@enmax.com

TELUS
Contact: Alanna Depree
Fixed Network Planning and Engineering -
Alberta South
Technical Support Assistant
715 – 41 Avenue NE
Calgary, Alberta T2E 3P8
Alanna.Depree@telus.com

Shaw Communications

TransAlta Corporation

Contact: Malcolm Sandbach
2400 – 32 Avenue NE
Calgary, AB T2E 9A7
Malcolm.sandbach@sjrb.ca

Contact: Anirban Bosu
Transmission Technical Manager
110, 12 Avenue SW
Calgary, Alberta T2R 0G7
Anirban_Bosu@TransAlta.com

Bell

Contact: Peter Kirillo
Detailed Engineering
OSP Western Region
12th Floor, 140 - 10 Avenue SE
Calgary, Alberta T2G 0R1
Peter.kirillo@bell.ca

The Contractor shall pay all costs associated with design, utility protection, relocation, damage to or other costs with respect to all utility rights of way, easements, or similar interests (whether registered against title to the land or not) affected by the Project.

The Contractor shall locate any abandoned utilities that impact construction of the New Infrastructure. The Contractor shall remove and decommission any such abandoned utilities in accordance with industry practice and in accordance with any applicable laws and regulations.

The Department has initiated the relocation of a number of major utilities directly with the affected utility companies. The following table identifies the utility relocations initiated by the Department (the “**AT Initiated Utility Relocations**”) and reference the relocation plans posted in the Electronic Data Room (as defined in the RFP). The AT Initiated Utility Relocations are not part of the Utility Costs as defined in section 15.4 (Assistance with Permits and Utility Agreements) of the DBFO Agreement.

AT Initiated Utility Relocations Table

Utility Company	Type of Work and Facility	Drawing Reference	Estimated Construction Start Time	Hoped for Construction Completion Date	Construction Completion Deadline after which potential Relief Event
AltaLink	Transmission line relocation and salvage <ul style="list-style-type: none"> • 3L/150L (overhead) • 693L/916L (underground) • 906L/928L (overhead) 	<ul style="list-style-type: none"> • SWCRR Detail Phota DP-1.pdf 	October 1, 2016	July 1, 2018	January 1, 2019
ENMAX	Transmission line relocation and salvage <ul style="list-style-type: none"> • 1.80L 	<ul style="list-style-type: none"> • SWRR - Sarcee & Glenmore Tr SE 	March, 2016	November 30, 2016	March 31, 2017

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	<ul style="list-style-type: none"> • 21.80L • 28.80L 	<p>Interchange - Proposed Transm - ENMAX_Altalink</p> <ul style="list-style-type: none"> • SWCRR - Sarcee Glenmore - NOV042015 - REV7 			
ENMAX	<p>Transmission line relocation and salvage</p> <ul style="list-style-type: none"> • 6.80L • 35.81L 	<ul style="list-style-type: none"> • NEW 6.80L • NEW 35.81L 	January 1, 2017	November 30, 2017	March 31, 2018
ENMAX	<p>Substation construction</p> <ul style="list-style-type: none"> • Substation 35 <p>Substation decommission and salvage</p> <ul style="list-style-type: none"> • Substation 30 		<p>March 3, 2016</p> <p>January 27, 2016</p>	<p>September 30, 2017</p> <p>March 31, 2018</p>	<p>January 31, 2018</p> <p>July 1, 2018</p>
ENMAX	<p>Transmission line relocation and salvage</p> <ul style="list-style-type: none"> • 6.82L 	<ul style="list-style-type: none"> • 6.82L.pdf 	November 2017	9-12 months following submission of the Contractor's designs to ENMAX	December 31, 2018
ENMAX	<p>Transmission line east of 69 Street SW along Highway 8 relocation and salvage</p> <ul style="list-style-type: none"> • 7.82L 	<ul style="list-style-type: none"> • 7.82L.pdf 	November 2017	9-12 months following submission of the Contractor's designs to ENMAX	December 31, 2018
The City of Calgary	Richmond Storm Trunk Phase 1	<ul style="list-style-type: none"> • 37 Street Storm Trunk Relocation IFC Drawings.pdf 	August 2015	June 30, 2016	September 30, 2016
The City of Calgary	Richmond Storm Trunk Phase 2		August 2016	None	September 30, 2018

The Contractor shall accommodate future utility rights of way, easements, or similar interests (the “**Future Utility**”) on, under or above the Lands when requested by the Department. All costs associated with the installation, maintenance and operation of the Future Utility shall be the responsibility of the Future Utility owner.

The Contractor shall recognize the authority of the Department of Infrastructure to manage the TUC at all times (including both during the Construction Period and the Operating Period). The Contractor shall follow the *Transportation/Utility Corridor (TUC) Program Policy*, as may be amended from time to time, at all times when processing a request for a Future Utility. For the purposes of the *Transportation/Utility Corridor (TUC) Program Policy*, the Contractor shall be considered a “stakeholder” in the TUC.

Applications for Ministerial Consent for a Future Utility will be referred to the Contractor for comment who shall return such comment to the Department of Infrastructure for further review. The Contractor recognizes that its comments will not be binding. In its response, the Contractor shall identify commercially reasonable steps to accommodate any proposal forwarded to it by the Department of Infrastructure. The Contractor is required to cooperate with existing and future utility providers within the TUC.

At the end of the Term, the Contractor shall return any and all utility as-built drawings and utility agreements to the Department and the Department of Infrastructure.

During the PNI Operating Period or the Operating Period, a Future Utility may need to be removed or relocated to facilitate major maintenance or rehabilitation by the Contractor. Relocation or removal of any Future Utility, including all associated costs, shall be borne by the owner of the applicable Future Utility.

In the event that a Future Utility is no longer required, the applicable Future Utility owner shall advise the Department of Infrastructure and the Contractor and such owner shall arrange for the applicable Future Utility to be removed and, when applicable, for the Lands to be restored to the condition commensurate with that prior to the installation of the applicable Future Utility.

200.2.11 RAILWAYS

This Section 200.2.11 is subject to section 4.8 (Utility, Railway and Drainage Agreements) of the DBFO Agreement. Reference is made to the Existing Railway Arrangement (as defined in section 4.8 of the DBFO Agreement). The Existing Railway Arrangement includes “structure outline drawings”. Structure outline drawings define clearance envelope requirements and illustrate the bridge configurations on which the Existing Railway Arrangement was based. However, confirmation of the feasibility of the illustrated bridge configurations is the Contractor’s responsibility. Changes to the bridge configurations that are illustrated on the structure outline drawings will require new railway arrangements or Canadian Transportation Agency orders. The Contractor shall include the Department in all meetings, correspondence, and discussions with the railroad companies during the negotiation of any railway agreements, as required. A period of two weeks will be required to review proposed agreements, after which the

Department will provide comments on their suitability. It should be noted that the cost apportionment section of the CTA order is final and no further negotiations between the two parties are necessary.

The Contractor shall design and construct bridge structures at the railway crossings as described in Section 200.2.3.7 (Other Crossings).

It shall be the Contractor's responsibility to pay all costs associated with design, railway protection and relocation associated with railway requirements. The Contractor should expect that the Canadian Pacific Railway Company (the "CPR") may choose to design and construct any detours, shooflies, or temporary crossings proposed by the Contractor; however the cost for such activities shall remain the responsibility of the Contractor.

Design and construction of all railway crossings will require coordination between the Contractor and the CPR. The Contractor shall submit all design and construction plans, including construction staging, to the CPR for their review and approval. The Contractor shall contact the CPR directly in order to locate CPR-owned utilities in the vicinity of CPR crossing locations.

The Contractor shall obtain all necessary approvals in accordance with and in addition to that established in the railway arrangements. Such approvals include but are not limited to those required for construction activities on or adjacent to railway lines, construction of temporary at-grade crossings, temporary railway closures, and temporary clearance boxes used during construction.

As part of the design, there shall be no net increase in the drainage along the railway right-of-way. The Contractor shall ensure that no increase of snow drifting, communications impedance, or splashing shall occur on railway right-of-way. The Contractor may be required to construct pier protection walls or crash walls at railway grade separations. Pier protection is normally required if a bridge element or other obstruction is within 7.620 m from the centreline of the railway track. The Contractor shall confirm all requirements for pier protection or crash walls with the CPR.

The Contractor shall be responsible for the notice of proposed railway work for all railway grade separations, as may be required by the *Railway Safety Act* (Canada).

The Contractor must comply with the *Railway Safety Act* (Canada) and sign a railway right-of-entry form for all sites. The Contractor shall meet Transport Canada's Draft RTD 10 *Road/Railway Grade Crossing Technical Standards* for all at-grade crossings.

For demolition of railway infrastructure, the Contractor shall obtain approval for removal of the existing railway structures from the CPR and the Department prior to any demolition work commencing.

It is the responsibility of the Contractor to conduct the work and adhere to the railway company's specifications and requirements. The Contractor is encouraged to make arrangements to retain

the services of railway personnel, such as a flag person or an operations coordinator, to assist with construction activities.

The Contractor shall provide to the Department a cost breakdown for the design and construction of the CPR railway crossing at Mile 10.75 CPR Macleod Subdivision (see Section 200.2.3.7.10), in the form and level of detail as reasonably requested by the Department, in support of the Province's apportionate cost recovery from the CPR.

The Department has established contacts with the CPR:

Pete Bayerle
7550 Ogdendale Rd SE,
Calgary, Alberta T2C 4X9
Telephone: 403-319-7488
Cell: 403-835-9372
Email: pete_bayerle@cpr.ca

200.2.12 LOCAL AUTHORITIES

The Department has established the following contacts with the Local Authority:

- The City of Calgary
Contact: Julie Radke
Manager, Ring Road Integration Project
10th Floor, Andrew Davidson Building
133, 6 Avenue SE
P.O. Box 2100, Stn. M
Calgary, AB, T2P 2M5
Telephone: (403) 268-1907
Fax: (403) 268-5645
Email: julie.radke@calgary.ca
- Tsuut'ina Nation
Contact: Darrell Crowchild
9911 Chiila Boulevard
Tsuut'ina Nation, AB, T2W 6H6
Telephone: (403) 238-6320
Email: darrellcc@tsuutina.com
- M.D. of Foothills No. 31
Contact: Jeff Edgington
Supervisor of Infrastructure
309 Macleod Trail, Box 305
High River, AB, T1V 1M7

Telephone: (403) 603-6208
Email: Jeff.Edgington@mdfoothills.com

- Rocky View County
Contact: Gord Rowland
Capital Projects Technologist
911-32 Avenue NE
Calgary, AB, T2E 6X6
Telephone: (403) 520-1654
Email: growland@rockyview.ca

200.2.13 ENVIRONMENTAL

The Contractor shall complete all investigations, studies or any other required work that may be necessary to support the design and construction including obtaining all necessary authorizations, permits, approvals or other consent as required by applicable law. The Contractor is the applicant on behalf of the Department and is required to perform all regulatory obligations including monitoring on behalf of the Department.

The *Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Volume 1 & 2 (AMEC)*, the *Environmental Assessment for the West Calgary Ring Road (Updated February 2015) Volume 1 & 2 (AMEC)* and the *Twining of Highway 8: Highway 22 to Calgary Western City Limits Environmental Evaluation 2014 (Spencer Environmental Management Services Ltd.)* collectively form the environmental assessment (the “EA”) that the Contractor shall refer to for guidance along with the provincial and federal legislative requirements for the purposes of carrying out its obligations under the DBFO Agreement. The EA is provided for information only and is not intended to determine the environmental regulatory requirements. Areas of impact noted in the EA are an initial estimate only and it is the responsibility of the Contractor to determine the final areas of impact based on its detailed designs and discussions with the regulatory authorities for replacement/offsetting requirements. The Contractor is advised that the preliminary work undertaken by the Department will not negate the Contractor’s ultimate responsibility to acquire all necessary regulatory approvals and authorizations, for the Project. The timely acquisition of all relevant approvals, authorizations and permits is the sole responsibility of the Contractor.

Under the *Water Act* (Water Ministerial Regulation) (Alberta), a dam is defined as a barrier constructed for the purpose of storing water, including water containing any other substance, that ‘provides for a storage capacity of 30,000 cubic metres or more, and is 2.5 metres or more in height when measured vertically to the top of the barrier, from the bed of the water body at the downstream toe of the barrier, where the barrier is across a water body, or from the lowest elevation at the outside limit of the barrier, where the barrier is not across a water body and includes a works related to the barrier.’ If a stormwater retention pond meets the above criteria, additional review and approval by Alberta Environment under Part 6 of the Water (Ministerial) Regulation under the *Water Act* (Alberta), is required.

Under the Navigation Protection Act (“**NPA**”), the Elbow River, Fish Creek, and Cullen Creek are not listed as scheduled waterbodies. It is, however, the Contractor’s responsibility to determine the requirements under the NPA for these three watercourses. The Contractor can request, from the Navigation Protection Program (“**NPP**”), to opt-in or -out of the NPA regime regarding non-scheduled navigable waters. If the Contractor chooses not to opt-in to the NPA review, the Contractor is encouraged to contact the NPP to discuss NPA provisions and relevant mitigations that protect navigational watercourses (i.e. public right to navigation) during the Construction Period and the Operating Period.

Fisheries and Oceans Canada (“**FAOC**”) has determined that the potential to cause serious harm may result to the Elbow River, Fish Creek, and Cullen Creek fisheries due to the realignment of these watercourses. As such, FAOC authorization under the *Fisheries Act* (Canada) will likely be required prior to the commencement of work in these watercourses. The Contractor may choose to utilize the fish survey information and the conceptual fisheries compensation plans presented in the EA as the basis for discussion with FAOC.

It is the Department’s understanding that watercourse realignment activities and wetland impacts require both *Water Act* (Alberta) approval and *Public Lands Act* (Alberta) approval from Alberta Environment. It is the Contactor’s responsibility to confirm and meet all regulatory requirements.

Applications under the *Water Act* (Alberta) for watercourse realignments require the following information:

- area of watercourse prior to construction and the area following construction (including the riparian area);
- fish habitat assessment of the existing channel prior to construction including the quantity and quality of habitat;
- a fish habitat assessment following construction which includes the quality and quantity of habitat;
- a list of any fish habitat deficiencies in the constructed channel along with a plan to remediate the habitat;
- an inventory of species expected to be present at or near the project site during construction including federally or provincially listed species;
- a comprehensive list of mitigation measures to minimize the impacts to fish and fish habitat;
- identify any adverse effects to the aquatic ecosystem as a result of the works;
- results of any hydrological, hydraulic or hydrogeological analyses conducted;
- a water management plan; and
- a description (including drawings), timing and duration of construction activities and structures.

Alberta Environment has indicated that the Project falls under the Interim Policy (wetlands) as field work for the Project started prior to June 1, 2015, provided that *Water Act* (Alberta) applications are made within two years of the date of the wetland survey. The Contractor is responsible for all wetland impact, replacement, and management activities during the

Construction Period and the Operating Period and must adhere to the Alberta Wetland Policy and *Water Act* (Alberta) approval process with respect to wetlands (including determining the ownership of potentially Crown-claimable wetlands for those impacted wetlands that are not within the Road Right of Way). All regulatory requirements including design, construction, maintenance, monitoring and/or reporting shall be the responsibility of the Contractor. The Department must be kept apprised of all discussions and shall receive copies of all agreements and approvals respecting wetland replacement.

Applications under the Interim Policy require the following information:

- area of wetland (including the flooded portion of the wetland and transition zone);
- hydrological assessment;
- statement of wetland benefits (*i.e.*, hydrological, ecological, economical);
- classification of wetland based on either the Cowardin Wetland Classification System or the Stewart and Kantrud Wetland Classification System;
- flora and fauna observed at the sites including the presence of any rare or endangered species;
- type of wetland margin and average width of wetland margin;
- surrounding upland use (e.g., cropping, natural, etc.);
- contributing drainage area for the wetland;
- historical aerial photographs;
- wetland compensation plan;
- reference photographs showing wetland area, margin and adjacent upland area; and
- report describing existing wetland site and proposed development, including a statement (and supporting technical information) indicating why the wetland impacts cannot be avoided or reduced.

The Contractor shall address all environmental issues in its Environmental Management System and shall have a comprehensive ECO Plan for the Project. The Contractor is responsible for obtaining all necessary environmental permits, including obtaining approval from Fisheries and Oceans Canada, Transport Canada, and Alberta Environment, which will include without limitation Fisheries Act authorizations, Navigation Protection Acts approvals (if required), *Water Act* (Alberta) approvals, *Environmental Protection and Enhancement Act* (Alberta) approvals, and *Public Lands Act* (Alberta) approvals (including Dam Safety approvals).

The Contractor will be responsible for ensuring that these approvals remain valid, that conditions are adhered to, and that any other approvals required for the Project or the O&M are obtained and are adhered to.

The following contacts have been provided:

Dallas Babiuk
Navigable Waters Protection Officer
Transport Canada
Marine - Winnipeg
9700 Jasper Avenue NW

Edmonton, Alberta T5J 4E6
dallas.babiuk@tc.gc.ca

Tara Schweitzer
Fish Habitat Biologist
Fisheries and Oceans Canada
Prairies Area, Regina District Office
1084 Victoria Avenue East
Regina, Saskatchewan S4N 7K3
Tara.Schweitzer@dfo-mpo.gc.ca

Pauline Scoffield
Water Technologist
Environment and Water
2938 – 11 Street NE
Calgary, Alberta T2E 7L7
Pauline.Scoffield@gov.ab.ca

Frankie Kerr
Land Use Forest Officer (Public Lands)
8660 Bearspaw Dam Road NW
Calgary, Alberta T3L 1S4
Frankie.kerr@gov.ab.ca

The Contractor shall carry out and fulfill all of the requirements (the “**Mitigation Measures**”) identified in the Table below entitled “Mitigation Measures to be Performed by the Contractor”. The Contractor shall provide the Department with reports on the Mitigation Measures every six months starting from the date of Execution of the DBFO Agreement until 12 months after RNI Traffic Availability. All reports shall detail, to a level of detail and in a form satisfactory to the Department, acting reasonably, the Contractor's progress as it relates to the Mitigation Measures with specific regard to implementation and performance of the Mitigation Measures.

Soil and/or groundwater impacts have been identified on a number of sites along the TUC, as documented in the Certain Phase IIs (as defined below).

In the Mitigation Measures, “**Certain Phase IIs**” means:

- Phase II Environmental Site Assessment portions of the West and Southwest Stoney Trail Ring Road, Alberta prepared by AMEC dated April 2015;
- Alberta Transportation Limited Phase II Environmental Site Assessment West/Southwest Calgary Ring Road Calgary, Alberta by Clifton Associates dated July 2015;
- Phase II Environmental Site Assessment for Tsuut’ina Gas Stop, Alberta prepared by Parkland GEO dated February 2015;
- Phase II Environmental Site Assessment for stressed vegetation area at 8-26-23-2 W5M within Tsuut’ina First Nation, Alberta prepared by Parkland Geo dated February 2015; and

- Phase II Environmental Site Assessment for former highway maintenance yard at Highway 22X west of 6 Street SW, Calgary, Alberta, prepared by Parkland GEO dated March 2015.

Unless otherwise specified, any soil and/or groundwater contamination disturbed by the construction activities shall be remediated and/or disposed of at an appropriate facility, with mitigation measures implemented to minimize the potential of ingress of contaminants back into the remediated areas. The Contractor shall complete the appropriate assessment and re-evaluate the data presented in the Certain Phase IIs and eliminate non-applicable exposure pathways for soil and groundwater contaminants identified in the construction area (for example, the freshwater aquatic life pathway where no surface water bodies exist within 300 m downgradient or 100 m upgradient of a site; or the direct soil contact pathway (human or ecological) below a depth of 3 m from grade).

A detailed risk management plan (“**RMP**”) shall be developed for the former highway maintenance yard currently located north of Highway 22X, west of Macleod Trail SE, and the impacted soil adjacent to it. Information for this site is provided in the report entitled, *Phase 2 Environmental Site Assessment Former Highway Maintenance Yard Highway 22X West of 6 Street SW Calgary, Alberta*, prepared on behalf of Alberta Transportation by Parkland Geo-Environmental Ltd., March 25, 2015.

Prior to commencement of construction activities at the following sites, the following sites shall be fully remediated to the applicable Alberta Environment standards:

- Tsuut’ina First Nation Gas Stop located at 9901 Chiila Boulevard near Calgary Alberta and documented in the report, *Phase 2 Environmental Site Assessment Tsuu T’ina Gas Stop 9901 Chiila Boulevard Tsuu T’ina First Nation Near Calgary Alberta*, prepared by Parkland Geo-Environmental Ltd., February 23, 2015; and
- Stressed Vegetation Area located on the southern side of an unnamed gravel road, west of Weaselhead Road, Tsuut’ina First Nation. Further information is provided in *Phase 2 Environmental Site Assessment Stressed Vegetation Area LSD 8-26-23-2 W5M Tsuu T’ina First Nation Near Calgary, Alberta*, prepared by Parkland Geo-Environmental Ltd., February 27, 2015.

The Contractor shall be responsible for development and execution of all RMPs, and follow-up actions detailed in the Certain Phase IIs.

Mitigation Measures to be Performed by the Contractor

Ecosystem Component	Potential Project Effect	Mitigation Measures
Soils	Slope stability	<ul style="list-style-type: none"> The Contractor will incorporate geotechnical data and recommendations into the detailed design phase and implement measures to address identified slope stability issues pre-, during and post- construction.
	Soil erosion	<ul style="list-style-type: none"> Develop appropriate site-specific erosion and sediment control (ESC) measures as described in the Department’s “Design Guidelines for Erosion and Sediment Control for Highways” (2003) as part of the Contractor’s ECO Plan. A Certified Professional in Erosion and Sediment Control (CPESC) shall prepare the ESC measures within the Contractor’s ECO Plan. The CPESC shall sign and stamp the ESC plan and will be responsible for ensuring that it is current. The CPESC shall be onsite to oversee ESC controls when work occurs near or is within waterbodies, including wetland and riparian areas.
		<ul style="list-style-type: none"> Stockpiled soils shall be stabilized with approved cover crop species or seed mixtures as soon as possible and no later than one month after stockpiling by seeding or applying tackifier to prevent erosion of soils (see Section 200.2.9). Implement, maintain and monitor ESC measures to stabilize disturbed soils until sufficient vegetation is established. Monitor for revegetation success within the TUC and the Road Right of Way.
		<ul style="list-style-type: none"> Re-vegetate with approved seed mixtures disturbed portions within the TUC within one month following construction and reclamation to stabilize disturbed areas (see Section 200.2.9).
		<ul style="list-style-type: none"> Minimize soil handling, stripping or topsoil replacement during windy and/or rainy conditions.
	Admixing	<ul style="list-style-type: none"> Stripping, grading and replacement and redistribution of topsoil should be scheduled during dry conditions to the extent practicable. Ensure topsoil is salvaged, stored and replaced appropriately during construction. The Contractor’s ECO Plan representative, or designate, will monitor soil handling activities during construction. Topsoil and subsoil will be segregated and stockpiled separately. Topsoil and subsoil stockpiles to be placed at appropriate distances away from wetlands, rivers, streams and stormwater management facilities to ensure no contamination of water resources. Topsoil with elevated gravels should be stockpiled and replaced separately from non-gravelly topsoils. Soils used for reclamation purposes shall be replaced back in same area from which it was originally removed/salvaged. Topsoil will be salvaged and stockpiled separately in the following areas: wetlands, native grasslands, pasture/grazing areas, areas containing weeds and, possibly, areas with rare plants. These topsoils will be replaced from the location from which they were salvaged, except for wetland topsoil which will be used for replacement in depressional areas and for use in replacement wetlands or stormwater ponds as appropriate.
Soils	Admixing	<ul style="list-style-type: none"> Strip to colour change or as directed by the Contractor’s ECO Plan representative. A preconstruction topsoil assessment of the Road Right of Way and TTN Temporary Use Areas shall be conducted to provide further detail regarding appropriate stripping depths and a basis for topsoil storage and replacement calculations.

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Ecosystem Component	Potential Project Effect	Mitigation Measures
		<ul style="list-style-type: none"> • If excess stones are brought to the surface, stones that are larger or in greater abundance than the pre-disturbance condition must be picked, as directed by the Contractor’s ECO Plan representative or designate.
	Rutting and compaction	<ul style="list-style-type: none"> • Strip topsoil over all disturbance areas. • Monitor soil conditions, suspend soil handling under wet or very moist conditions as appropriate and/or as directed by the Contractor’s ECO Plan representative or designate.
		<ul style="list-style-type: none"> • Use appropriate equipment, subsoiling and/or deep ripping followed by discing as needed to alleviate compaction prior to reclamation. (Note: Subsoiling is only effective when the soil is dry enough to shatter, as subsoiling wet soils can lead to deformation and alteration of the soil structure).
	Disturbance of contaminated soils and groundwater	<ul style="list-style-type: none"> • The Contractor shall develop mitigation strategies to ensure the proper management of contaminated soils/groundwater indentified in the Certain Phase IIs, Environmental Site Assessments or otherwise encountered. • Topsoil and subsoils removed from areas identified as possibly UXO contaminated lands shall be stockpiled separately and shall be tested accordingly for contaminants and processed appropriately. • Contaminated soils/groundwater disturbed during construction shall be remediated or disposed of at an appropriate facility; however, re-evaluation of soil and groundwater quality data against Tier 2 guidelines, in particular, accounting for applicable pathway eliminations, is encouraged. The Contractor shall develop risk management plans, in accordance with Alberta Environment draft <i>Contaminated Sites Policy Framework</i> (October 2014) and draft <i>Exposure Control Guidelines</i> (February 2014), to manage residual contaminated soil/groundwater, outside of the construction area, in place.
	Soil contamination caused by construction activities	<ul style="list-style-type: none"> • The Contractor’s ECO Plan shall identify appropriate spill release response procedures to ensure all soil contamination caused by construction activities is cleaned to pre-spill state. • Excess paving and concrete material will be disposed of appropriately (not within the TUC).

Ecosystem Component	Potential Project Effect	Mitigation Measures
Vegetation Native, Riparian and Rare Plant	Vegetation clearing	<ul style="list-style-type: none"> • Explore potential to avoid native plant communities and refine clearing limits. • Clearly mark clearing limits with snow fence or other highly visible flagging. • Revegetation of disturbed and cleared areas to be undertaken as soon as possible (see Section 200.2.9). • Salvage topsoil in areas of native grassland prior to grading and stockpile and replace separately within the TUC, to preserve the seedbed and enhance revegetation of these areas to native species see Section 200.2.9). • Trees shall not be allowed to fall into a water body. Trees and large shrubs within 30 m of a waterbody will be hand cleared only. • No equipment is allowed to cross any waterbody during clearing operation. • Retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation • Apply suitable seed mixes to revegetate disturbed areas; native mixes will be used for areas with native vegetation (see Section 200.2.9). • Consider inclusion of an upland component as part of the wetland replacement plan for the Project. • Monitor revegetation success within the TUC and the Road Right of Way and undertake remedial measures as appropriate. • Monthly vegetation inspections shall occur in order to identify areas where re-seeding is required to meet the requirements in Section 200.2.9. • Prohibit equipment storage, maintenance and refuelling in areas that support native plant communities. • Burning of cleared vegetation will not be permitted.

Ecosystem Component	Potential Project Effect	Mitigation Measures
	Loss of rare plants	<ul style="list-style-type: none"> • A rare plant specialist shall accompany the pre-construction weed survey in order to identify/confirm any rare plants within and adjacent to the construction footprint and flag all locations prior to construction. Alberta Conservation Information Management System (ACIMS) ranks were revised in October 2015 which results in changes to the rare plants identified in the EA. • The rare plant specialist should submit information on the identified ecological community (<i>Elaeagnus commutata</i> riparian shrubland) to the ACIMS for confirmation of merit and determine appropriate site-specific mitigation measures. • Avoid areas with rare plant species wherever possible. The rare plant specialist shall determine appropriate site-specific mitigation measures for all rare occurrences; transplanting should be a last resort. Mitigation may include measures such as: narrowing the right-of-way; gap in spoil pile; separate topsoil salvage; storage and replacement; ramping over; etc. Increased effort should be made to avoid the rarest species (those with S1 and S2 ranks). • Monitor all rare plant occurrences for a minimum of two years, or as regulatory requirements specify, (which ever is more stringent) following reclamation to determine survival. • Only native grass seed mixtures are permitted for use within the Elbow River valley floodplain, Cullen Creek realignment area and the Fish Creek valley floodplain area. No agronomic seed mixtures are permitted for use within these areas. Apply suitable seed mixes to revegetate disturbed areas; native mixes will be used for areas with native vegetation (see Section 200.2.9). • Allow for natural regeneration and succession by preserving native vegetation to the extent possible. • No legumes are to be seeded for any revegetation. • Restrict clearing and construction activities to the TUC limit, utilizing existing disturbed areas to the extent practical.
	Dust	<ul style="list-style-type: none"> • Implement regular watering or other appropriate dust control measures during construction (particularly during grading in windy conditions). • Minimize soil handling involving dumping soil (e.g., backhoe and bucket excavator use) during windy periods. • Tackifier and interim cover crops will be applied on soil stockpiles that are to remain in place for more than one month. • Revegetation of disturbed and cleared areas to be undertaken as soon as possible (see Section 200.2.9). • During construction, the Contractor will conduct regular inspections of the TUC and the Road Right of Way, particularly during windy conditions, to ensure that best practices for dust control are being effectively implemented. These inspections shall be documented and made available to the Department.

Ecosystem Component	Potential Project Effect	Mitigation Measures
	Road salt	<ul style="list-style-type: none"> • Minimize salt use on roadways to the extent practicable. • Include salt-tolerant species in seed mix for ditch areas (e.g., alkali grass) (see Section 200.2.9). • Develop and implement Road Salt Management Plan (RSMP) for the operation and maintenance of the roadways during the Construction Period and the Operating Period. Identify areas of sensitive vegetation and waterbodies/riparian areas within the RSMP and those mitigations to be implemented to minimize impacts. The Elbow River valley and Fish Creek valley are to be specifically addressed within the RSMP. • Avoid snow dumps near sensitive vegetation. No snow dumps will be permitted within the Elbow River valley floodplain or the Fish Creek valley.
	Weed establishment	<ul style="list-style-type: none"> • Preconstruction weed survey to be undertaken to identify and address problem weed areas if any. • Restrict herbicide application in areas that have been reclaimed with native seed or plants, or where spray can drift onto native grasslands, wooded or shrub areas, open water wetlands, riparian habitats or areas within the Elbow River valley floodplain, or the Fish Creek valley. Herbicide application in these areas is to be performed using low-impact methods (e.g., spot application or wicking). • Develop a weed management plan to address long-term weed issues within the TUC and the Road Right of Way during the PNI Operating Period and the Operating Period for “prohibited noxious” or “noxious weeds” in accordance with the <i>Weed Control Act</i> (Alberta) and Weed Control Regulations. Establish priorities regarding the most problematic weed species. • Weed control shall be used on soil stockpiles left for long periods. • Weed control in disturbed areas to be utilized until desired vegetation is established. • Monthly weed inspections are required as part of the weed management plan. Identified problem areas must be adequately addressed within a 30 day period. • Revegetation of disturbed and cleared areas to be undertaken as soon as possible (see Section 200.2.9). • All equipment shall be cleaned of dirt and mud, and be free of weeds prior to entering the project area. Documentation that equipment has been cleaned shall be provided to the Department. • No fertilizer use will be permitted in areas seeded with native vegetation.
		<ul style="list-style-type: none"> • The Contractor shall clean equipment after it has been used in weedy areas before moving into new project areas and shall pay particular attention to parts of equipment where grease and oil can collect. All equipment shall be cleaned prior to working in the Elbow River and the Fish Creek valleys and documentation that equipment has been cleaned shall be provided to the Department.
		<ul style="list-style-type: none"> • Separate soil salvage, storage and replacement in areas of weed infestations. • Monitor for and control Prohibited Noxious and Noxious weeds using appropriate methods on an ongoing basis, during the Construction Period and the Operating Period.

Ecosystem Component	Potential Project Effect	Mitigation Measures
		<ul style="list-style-type: none"> • Control measures may include but are not limited to one or a combination of mowing at appropriate intervals prior to seed dispersal, targeted herbicide application, handpicking, tillage and remedial seeding as appropriate.
	TTN Temporary Use Areas	<ul style="list-style-type: none"> • The Contractor shall document the pre-construction vegetation condition noting the species and location of rare plants, native grasses, trees, shrubs, and weeds. • The Contractor shall develop a planting plan in accordance with the specifications in “Watercourse Realignment Plantings” in Section 200.2.8 (Landscaping) that identifies the approach to replant the area to match pre-construction native vegetative conditions. • Only native grass, shrub and tree species are permitted for replanting within the TTN Temporary Use Area. • The Contractor shall conduct monthly monitoring of planted tree stock for the first growing season following construction and in May, early July and mid-August in the second year following construction. Rooted stock shall have, at a minimum, a survival rate of 85% - 90% for the first year and the Contractor shall replace stock up to that level. The Contractor shall correct deficiencies within two months of discovery. • The Contractor shall conduct a post-construction topsoil assessment to ensure that site conditions are similar to those identified during the pre-construction topsoil assessment and correct any deficiencies.
Wetlands	Decrease in wetland habitat	<ul style="list-style-type: none"> • Explore potential for further avoidance of wetlands during detailed design. Identify all potentially impacted wetlands through site investigation. • Develop a wetland impact assessment and mitigation plan to address potential replacement options for wetland loss as required based on detailed designs and as negotiated with Alberta Environment to achieve “no net loss” of wetland function regionally in accordance with the requirements and objectives of the <i>Water Act</i> (Alberta) and the Alberta Wetland Policy. • Complete wetland replacement plan in support of <i>Water Act</i> (Alberta) and Alberta Wetland Policy and confirm required replacement ratio with Alberta Environment.
		<ul style="list-style-type: none"> • Salvage and stockpile upper surface material (wetland substrate) from wetlands that will be disturbed, for replacement in depressional areas or for use in replacement wetlands or stormwater ponds, as appropriate. Salvage upper surface material separate from the underlying mineral soil. • Salvage upper surface material to a maximum depth of 50 cm or to the depth of colour change where there is less than 50 cm of surface material. • Delay salvage of upper surface material in wetlands until immediately prior to construction. • Stockpile wetland soils separate from other soil stockpiles to avoid admixing. Keep soils moist to maintain the viability of the seebank and root tubers. • Replace salvaged upper surface material over the designated area as evenly as practicable. All efforts should be made to replace wetland soils immediately and to avoid storing wetland stockpiles for extended periods.

Ecosystem Component	Potential Project Effect	Mitigation Measures
		<ul style="list-style-type: none"> • Flag or fence-off any shrubs or trees to be salvaged and replaced at constructed wetlands or stormwater ponds following construction. Store shrubs and trees on the construction site, or near to their final location, in a manner in which they will not dry out before they are replanted. • Flag or fence-off any shrubs where stakes are to be salvaged for replanting at constructed wetlands or stormwater ponds following construction. • Revegetation of disturbed and cleared areas to be undertaken as soon as possible (see Section 200.2.9). • Install shrub staking along the disturbed margins of the wetland or around selected constructed wetlands or stormwater ponds to stabilize disturbance, reduce the potential for sediment introduction and restore habitat function where shrubs were present prior to construction and where directed by the environmental inspector. • The Contractor shall provide an Elbow River stormpond planting plan that identifies the planting prescriptions as identified in Section 200.2.8.
		<ul style="list-style-type: none"> • Protect retained wetlands with a 30 m riparian buffer zone, as practicable. Snow fencing or flagging shall be used to identify the 30m buffer.
	Alteration of hydrological regime	<ul style="list-style-type: none"> • The Contractor’s grading design and installation of overland drainage measures (e.g., ditches, culverts, stormwater management facilities) should maintain surface water flow volumes for retained wetlands. If hydrological regime of any retained wetlands cannot be maintained, account for impacts within the wetland replacement plan.
Wildlife	Decrease in wildlife habitat	<ul style="list-style-type: none"> • Clearly mark clearing limits prior to clearing.
		<ul style="list-style-type: none"> • Implement mitigation measures as described above under ‘Vegetation Native, Riparian and Rare Plant – Clearing’, ‘Vegetation Native, Riparian and Rare Plant – Dust’, ‘Soils – Soil erosion’ and ‘Wetlands – Decrease in wetland habitat’ and below under ‘Mortality Risk’.
	Sensory disturbance	<ul style="list-style-type: none"> • Implement mitigation measures as described under ‘Noise Construction’. • Recreational pathways will not be constructed at the Elbow River or Fish Creek crossings in order to minimize interactions between humans and wildlife.
	Barriers to movement/Fish Creek and Elbow River Crossings	<ul style="list-style-type: none"> • Minimize activity during winter months within Key Wildlife and Biodiversity Zones to avoid displacing wildlife. If clearing and construction activities occur between December 15th and April 30th, implement the following mitigation measures: <ul style="list-style-type: none"> • No construction will take place overnight (e.g., between 1900 and 0600). • The construction crew size will be increased in order to reduce the overall construction time within the Key Wildlife and Biodiversity Zone. • Construction to be initiated prior to December 15th to allow wildlife to adjust to the disturbance and move to other areas of favorable habitat. • Install specialized wildlife fencing as described in Section 200.2.15. • Native grass/shrub/tree plantings and seeding will be established under the Elbow River at the Weaselhead bridge, the Elbow River at Highway 8

Ecosystem Component	Potential Project Effect	Mitigation Measures
		<p>bridge, and at Fish Creek bridge, and along the Fish Creek and Elbow River at Weaselhead stream realignments and in the associated TUs to facilitate wildlife movement. The Contractor shall provide detailed planting designs that meet the requirements of the Environmental Assessment for the Southwest Calgary Ring Road (Updated December 2014) Elbow River Bridge Crossing Wildlife Planting Concept (Figure 3.5-17a), the Fish Creek Bridge Crossing Wildlife Planting Concept (Figure 3.5-17b) and the Twinning of Highway 8: Highway 22 to Calgary Western City Limits Environmental Evaluation (dated February 2014).</p> <ul style="list-style-type: none"> • Establish wildlife movement corridors under the Elbow River and Fish Creek bridges as per Sections 200.2.3.7.4, 200.2.3.7.5 and 200.2.3.7.9. • Recreational pathways will not be constructed under the Elbow River and Fish Creek bridge crossings to minimize interactions between humans and wildlife. • Amphibian movements shall be considered in the design of culverts along ephemeral drainages to facilitate amphibian movement between breeding habitats. <p>The Contractor shall retain a professional biologist (a member in good standing with the Alberta Society of Professional Biologists) to ensure wildlife movement is not impeded during construction at both the Elbow River and Fish Creek crossings. A monitoring report shall be submitted monthly and shall address the items listed below:</p> <ul style="list-style-type: none"> • Verification that any mitigations developed to reduce barriers to wildlife movement during construction are implemented and functioning as intended; • Verification that mitigations to facilitate wildlife movement during operations (e.g., vegetation plantings and seeding) are installed in accordance to the requirements of the Technical Requirements; and • Identification of any deficiencies in not meeting conformance to the Technical Requirements as they relate to wildlife considerations and a description of corrective actions taken. <p>The Contractor shall retain a professional biologist (a member in good standing with the Alberta Society of Professional Biologists) to ensure wildlife movement is not impeded during operations at both the Elbow River and Fish Creek crossings. Monitoring shall commence following the completion of construction and last for a period of 36 months. A monitoring report shall be submitted quarterly (i.e., seasonal) and shall address the items listed below. The Contractor may choose to enter into partnerships with local environmental groups for monitoring activities that occur after RNI Traffic Availability. The wildlife monitoring reports shall contain the following information:</p> <ul style="list-style-type: none"> • Species identification and frequency of use of wildlife movement corridors at the Elbow River and Fish Creek crossings; • Verification that mitigations implemented for wildlife movement corridors (e.g., vegetation plantings and seeding) are viable and functioning as intended; • Identification of any human foot traffic and/or dog presence within the TUC within the Elbow River or Fish Creek valleys; • Identification of any deficiencies in not meeting conformance to the Technical Requirements as they relate to wildlife considerations and a description of corrective actions taken; and • Identification of constraints that are impacting wildlife movement for relevant species and recommendations for improvement.
	Mortality risk	<ul style="list-style-type: none"> • Prohibit harassment of wildlife during construction.

Ecosystem Component	Potential Project Effect	Mitigation Measures
		<ul style="list-style-type: none"> • Maintain ability for wildlife passage during construction • Vegetation clearing will not occur between April 12 and August 30 of any given year to avoid breeding season for non-migratory and migratory birds; prevent disturbance to breeding amphibians; reduce sensory disturbance unless permission has been given to the Contractor to do so by a professional biologist (a member in good standing with the Alberta Society of Professional Biologists) upon the results of relevant surveys, and contact with the appropriate regulatory agency for permitting requirements. • The dens of specified animal species are protected under the <i>Wildlife Act</i> (Alberta). The nests of migratory birds are protected under the <i>Migratory Birds Convention Act</i> (Canada). If an active den or bird nest is identified within the corridor prior to or during clearing or construction activity, consult with Alberta Environment to determine the appropriate mitigation. Avoidance or mitigation measures may be required and may include monitoring the den or nest and/or modifying the construction schedule to avoid activity until the den or nest is inactive. • The timing restriction of April 15th to August 15th will also prevent disturbance to breeding amphibians. In the event clearing or construction activities occur within this period, obtain the appropriate permit in the event that amphibians may need to be moved off the construction footprint during construction and/or an amphibian salvage from a breeding pond is required. Contact the appropriate regulatory agency for permitting requirements, and discuss the salvage plan with Alberta Environment prior to this activity. • Install lighting and signage at locations with a high risk of vehicle-wildlife collisions. • Develop and implement an animal-vehicle collision (AVC) Plan that records the dates, locations, and types of animals involved in AVCs during construction and operations. AVC reports are to be submitted to the Department every six months. • Report AVCs to the nearest Alberta Environment office in cases where an animal is injured or poses a threat to public safety. • Conduct searches for roosting bats, bat colonies and hibernacula, and nesting birds prior to demolishing old buildings or bridge works. The searches are to be conducted by a professional biologist (a member in good standing with the Alberta Society of Professional Biologists) and the results and recommendations shall be documented. • Keep ditches clear of debris and tall vegetation to improve visibility and avoid providing cover for wildlife along the roadways. Improve line-of-sight on either side of the highway by maintaining wide ditches with low-lying vegetation. • Ensure waste management plans are adhered to at all times to prevent attraction of wildlife to work sites. • Fence in disposal and wastewater areas and any accidental spill sites to prevent wildlife access. • Prohibit feeding and/or harassment of wildlife during construction activities. • Prohibit firearms and pets and do not allow any hunting, trapping or fishing on the project site during construction activities.

Ecosystem Component	Potential Project Effect	Mitigation Measures
Fish and Fish Habitat	Elbow River / Fish Creek / Cullen Creek Realignment	<ul style="list-style-type: none"> • Implement appropriate mitigation as described under ‘Fish and Fish Habitat Ecosystem Component’ • The Contractor shall survey the existing channels to obtain length, cross-section, curvature, natural morphology, and slope information. • The realigned channels shall match the length of the proposed realigned channels as shown on Drawings 18-A-03.05SW, 18-A-03.08SW, and 18-A-03.11SW in Appendix A, and match the flow characteristics, curvature, natural morphology, cross-section and slope of the existing Elbow River/Cullen Creek/Fish Creek channels. • The Contractor’s design of the realigned Elbow River/Cullen Creek/Fish Creek channels shall not result in negative effects to the watercourses or fish habitat (e.g., erosion, scour, sedimentation, etc.) upstream or downstream of the proposed realignments, including for lands outside of the TUC. • The realignment shall occur within the TUC/Road Right of Way at the Elbow River at Weaselhead Crossing. The realignment at Fish Creek is to occur within the TUC/Road Right of Way and the TTN Temporary Use Area. The realignment of the Elbow River at Highway 8 shall occur within the bed and shore of the existing river. • The channels at Elbow River at Weaselhead, Fish Creek and Cullen Creek are to be constructed one year in advance of activation see Section 200.2.8). • Bioengineering treatments shall be installed and maintained one year in advance at the realignments of Elbow River at Weaselhead, Fish Creek and Cullen Creek (see Section 200.2.8). • The Contractor shall develop a plan that describes the details regarding the opening of the Elbow River at Weaselhead, Cullen Creek and Fish Creek channel realignments. Fisheries, water quality, and navigational resources must be addressed within the plan as well as the mitigations the Contractor will have in place. This plan is due to the Department 60 days prior to the scheduled opening of the realignments.
	Infilling of old stream bed	<ul style="list-style-type: none"> • Contractor shall, in accordance with applicable law, obliterate the existing channel for the extent of the stream segment which is realigned. The existing channel under the highway footprint will be filled with clean engineered fill consisting of low to medium plastic clay or clay till material that is suitable for founding the construction and operation of current and future highway lanes. The remainder of the existing channel outside of the highway footprint is to be infilled with native materials salvaged from within the floodplain (i.e. from the excavation of the excavation of the realigned stream channels). • The fill shall be placed and compacted in accordance with the Technical Requirements for roadway embankments. • The backfill material shall be placed in the channel at least to an elevation equal to the top of banks, except to greater depth as required to comply with design requirements, and with environmental or with jurisdictional requirements, and when one bank elevation is higher than the other the top of fill shall transition uniformly from one side of the infilled channel to the other side. • Except where roadway construction occurs on top of the infill the infill shall be topsoiled and reseeded and replanted to match the pre-construction existing vegetation conditions unless the Technical Requirements require alternative treatment, and in accordance with authorizations, permits, approvals or other consent as required by applicable law. • Contractor is advised of the possibility of unsuitable soil material such as organics or other materials underlying the channel bed. All unsuitable channel bed material shall be removed and replaced with engineered fill where required to ensure geotechnical stability of the highway. Unsuitable

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Ecosystem Component	Potential Project Effect	Mitigation Measures
		material shall be disposed of in accordance with the Technical Requirements
Navigational Safety		<ul style="list-style-type: none"> • For non-scheduled navigable waters the Contractor must ensure that the public right to navigation is maintained during all periods of open water. The Contractor is required to maintain safe passage of navigation through that portion of the watercourse that is subject to work activity. The Contractor’s activities cannot change a vessel’s passage in a significant way or make it more dangerous to navigate. • Contractor shall not permit any tools, equipment, vehicles, temporary structures or parts thereof used or maintained for the purpose of building or placing the bridge structures in the water to remain after the completion of the instream construction period. • Where the work or a portion of the work is being constructed or maintained in the water that causes material to be placed or debris to accumulate on the bed or on the surface of the water, the Contractor shall remove all debris or other materials (e.g. rock used for berm protection). • The Contractor shall conduct pre- and post-construction surveys of the bed(s) in order to verify that the streambed(s) has been restored and that post-construction streambed profiles do not create additional navigational hazards when compared to the pre-existing condition. • The Contractor shall identify a strategy to address issues that arise with stakeholders during the instream construction period including, but no limited to, site security and public complaints. Any complaints received from the boating public shall be forwarded to the Navigation Protection Program. • The Contractor shall identify a strategy that includes the scope and schedule/frequency for monitoring, inspecting and reporting on all components of the navigational safety plan during the instream construction period. This includes the type of information to be collected and method and timing that the inspection information will be reported to the Department. • During the PNI Operating Period and the Operating Period the Contractor is required to remove any project related debris that may cause a hazard to navigational safety. If the debris is a pre-existing condition the debris shall be removed. • During the instream construction period the Contractor shall ensure that warnings signs are placed adjacent to the work site and shall meet the following criteria: <ul style="list-style-type: none"> • Signs shall be located in a visible location 250 m upstream and 250 m downstream of the bridge structures until completion of the instream bridge construction period. • Signs measuring 4’ x 8’ shall include the message “CAUTION BRIDGE CONSTRUCTION AHEAD” and shall be oriented to warn approaching river traffic of the construction site. • Lettering shall be Arial font and letter sizing shall be as large as possible to fit on the sign panel. • Black lettering shall be displayed on a reflective yellow background with sheeting meeting ASTM D4956 Type III or IV retro-reflectivity requirements. • Signs shall be maintained in the proper location and kept clear of debris throughout all periods of open water. • A copy of the navigational safety plan and any approval from the NPP shall be available on site at all times throughout the Construction Period
	Standard Mitigation for Working Near Water	<ul style="list-style-type: none"> • Implement appropriate precautions to prevent deleterious substances (e.g., gasoline, sediment, oil, wet concrete, etc.) from entering

		<p>watercourses. Cleaning, fuelling and servicing of equipment cannot be conducted in an area where spills or wash water may contaminate surface water or groundwater resources.</p> <ul style="list-style-type: none"> • A spill management plan (“SMP”) will be developed to describe measures for spill prevention and emergency spill response including, but not limited to spill control and response measures. The SMP shall form part of the Contractor’s ECO Plan. • An appropriate emergency spill kit is to be available at all times. • Store spoil and waste materials removed from the proposed crossing above the high watermark. Stabilise this material, if warranted, to minimise the potential for runoff events to transport them into the waterbody. • Biodegradable oils and lubricants are to be used in equipment whenever possible. • Clean all equipment entering the project site prior to arrival. It shall also be cleaned after construction to ensure it does not transfer mud, debris, invasive plants or aquatic pests (e.g., <i>Myxobolus cerebralis</i> - the parasite that causes whirling disease in fish). • Install and maintain appropriate erosion and sediment control methods to prevent sediments from disturbed areas from being transported into watercourses. This should include the management of slopes adjacent to each watercourse. • Correspondence from regulatory agencies (e.g., FAOC) may result in additional conditions and measures on the proposed works that will need to be incorporated into the mitigation program. • Prevent construction materials and debris from entering watercourses. • Soil stockpiles must be located away from watercourses and slopes. • Make every reasonable effort to minimize the duration of instream work and ensure construction is halted during heavy rains. • Review all mitigation and regulatory requirements prior to construction to ensure that all mitigation requirements are understood and can be implemented. • Do not store fuel, oil or hazardous material within 100 m of a wetland or other waterbody. • Conduct refuelling a minimum of 100 m from any wetland or other waterbody, where feasible. Where equipment refuelling is necessary within 100 m of a wetland, ensure that: <ul style="list-style-type: none"> ○ all containers, hoses and nozzles are free of leaks; ○ operators are stationed at both ends of the hose during fuelling unless the ends are visible and readily accessible by one operator; and ○ fuel remaining in the hose is returned to the storage facility. • Do not wash equipment or machinery in any waterbody. Control wastewater from construction activities, such as equipment washing, to avoid discharge directly into any waterbody.
	<p>Blockage of Fish Movement / Fish Mortality or Injury during Instream Construction Activities</p>	<ul style="list-style-type: none"> • Crossings at fish-bearing watercourses will be designed to allow for fish passage at all times and a monitoring plan during construction shall be developed and implemented. • Assign a qualified aquatic environmental specialist (“QAES”) to conduct a fish salvage from the isolated area prior to and during dewatering where isolated crossing techniques are used. In addition, fish salvage is undertaken on any bypass structures such as diversion channels and flumes prior to them being dewatered after use. • A Fish Research License is required from Alberta Environment for fish salvage activities. • Fish salvage shall be conducted according to permit requirements, including but not limited to using an effective method (e.g. seine netting, electrofishing, minnow traps), capture and handling procedures are designed to minimize mortality, and release of captured fish to pre-determined areas of similar or better habitat where possible, preferably downstream of the work site.

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		<ul style="list-style-type: none"> • Maintain the quantity and quality of stream flow throughout crossing construction. • Restrict water withdrawal to less than 10% of the stream flow of the watercourse at the time of withdrawal or as otherwise specified by the appropriate regulatory agency. • Project personnel are not permitted to hunt or fish on the work site. • Consult with a QAES to ensure upstream and downstream fish migration is accommodated at all times during both the Construction Period and Operating Period.
	Alteration or loss of riparian habitat function	<ul style="list-style-type: none"> • Disturbance of riparian vegetation shall be kept to a minimum. • Revegetation of realignments to occur a minimum of one year prior to construction or as regulatory requirements dictate (the more stringent shall apply). • Prohibit brushing of extra temporary workspace within the riparian buffer. • Surface stability shall be promoted by leaving vegetation undisturbed in areas not exposed to construction. • Clearing shall be immediately before construction is scheduled to start. • Follow spill management plan mitigations when working near water.
	Alteration or loss of instream habitat function	<ul style="list-style-type: none"> • The Contractor should initiate discussions with regulatory bodies such as FAOC and Alberta Environment to discuss the requirements in regards to an application for authorization, offsetting opportunities and monitoring program. • All necessary approvals required for a particular activity or construction-site will be obtained, by the Contractor, prior to the commencement of the applicable activity or construction at that site. • Construct watercourse crossings in accordance with applicable existing provincial and federal guidelines and conditions of the <i>Fisheries Act</i> (Canada) authorization. • Abide by applicable instream restricted activity periods . No instream construction activity will occur within the instream restricted activity period at any watercourse, unless the watercourse is dry or frozen to the bottom at the time of construction or approval has been granted by the QAES and the appropriate regulatory agencies. • Ensure water from flumes, pump-around, diversions or other methods used to maintain downstream flow does not cause erosion or introduce sediment into the channel. Examples of options for preventing erosion include flow dissipaters, protection of the substrate with geotextile, and releasing water onto vegetation if it can be done without erosion. • If a pump-around method is used to maintain downstream flow, back-up pumps with adequate capacity to maintain 100% of downstream flow at all times are on-site and ready to take over pumping if the operating pumps fail. The pumps are continually monitored to ensure downstream flow is maintained at all times until the isolation materials are removed and normal flows restored to the channel.

	<p>Construction related sedimentation and/or contaminant release (Water Quality)</p>	<ul style="list-style-type: none"> • A water quality monitoring plan shall be developed by a QAES to monitor turbidity (e.g., documenting nephelometric turbidity units) and total suspended solids (TSS) concentrations during construction activities in or near water. This plan should be used to direct construction activities, and to inform decisions about timing and sequencing of construction. If monitoring reveals construction activities are causing potentially harmful sediment events, additional mitigation will be required or construction activities will be halted until turbidity and TSS levels return to background. • Ensure turbidity levels and TSS concentrations do not exceed guidelines provided by the Canadian Council of Ministers of the Environment (CCME) and Environmental Quality Guidelines for Alberta Surface Waters. • A QAES shall be on-site during instream construction to ensure regulatory compliance and provide environmental protection advice. • Notify the emergency contacts, including the appropriate regulatory agencies if sediment-laden water or other deleterious substances enter the watercourse. • During construction and until revegetation is sufficient to prevent sediment erosion, ensure effective sediment and erosion control measures are in place, functioning properly, and are maintained and/or upgraded as required to prevent sediment from entering fish habitat. • Ensure sediment laden water in coffer dams sufficiently settles prior to pumping water back into the watercourse. • Any water removed from an isolation area, must be discharged in a manner that ensures suspended sediments are not introduced into a water body. • The Contractor shall control the water from their site and shall only release water into a waterbody when the quality of the water being released is equal to or better than the quality of the receiving waterbody. Each release of water from the project site must be detailed in the Contractor’s ECO Plan. • Excavated materials, debris and spoil materials must be disposed of above the ordinary high water mark and located such that they do not enter any watercourse. • All fill material must be obtained from off-site and not from below the ordinary high water mark of any watercourse. • If riprap is used, the riprap is clean, free of fine materials, and of sufficient size to resist displacement during design flood events. Riprap is placed at the original streambank grade to ensure that there is no infilling or narrowing of the watercourse at the crossing site. • Interim sediment and erosion control structures shall be maintained until the vegetation is established. • All riprap is to be washed prior to installation. No washing activities are permitted within the Elbow River valley floodplain, the Fish Creek valley or Cullen Creek valley.
<p>Post Construction / Operation</p>	<p>Deleterious substance release from bridges over fish bearing water bodies</p>	<ul style="list-style-type: none"> • Meet with relevant federal and provincial regulators to discuss bridge deck drainage strategies in order to acquire the pertinent authorizations/approvals. • No through deck drainage is permitted on any new bridge structures that are constructed over the Elbow River, Fish Creek and Cullen Creek.
<p>Hydrology Construction</p>	<p>Contaminant release</p>	<ul style="list-style-type: none"> • A spill management plan (“SMP”) will be developed to describe measures for spill prevention and emergency spill response including but not limited to spill control and response measures. The SMP shall form part of the Contractor’s ECO Plan. • Provide appropriate measures for spill containment in fuel storage and servicing areas and include these measures in the SMP. • Train all personnel working on the Project regarding spill response and ensure appropriate spill kits are available near work areas. • Refuelling, maintenance and hazardous materials storage will not be permitted near any water body or in areas supporting native plant communities.

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		<ul style="list-style-type: none"> • Clearing shall be immediately before construction is scheduled to start.
	Sedimentation	<ul style="list-style-type: none"> • A CPESC shall prepare, approve, and implement the erosion and sediment control plan within the Contractor’s ECO Plan. The CPESC shall be on site whenever activities are being conducted within waterbodies or within riparian zones. • Surface stability shall be promoted by leaving vegetation undisturbed in areas not exposed to construction. • Soil stockpiles will be located away from watercourses and slopes. • Implement mitigations as described above under ‘Soils – Soil erosion’. • Implement standard erosion control techniques on open slopes. • Monitor and maintain erosion and sedimentation controls until vegetation established. • Implement appropriate erosion and sediment control measures for works adjacent to or which might potentially affect water bodies. • Vegetate ditches to provide detention for settling out of sediments upstream of stormwater management facilities and ultimately prior to discharge into natural drainages. • Vegetation will be established on disturbed areas immediately after construction. • Standard erosion control techniques will be kept in place until vegetation is established. • Monitoring and maintenance of erosion and sedimentation controls will be undertaken until vegetation established.
	Alteration of drainage patterns	<ul style="list-style-type: none"> • Maintain surface flows to wetlands retained within the TUC; develop replacement options as part of the wetland replacement plan as required, if hydrology of any wetlands will be altered. • Maintain existing hydrologic connections. • Confirm requirements for permanent slope drainage during detailed design. • Identify and confirm groundwater discharge and recharge areas.
	Interaction of stormwater management with existing adjacent municipality stormwater systems	<ul style="list-style-type: none"> • Communicate with the Local Authority drainage services, to confirm design compatibility as required.
Hydrology Operation	Increased stormwater release	<ul style="list-style-type: none"> • Design of stormwater management facilities in accordance with the Technical Requirements to maintain runoff volumes and control release rates based on 1:100 yr storm runoff.
	Contamination of waterbodies caused by roads/bridge deck runoff	<ul style="list-style-type: none"> • Meet with relevant federal and provincial regulators to discuss bridge runoff strategies in order to acquire the pertinent authorizations/approvals.
Groundwater Construction	Impacts to groundwater levels due to dewatering activities	<ul style="list-style-type: none"> • Visibly mark and/or fence off any known spring and well locations. • Avoid any known springs and water supply wells during construction; if other springs, water supply wells or other such features are encountered during construction, limit heavy equipment use and disturbance in proximity to the springs, water supply wells, or other such features to the extent practicable and install appropriate engineering controls to maintain groundwater flow. • Determine appropriate pumping rates and durations in areas with local shallow wells or dugouts. • Negotiate replacement for affected wells, if required

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	Seepage from cuts	<ul style="list-style-type: none"> • During detailed design, develop measures to manage potential seepage, such as blanket drains and trench drains. • Minimize cuts below groundwater table during detailed design
Groundwater Operations	Changes to local shallow groundwater flow regime	<ul style="list-style-type: none"> • Implement appropriate engineering controls such as drains to maintain groundwater flow. • Design, locate and construct stormwater management facilities so as to maintain surface drainage patterns and release at controlled rates. Stormwater shall be released within the same catchment area as the area in which such stormwater originates and within the range of natural flows.
Water Quality Construction	Runoff and sediment transport	<ul style="list-style-type: none"> • Implement mitigations as described above under ‘Hydrology Construction – Sedimentation’ and ‘Soils – Soil erosion’. • Monitor surface water quality as appropriate for construction activities near water.
	Release of contaminants	<ul style="list-style-type: none"> • Implement mitigation measures as described above under ‘Hydrology Construction – Contaminant release’. • Stormwater management facilities will be designed to contain hazardous spills until spill response protocols can be implemented.
Water Quality Operations	Stormwater runoff	<ul style="list-style-type: none"> • Utilize existing and proposed stormwater management facilities. • The design and construction of stormwater management facilities shall be in accordance with the Technical Requirements to maintain runoff volumes and control release rates. • Stormwater management facilities will be designed to contain hazardous spills until spill response protocols can be implemented.
Air Quality Construction	Dust and smoke created by construction activities	<ul style="list-style-type: none"> • Burning of cleared vegetation is not be permitted. • Implement winterization measures on stockpiles and right-of-way. • Reduce construction vehicle speed during dry, windy periods. • Minimize soil handling during periods of high wind. • Alberta Environment’s Codes of Practice for Asphalt Paving Plants and Code of Practice for Concrete Producing Plants will be followed with respect to asphalt and concrete batch plant emissions.
Socio-Economics and Land Use Construction	Communities (noise and dust)	<ul style="list-style-type: none"> • Implement mitigation measures as described above under ‘Vegetation Native, Riparian and Rare Plants – Dust’ and ‘Soils – Soil erosion’. • The Contractor must adhere to the hours of work unless an exemption is granted by the Department. • Consider use of vibratory or enclosed-hammer pile drivers during pile driving.
	Transportation	<ul style="list-style-type: none"> • Implement traffic accommodation measures (e.g., detours, local access relocations and signage, along with public information and notices) to minimize effects on traffic congestion and maintain traffic flow.
	Recreation and pathways	<ul style="list-style-type: none"> • Manage public access to the TUC and the Road Right of Way to ensure safety.
	Public safety	<ul style="list-style-type: none"> • Implement traffic accommodation measures (e.g., detours, local access relocations and signage, along with public information and notices) to minimize effects on traffic congestion and maintain traffic flow. • Provide notice to commuters and residents adjacent to the TUC and the Road Right of Way of construction-related traffic and safety issues. • Manage public access to the TUC and the Road Right of Way to ensure safety.

Socio-Economics and Land Use Operation	Recreation and pathways	<ul style="list-style-type: none"> Operate new pathway connections in accordance with the Technical Requirements (see Section 400.4.7.8).
Historical Resources Construction	Inadvertent impacts to unrecorded historical resources during construction	<ul style="list-style-type: none"> Suspend construction in area of any discovered historical or archaeological artifact or palaeontological resource and contact Alberta Culture & Tourism (“ACT”) or The Royal Tyrrell Museum for required course of action before proceeding further. and also inform the Department. Conduct all activities in accordance with ACT approvals that pertain to the work.
Burial Site Protocol	Inadvertent impacts to unrecorded burial sites during construction and/or discovery of unrecorded human remains	<ul style="list-style-type: none"> Follow the requirements contained within Appendix K - Burial Site Protocol
Noise Construction	Increased noise from construction equipment	<ul style="list-style-type: none"> Consider use of vibratory or enclosed-hammer pile drivers during pile driving.
Noise Operation	Noise levels in excess of 65 dBA Leq(24 hr)	<ul style="list-style-type: none"> Install noise attenuation barriers between the roadway and adjacent residential areas as required in accordance with the Technical Requirements 200.2.14.
Lighting Operation	Increased illumination of non-TUC areas	<ul style="list-style-type: none"> Lighting will be located adjacent to all roadways to ensure driver safety. Where feasible, lighting will be used that minimizes lighting spill outside the Road Right of Way (see Section 200.2.6 Lighting).

200.2.13.1 Watercourse Realignment

Further to the requirements noted in the Mitigating Measures in the previous Section 200.2.13, the Contractor shall also ensure that the following construction and operating requirements are met for the watercourse realignment activities.

Navigational Measures

The following navigational safety items shall be implemented during Construction Period and the Operating Period:

1. For non-scheduled navigable waters the Contractor must ensure that the public right to navigation is maintained during all periods of open water. The Contractor’s activities cannot change a vessel’s passage in a significant way or make it more dangerous to navigate. The Contractor is required to maintain safe passage of navigation through that portion of the watercourse that is subject to work activity. The mitigation measures implemented by the Contractor must ensure that ongoing passage of known vessel usage is maintained at all times during open water.
2. Clearly illustrate the portions of the Elbow River and Cullen Creek that are to remain open for navigation throughout the different phases of construction. These drawings shall also identify the safety features to be implemented to protect both upstream and downstream navigation during the Construction Period and the Operating Period.

3. The Contractor shall not permit any tools, equipment, vehicles, temporary structures or parts thereof used or maintained for the purpose of building or placing the bridge structures in the water to remain after the completion of the instream construction period.
4. Where the work or a portion of the work is being constructed or maintained in the water that causes material to be placed or debris to accumulate on the bed or on the surface of the water, the Contractor shall remove all debris or other materials (e.g. rock used for berm protection).
5. The Contractor shall conduct pre- and post-construction surveys of the bed(s) in order to verify that the streambed(s) has been restored and that post-construction streambed profiles do not create additional navigational hazards when compared to the pre-existing condition.
6. During the instream construction period the Contractor shall ensure that warnings signs are placed adjacent to the work site and shall meet the following criteria:
 - a. Signs shall be located in a visible location 250 m upstream and 250 m downstream of the bridge structures until completion of the instream bridge construction period.
 - b. Signs measuring 4' x 8' shall include the message "CAUTION BRIDGE CONSTRUCTION AHEAD" and shall be oriented to warn approaching river traffic of the construction site.
 - c. Lettering shall be Arial font and letter sizing shall be as large as possible to fit on the sign panel.
 - d. Black lettering shall be displayed on a reflective yellow background with sheeting meeting ASTM D4956 Type III or IV retro-reflectivity requirements.
 - e. Signs shall be maintained in the proper location and kept clear of debris throughout all periods of open water.
7. Identify the strategy to address issues that arise with stakeholders during the instream construction period including, but not limited to, site security and public complaints. Any complaints received from boating public shall be forwarded to the Navigation Protection Program.
8. Include the scope and schedule/frequency for monitoring, inspecting and reporting on all components of the navigational safety plan during the instream construction period. This includes the types of information to be collected and method and timing that the inspection information will be reported to the Department.
9. During the PNI Operating Period and the Operating Period the Contractor is required to remove any debris that may cause a hazard to navigational safety. If the debris is a pre-existing condition the debris shall be removed immediately if it has the ability to interfere with navigation.
10. A copy of the navigational safety plan and any approval from the Navigation Protection Program shall be available on site at all times throughout the Construction Period.

Additional armouring for Fish Creek shall be provided to protect the unstable bank and the grave site located within LSD 7-1-23-2 W5M (UTM (11U) 700476 5645656).

The following mitigation measures shall be implemented by the Contractor in the key wildlife and biodiversity zones (Elbow River/Fish Creek):

1. Construction activities will not take place overnight (between 7:00 p.m. and 6:00 a.m.);
2. Construction crew size will be increased within the key wildlife biodiversity zones in order to reduce the overall construction time within the river valleys;
3. Construction will be initiated prior to December 15th to allow animals to adjust to the disturbance and move to other areas of favourable habitat before they enter into a period of negative energy balance;
4. The crossings/river realignments will incorporate the planting of a variety of native grasses/shrubs/trees in order to facilitate wildlife movement, and to provide cover and rest habitat;
5. No legumes are to be seeded for any re-vegetation;
6. Recreational pathways will not be constructed through the bridge crossings to minimize interactions between humans and wildlife;
7. Wildlife fencing shall be installed to prevent wildlife from entering the Right of Way to assist in minimizing animal-vehicle collisions; and
8. Bridge structures, in conjunction with the wildlife fencing, will be designed to maintain wildlife passage along these important local/regional movement corridors.

200.2.14 NOISE ATTENUATION

The Contractor is responsible for all road traffic noise attenuation for the New Infrastructure.

The Contractor shall ensure that the maximum noise level of 65 dBA Leq₂₄ (A-weighted 24 hour equivalent sound level) measured 2 metres inside the affected residential property line is adhered to. If the threshold is exceeded, the Contractor shall implement noise mitigation measures. Monitoring and measurement to determine where and when noise mitigation measures are required shall be generally completed in accordance with Section 400.4.9 (Road Traffic Noise Mitigation (New Infrastructure Only)). The mitigation of noise issues could include constructing noise walls or berms. The mitigation must be broadly supported by the affected residents. If noise mitigation is required the minimum height implemented shall be 1.8 m.

Where a new residential subdivision is constructed (after October 1, 2015) adjacent to the New Infrastructure, the new residential subdivision development proponent will be responsible for noise attenuation in respect to that new residential subdivision.

The Contractor's responsibility for noise mitigation applies up to and including Mainline AADT volumes of 167,000 vehicles per day, to be determined in accordance with Section 200.3.1 (Traffic Volume Payment Adjustments).

200.2.15 FENCING

Fencing shall be consistent with the Department’s approach on other areas of the Calgary Ring Road already constructed. The fencing shall be installed to separate the Lands from the rest of the TUC or to delineate the Road Right of Way. For areas adjacent to existing residential developments, the fence shall be the Department’s Class E Standard as shown on Standard Drawing CB6-2.12M5 in Alberta Transportation’s CB-6 Manual (Highway Standard Plate), modified by replacing the two strand barbed wires (four point galvanized 2.5 mm thick strands) at the top of the fence with two strand 3.35 mm thick galvanized wire. In all other locations, the fence shall be the Department’s Class B fence as shown on Standard Drawing CB6-2.12M2 in Alberta Transportation’s CB-6 Manual (Highway Standard Plates). Notwithstanding the aforementioned requirements, the Contractor shall construct a Class H, 1.8 m high chain link fence at the TUC boundary adjacent to the Grey Eagle parking lot. The extent of the chain link fence shall be as shown on Drawing 18-A-03.09SW in Appendix A, generally described as extending from the northwest corner of the existing parking lot to the southeast corner of the existing parking lot.

The Contractor must obtain the prior written approval from the Department for the proposed fence lines. The fenced areas must be of a practical size and dimension with free and clear access so that lease potential or other future uses of the rest of the TUC have not been compromised.

The Road Right of Way shall be fenced and the fencing shall extend to the TUC boundaries at the crossroads. Any stormwater management facilities outside the Road Right of Way shall also be fenced.

Access to the utility components shall be controlled by gates. The Contractor shall install gates at various locations throughout the fence line so as to permit ease of access to the utility components, ensuring that no area is inaccessible. Gates shall be large enough to accommodate passage of vehicles, equipment, utility vehicles and farm equipment. The Contractor shall obtain prior written approval from the Department for gate types, sizes and locations. TUC access will be permitted from the crossroads only. No access points will be permitted from the Mainline or its associated entrance and exit ramps.

200.2.15.1 Wildlife Fencing

The Contractor shall supply and install wildlife fence as shown on the sketch titled “Wildlife Fence Details” in Appendix B Part 2. The wildlife fence shall be located as shown on Drawings 18-A-03.01SW to 18-A-03.11SW inclusive in Appendix A. Generally the wildlife fence will be located in the Elbow River valley and the Fish Creek valley.

200.2.16 PREFERENTIAL BRIDGE DECK ICING

The Contractor shall address the prevention of preferential bridge deck icing on the following bridges (the “**PBD Bridges**”) in the Preferential Bridge Deck Icing Plan (as defined in Section 100.2.9):

- The Elevated Directional Ramp bridge(s) at Sarcee Trail;
- The Elevated Directional Ramp bridge(s) at Anderson Road;
- The Elevated Directional Ramp bridge(s) at Highway 22X;
- The Elevated Directional Ramp bridge(s) at Macleod Trail;
- The river bridges carrying Mainline Calgary Ring Road over the Elbow River;
- The river bridge carrying Mainline SB Calgary Ring Road over the Fish Creek;
- All bridges, other than crossroads, that have resultant bridge deck slopes greater than 4% at any point along their length. For this purpose the bridge length shall be considered to be the distance between abutment centrelines (the resultant bridge deck slope is the vector sum of the longitudinal grade and the crossfall); and
- All bridges that are located in areas where changes in traffic speed are required.

The PBD Bridges that are part of the New Infrastructure (the “**PBD Bridges (NI)**”) will be fitted with the Road Weather Information Systems (“**RWIS**”) by the Department’s then current RWIS contractor (the “**RWIS Contractor**”). The Contractor acknowledges having been provided with and having reviewed a copy of RWIS contracts without the bid prices in effect as of Execution of the DBFO Agreement.

The Contractor shall permit the RWIS Contractor to complete, prior to Traffic Availability, the installation and commissioning of RWIS on the PBD Bridges (NI).

For each of the PBD Bridges (NI), the RWIS Contractor shall be permitted by the Contractor to install sensors in the pavement approaching the applicable bridge and on the bridge itself and install RWIS tower structures in the Road Right of Way, in locations determined by the RWIS Contractor, acting reasonably.

Once the RWIS on the PBD Bridges (NI) is commissioned and operational, the Contractor shall be entitled to receive weather forecasts from the RWIS Contractor on the same terms and conditions as the Department’s other highway maintenance contractors do under the then current RWIS contract. The Department assumes no responsibility for the Contractor’s use of such weather forecasts. The Department contact for information about the weather forecasts is:

Allan Lo, P.Eng.
Intelligent Transportation Systems and Traffic Safety Specialist
Alberta Transportation
Telephone: (780) 415-1021.

The Contractor shall:

- (a) provide all reasonable cooperation with the RWIS Contractor in respect of the installation, operation, maintenance, or rehabilitation of the RWIS for the New Infrastructure (the “**RWIS Work**”);
- (b) coordinate and schedule the Project or the O&M, as applicable, in such manner as will facilitate the RWIS Work;
- (c) if and as often as it becomes aware of deficiencies in the RWIS Work as will materially

- adversely affect or interfere with the Project or the O&M, as applicable, or the obligations of the Contractor under the DBFO Agreement, immediately provide the Department with notice, including reasonable details, of those deficiencies;
- (d) without limiting (a) and (b) above, design, build and rehabilitate the New Infrastructure to accommodate the RWIS as set out in Drawing 18-I-01 in Appendix I.
 - (e) without limiting (a) and (b) above, complete grading and landscaping to enable the installation of the RWIS tower structures for the PBD Bridges (NI) prior to Traffic Availability;
 - (f) without limiting (a) and (b) above, for the purposes of powering the RWIS systems, provide 120 VAC, 60 Hz power source to each of the four quadrants of each interchange having PBD Bridges (NI) for use by the RWIS Contractor. Each power source shall be available continuously, terminated with a breaker, and located within a weather proof and lock-secured panel box at a streetlight pole located in each of the respective interchange quadrants. The Contractor is required to supply power to the RWIS systems throughout the PNI Operating Period and the Operating Period;
 - (g) without limiting (a) and (b) above, consult with the RWIS Contractor to determine the specific streetlight poles at which the RWIS power sources described in (f) above will be housed;
 - (h) without limiting (a) and (b) above, permit the RWIS Contractor to obtain power from the power sources described in (f); and
 - (i) without limiting (a) and (b) above, provide traffic accommodation services to the RWIS Contractor, as reasonably requested by the RWIS Contractor, but at the cost of the RWIS Contractor, such cost as determined by the Contractor acting reasonably.

The Department shall arrange the reciprocal reasonable cooperation of the RWIS Contractor.

200.2.16.1 INTENTIONALLY DELETED

200.2.17 MISCELLANEOUS ENVIRONMENTAL CONCERNS

200.2.17.1 Existing Sewage Treatment Facilities and Septic Fields

The Contractor is advised that septic fields, holding tanks, sewage conveyance facilities, and sewage treatment facilities may be encountered within the Project Limits. The Department is aware of the potential of such facilities adjacent to the Gray Eagle Casino, the site of the former Dick Big Plume Building, and the sanitary lift station south of Anderson Road SW as noted in Section 200.2.3.24 (Demolition). In addition to the above mentioned locations the Contractor may encounter septic fields and/or holding tanks at the locations shown on the drawing “Potential Existing Sewage Treatment Facilities and Septic Fields Within The TUC” available in the Electronic Data Room (as defined in the RFP). The Contractor shall undertake site investigations to identify sewage facilities within the TUC to be abandoned. The Contractor shall develop and implement an abandonment and disposal procedure consistent with industry standards and relevant Provincial guidelines. The Province makes no representation as to the completeness or accuracy of the description therein and no error or omission shall relieve the Contractor of its obligations under this Section.

200.2.17.2 Campsites

There shall be no campsites or sleeping trailers permitted within the TUC.

200.2.17.3 Burning

No burning will be allowed within the TUC or the Road Right of Way.

200.2.17.4 Historical Resources

Copies of the *Historical Resources Act* (Alberta) clearance for Southwest Calgary Ring Road - City of Calgary Weaselhead Flats Park Lands, the *Historical Resources Act* (Alberta) clearance for Southwest Calgary Ring Road Project – Non Tsuut’ina Nation Lands, the *Historical Resources Act* (Alberta) clearance for West Calgary Ring Road Lands, and the *Historical Resources Act* (Alberta) approval with conditions letter for Southwest Calgary Ring Road Project – Lands Transferred from Tsuut’ina Nation, are attached as Appendix D (collectively, the “Clearances”).

The Contractor shall until the end of the Term or sooner termination of the DBFO Agreement duly perform and carry out on behalf of the Province all obligations of the Province in respect of the Clearances, and shall, subject to section 16.2 of the DBFO Agreement, indemnify the Province against any liability under or in relation to the Clearances arising from the Contractor’s failure to perform all such obligations on behalf of the Province, except only to the extent that such failure was caused or contributed to by the Province or those for whom the Province is legally responsible or caused by any person exercising rights under an Identified Encumbrance, a grant contemplated by the third paragraph of section 4.1 of the DBFO Agreement, Future Utilities (as defined in section 4.8 of the DBFO Agreement), or a consent contemplated by the last sentence of section 4.14 of the DBFO Agreement.

Pursuant to section 31 of the *Historical Resources Act* (Alberta), should any paleontological or historical resources be discovered during the conduct of construction activities, the Contractor shall immediately inform the Department in writing.

200.2.17.5 Pollutants

The Contractor shall ensure that no pollutant occasioned by the carrying out of the Project or the O&M, including debris from clearing operations, petroleum products from equipment operations and construction refuse, is allowed to enter any water body whether flowing or static.

200.2.17.6 Topsoil

Topsoil, salvaged during the Project or the O&M, shall be maintained free of deleterious material and subsoil and shall be distributed evenly over designated areas once embankment construction and excavation have been completed. No burial, removal and/or sale of topsoil materials salvaged during the Project or the O&M is allowed without the prior written approval of the

Department.

200.2.17.7 Organic Materials

Organic materials from wetland excavation shall be salvaged and stockpiled in separate stockpiles prior to reuse in accordance with environmental requirements. No burial, removal and/or sale of organic materials salvaged during the Project or the O&M is allowed without the prior written approval of the Department.

200.2.17.8 Disposal of Construction Debris

Any debris created or accumulated during the Project or the O&M shall be the responsibility of the Contractor to dispose of. No burial or disposal of debris within the TUC is allowed without the prior written approval of the Department.

200.2.18 AESTHETICS

The Contractor shall develop and incorporate in its design an aesthetic theme throughout the New Infrastructure that complements the surrounding environment. As much as is practical, architectural treatments shall be similar to the northeast and southeast legs of the Calgary Ring Road. The Contractor acknowledges having reviewed the plans and specifications for the northeast and southeast legs of the Calgary Ring Road and acknowledges having inspected the condition of the northeast and southeast legs of the Calgary Ring Road just prior to the signing of the DBFO Agreement.

The following specific aesthetic features shall be incorporated into the New Infrastructure:

- Bridge structures within the Remaining New Infrastructure shall include the “wild rose” emblem 1.6 m in diameter on abutment wingwalls facing traffic. On twin bridge structures, the emblem is not required on the downstream structure;
- Bridge structures within the Priority New Infrastructure shall include an emblem or graphic provided by the Department on abutment wingwalls facing traffic, MSE walls, or headslopes, as the case may be. On twin bridge structures, the emblem is not required on the downstream structure;
- The aesthetic treatment of pier shapes for roadway grade separation bridges;
- The use of pigmented sealers (three colours) on exposed concrete surfaces;
- Artistic renderings that cover a minimum of 25% of the exposed surface area on all retaining walls except for retaining walls at railway overpasses;
- Unless otherwise specified elsewhere in the Technical Requirements, the height of any retaining wall, or the combined height of multiple retaining walls, shall not exceed 8.0 m at any location adjacent to roadways, or 12 m adjacent to railway grade separations. The height of retaining wall for this purpose shall be taken as the vertical height from top of coping to top of finished grade in front of the wall;
- Circular or square column cross sections in bridge piers shall not be used on grade separation structures. Ends of pier caps and pier shafts facing oncoming traffic shall be either circular or

chamfered (minimum 300 mm x 300 mm). Similar type architectural treatment shall be used as far as practicable for all structures having similar characteristics such as spans, superstructure type, etc.; and

- Down spouts at high abutments shall be recessed into the exposed face of the abutment wall in a chase formed into the front of cast-in-place concrete walls, or by using special wall panels in the case of MSE walls.

200.3 OPERATION AND MAINTENANCE OF THE INFRASTRUCTURE

200.3.1 TRAFFIC VOLUME PAYMENT ADJUSTMENTS

The New O&M Payments shall be adjusted, in accordance with this Section, effective each April 1st of the Operating Period based upon changes in traffic volume calculated during the previous calendar year.

The Department shall provide automatic traffic recorder (“**ATR**”) devices and all connections, to the Contractor for installation by the Contractor at the Contractor’s expense on the Infrastructure. Thereafter, the Department shall, at its own expense, operate and maintain the ATRs throughout the Operating Period on the Infrastructure.

The detailed ATR specifications are contained in Appendix H – Automatic Traffic Recorder (ATR) Specifications.

The Department has an existing ATR at the following location:

- Highway 22X approximately 1.4 km west of Macleod Trail interchange.

The Contractor is responsible for removing the ATR hardware at the aforementioned location of the existing ATR and replacing it with a new ATR on the Mainline lanes of the Calgary Ring Road between James McKeivitt Road and the Highway 22X interchange.

The Contractor shall install a new ATR on the Mainline lanes of the Calgary Ring Road between 90 Avenue SW and the Elbow River crossing. The data collected from the ATR located between 90 Avenue SW and Elbow River crossing shall be the only ATR used for the purpose of determining Traffic Volume Payment Adjustments and the upper threshold for noise mitigation requirements.

No Traffic Volume Payment Adjustments shall be made based on partial years or for changes in traffic volume within the current year.

There shall be no Traffic Volume Payment Adjustment for the first April 1st of the Operating Period.

The Department shall count the total number of vehicles to cross a point in both directions during a calendar year and shall divide this total by the number of days in that calendar year to determine the average annual daily traffic (the “**AADT**”). For any portion of a year between

RNI Traffic Availability and the subsequent April 1st, the AADT shall be considered equivalent to the average daily traffic measured in that partial year. The AADT shall be calculated by the Department's traffic statistics consultant. In the event that the ATR is not recording for a given period of time, the Department's traffic statistics consultant shall make an estimate of AADT. Weather conditions permitting, the Department shall repair the ATR to bring it into operation within four weeks of the time that the Department first becomes aware that the ATR is not functioning.

If the AADT for any calendar year exceeds 167,000 vehicles per day for the location identified on the New Infrastructure (Calgary Ring Road Mainline between 90 Avenue SW and Elbow River crossing), a onetime supplement of 5% of the New O&M Payment for such calendar year (before any Traffic Volume Payment Adjustment) shall be added to each of the New O&M Payments for the 12-month period starting April 1st after such calendar year.

In the event that unusual conditions, such as construction activity by a Local Authority on roadways other than the New Infrastructure, result in a temporary change in traffic volume on the Mainline of Calgary Ring Road, the Department, in the interest of both parties avoiding unnecessary costs, will advise the Contractor that the Department wishes to negotiate with the Contractor with respect to a temporary full or partial waiver of the Traffic Volume Payment Adjustment and a corresponding temporary full or partial waiver of certain requirements under Section 400.3 (Winter Maintenance Operation Requirements).

200.3.2 INTENTIONALLY DELETED

200.3.3 INTENTIONALLY DELETED

200.3.4 WEED CONTROL AND LANDSCAPE
MAINTENANCE

200.3.4.1 General

All areas within the TUC or the Road Right of Way, except for Privately-Owned TUC Land (as defined in section 2 of Schedule 12 of the DBFO Agreement) and the Third Party Leased Lands, shall be mowed/cut as seeded areas in accordance with Section 200.3.4.5 (Seed Establishment and Maintenance of Seed Areas) and maintained in a weed free condition by the Contractor until Construction Completion. The TUC outside of the Road Right of Way shall be maintained in a weed free condition until the Contractor is relieved of this obligation in accordance with Section 200.4.6 (Land Requirements within the Existing TUC). The "**Third Party Leased Lands**" are those lands as set out in Appendix G (Alberta Infrastructure Land Lease Summary and Drawings) where it is indicated at the relevant time that such land is still subject to a lease. Thereafter, all areas within the Road Right of Way and/or stormwater management facilities of the Infrastructure shall be maintained in a weed free condition by the Contractor until the end of the Term.

Weeds to be eradicated include all species identified under the *Weed Control Act* (Alberta) and the Local Authority's bylaws, or species which interfere or compete with the seeded varieties.

Volunteer crops from previous land use will be considered as weeds.

The Contractor shall be responsible for any fines or weed control notices issued for the TUC or the Road Right of Way until Construction Completion and then for the Road Right of Way and/or any stormwater management facilities outside the Road Right of Way but inside the TUC until the end of the Term. All notices shall be dealt with in a timely fashion. Copies of all fines and notices shall be provided to the Department. The Contractor shall be responsible for any fines or weed control notices issued for the TUC outside the Road Right of Way until the Contractor is relieved of this obligation in accordance with Section 200.4.6 (Land Requirements within the Existing TUC).

200.3.4.2 Method

Weed control shall be carried out by cultivation, seeding, and spraying. The areas (as set out in the first sentence of Section 200.3.4.1 (General)) not affected by the Project as determined by the Contractor shall be tilled to ensure that all nuisance weeds are controlled. In addition, the tilled areas shall be seeded in the Spring of 2019 for the Priority New Infrastructure and 2020 for the Remaining New Infrastructure using the seed mixes in Section 200.2.9 (Topsoil and Seeding).

Any method of weed control adopted by the Contractor shall take into account wind directions and velocities. The Contractor shall ensure that residents located near the Infrastructure are not subjected to dust and/or spray drift resulting from its weed control operations. Natural areas shall not be subjected to spray drift. The Contractor shall be responsible for all costs associated with any damage to residential property, natural areas or retained plant materials resulting from spray drift or poor agricultural or weed control practices carried out by or for the Contractor.

In the event the Contractor chooses seeding with commercial crops as a method of weed control, any crops harvested shall become the property of the Contractor. The use of commercial crops as a method of weed control shall only be allowed during the PNI Construction Period for the Lands applicable to the Priority New Infrastructure and the Construction Period for the Lands applicable to the Remaining New Infrastructure, and not during the PNI Operating Period for the Lands applicable to the Priority New Infrastructure and not during the Operating Period.

Pesticide applicators must meet all requirements in the *Code of Practice for Pesticides* (applicable by regulation under section 36 of the *Environmental Protection and Enhancement Act* (Alberta)). Pesticide applicators must also comply with all requirements of the *Environmental Protection and Enhancement Act* (Alberta), its associated regulations and all other applicable laws. The Contractor or any subcontractor that the Contractor hires for herbicide application must hold a valid Pesticide Service Registration with Alberta Environment.

200.3.4.3 Weed Control Signage and Notification

The Contractor shall provide signs and notices to residents affected by the work prior to commencement of chemical applications. Signage and notification shall follow policies and procedures set by the Local Authority. The Contractor shall become familiar with the policies and procedures by contacting the Local Authority for the affected area.

The Contractor shall notify the Local Authority a minimum of 48 hours prior to spraying with information including the following: location, target weeds, chemicals to be used and date and time of application.

Prior to spraying, the Contractor shall purchase all necessary signage from the Local Authority to assist in identifying spray areas. Signage shall be installed at a minimum 100 m interval and at all entry points, corridors and walkways adjacent to the TUC or the Road Right of Way or as directed by the Local Authority. The Contractor shall be responsible for displaying and removing signs in accordance with the time frame required for public notification and re-entry intervals. The Contractor is to ensure that signs refer project inquires to the Contractor's contact number.

The Contractor shall be responsible for obtaining information from the Local Authority regarding citizens in the vicinity of the TUC or the Road Right of Way with medical sensitivities or other concerns related to spraying. The Contractor shall be responsible for determining if any such area residents are affected and then take appropriate measures to meet their specific needs.

200.3.4.4 Mowing and Trimming at Fences

The Contractor shall carry out mowing and trimming around fences, as part of weed control in the following instances:

- as an emergency procedure in response to weed notices;
- to control weeds that are not effectively responding to the weed management program;
- as a clean-up procedure at the end of the growing season; and
- in areas adjacent to residences where spraying is not feasible.

The trimming of weeds around fences shall be conducted as reasonably required and in any event at least once every 60 days during the period April 1 to October 31 each year.

200.3.4.5 Seed Establishment and Maintenance of Seeded Areas

Any area of unsatisfactory seed establishment shall be top dressed and reseeded by the Contractor. The acceptable minimum number of plants of all seeded species per square metre shall be 150.

The seeded areas shall be mowed/cut to 100 millimetre height a minimum of twice during the growing season. Baling and/or raking of the mowed/cut plant material shall be performed upon completion of the mowing/cutting operation in order to prevent accumulation of mulch. Bales and raked material shall be removed from site immediately upon completion of the baling/raking operation. All bales and raked material shall become the property of the Contractor.

Weeds that emerge during the one year establishment period are to be controlled as per the requirements and methods described in the Section 200.3.4.2 (Method).

200.3.5 MAINTENANCE OF DRAINAGE SYSTEMS

In addition to maintenance of the drainage system that is part of the New Infrastructure, the Contractor is responsible for the maintenance of previously installed drainage systems on other portions of the Road Right of Way and the TUC as set out in Drawings 18-A-3.01SW to 18-A-3.11SW in Appendix A. The Contractor shall ensure that the design hydraulic capacity, water quality treatment capabilities and spill containment features of the drainage system as a whole and each of its elements are maintained at all times. The Contractor shall have a regular inspection/performance monitoring program for the whole drainage system, and carry out a regular cleanup of rubbish or other deleterious materials.

All existing drainage infrastructure within the Project Limits that remain exclusively for use by the City will continue to be owned, operated and maintained by the City, for example the trunk sewer portion of the South Richmond Storm Trunk diversion to 37 Street SW Storm Trunk, and the Sarcee Storm Trunk.

Existing drainage infrastructure that becomes jointly used as part of the new drainage system will become the operating and maintenance responsibility of the Contractor.

Stormwater collection and conveyance, including catchbasins, manholes and storm sewers required for the portions of Glenmore Trail within the Project Limits that discharges stormwater to the City's 37 Street SW storm trunk system will remain the responsibility of the Contractor up to the connection point to the City's 37 Street SW storm trunk.

The Contractor is responsible for the drainage infrastructure for the portion of Grey Eagle Drive within the TUC.

The Contractor is not responsible for the drainage infrastructure for the portion of Grey Eagle Drive outside the TUC.

Further responsibilities of the Contractor for operation and maintenance of storm water systems are included in Section 200.2.5 (Drainage) and in Section 400.4.7.6 (Drainage Systems).

In the event of a roadway spill that discharge to, or collects in, any part of the drainage system, the Contractor shall be responsible for managing the clean-up. This shall include but not be limited to implementing any safeguards to prevent contaminants from entering adjacent water bodies or the groundwater system.

200.3.6 BRIDGE INSPECTIONS

200.3.6.1 Level 1 BIM Inspections

Level 1 BIM inspections shall be completed for all bridges in the Existing Infrastructure within 30 days after Construction Completion. Level 1 inspections shall be repeated every 21 months thereafter, until the end of the Operating Period.

200.3.6.2 Level 2 Bridge Deck Inspections

Initial specialized Level 2 Bridge Deck Inspections (as defined by *Alberta Transportation's Bridge Inspection and Maintenance System* (“**BIM**”)) for bridges in the Existing Infrastructure shall be carried out by the Contractor as follows:

Starting in 2026: Specialized Level 2 deck inspections consisting of concrete deck inspection, Copper Sulphate Electrode testing and chloride ion content testing.

- Bridge carrying Highway 8 over the Elbow River (Bridge File 2143);
- Bridge carrying the Calgary Ring Road over Fish Creek (Bridge File 375).

Only qualified and experienced bridge inspectors that have a current Class A certification under BIM shall complete inspections.

Following the initial Level 2 Bridge Deck Inspection, subsequent Level 2 Bridge Deck Inspections for the bridges in the Existing Infrastructure shall be repeated by the Contractor at an interval of every four years, until the end of the Operating Period.

200.3.7 PREVENTATIVE BRIDGE MAINTENANCE

Sealing of the bridges in the New Infrastructure and Existing Infrastructure shall initially be carried out by the Contractor in 2020 for bridges within the Priority New Infrastructure and 2021 for bridges within the Remaining New Infrastructure and subsequently repeated at an interval of every four years thereafter until the end of the Operating Period.

200.3.8 INTENTIONALLY DELETED

200.3.9 SPECIAL EVENTS

There will be occasions where the Department requires the cooperation and coordination of the Contractor for special operations. Any work required by the Contractor under Sections 200.3.9.1 (Full Lane Availability Events), 200.3.9.2 (Partial or Full Closure Events), and 200.3.9.3 (Spruce Meadows Events) shall require a Change Order.

200.3.9.1 Full Lane Availability Events

Sometimes special events will be approved by the Department in the area which will generate extra traffic on the Infrastructure. Some events that generate extra traffic on the Infrastructure will occur independently of approval by the Department.

Such events may require:

- Installation of special banners or special signs;
- Adjustment of traffic signals; and

- Additional traffic management or traffic accommodation measures.

200.3.9.2 Partial or Full Closure Events

There will be times when the Infrastructure is utilized for special events (“**Approved Special Events**”), approved by the Department that may require closure or partial closure of the Infrastructure. The following measures may be required:

- Installation of special signs; and
- Additional traffic management or traffic accommodation measures.

The Contractor is required to develop a communications and operations plan to accommodate Approved Special Events when so notified by the Department. The plan shall be submitted to the Department for review and upon acceptance the Contractor shall implement the approved plan.

Lane Closure Payment Adjustments (as set out in Section 400.1.6 (Lane Closure)) shall not apply to lane closures required for Approved Special Events.

200.3.9.3 Spruce Meadows Events

There will be times when the Infrastructure is utilized for major public events at Spruce Meadows (“**Spruce Meadows Events**”), approved by the Department that may require closure or partial closure of the Infrastructure. The Contractor shall, on an annual basis, communicate with the Spruce Meadows event organizers to preschedule the Contractor’s operations during the Construction Period and the Operating Period such that Spruce Meadows Events are accommodated. The Contractor shall provide a copy of its communication and operations plan to the Department a minimum of 30 days prior to a Spruce Meadows Event. The Contractor shall coordinate its activities adjacent to Spruce Meadows such that access to and from the Spruce Meadows Events are not adversely impacted and that access and egress is maintained at a level of service equivalent to what existed prior to Execution of the DBFO Agreement.

The following measures may be required:

- Installation of special signs or banners;
- Adjustments to traffic signals; and
- Additional traffic management or traffic accommodation measures.

The Contractor is required to develop a communications and operations plan to accommodate Spruce Meadows Events when so notified by the Department or Spruce Meadows. The plan shall be submitted to the Department for review and upon acceptance the Contractor shall implement the approved plan.

Lane Closure Payment Adjustments (as set out in Section 400.1.6 (Lane Closure)) shall not apply to lane closures required for Spruce Meadows Events.

**200.3.10 OPERATION AND MAINTENANCE OF IN-SERVICE
ROADS DURING CONSTRUCTION PERIOD**

Commencing at 12:00 a.m. on the date that is two months after Execution of the DBFO Agreement, the Contractor shall be responsible to perform operations and maintenance on existing infrastructure within the Project Limits during the PNI Construction Period for such existing infrastructure related to the Lands applicable to the Priority New Infrastructure and during the Construction Period for such existing infrastructure related to the Lands applicable to the Remaining New Infrastructure, including snow and ice control. The following sections of roadway and crossroads (including bridges in both cases) within the Project Limits are currently open to public traffic (the “**In-Service Roads**”) and are to be operated and maintained by the Contractor during the PNI Construction Period for such roadway and crossroads (including bridges in both cases) related to the Lands applicable to the Priority New Infrastructure and during the Construction Period for such roadway and crossroads (including bridges in both cases) related to the Lands applicable to the Remaining New Infrastructure as if the roadway and crossroads (including bridges in both cases) were New Infrastructure:

- Highway 8/Glenmore Trail and the associated crossroads as follows:
 - 69 Street SW;
 - Sarcee Trail SW; and
 - 37 Street SW.
- 37 Street SW and the associated crossroads as follows:
 - Anderson Road SW;
 - 130 Avenue SW; and
 - 146 Avenue SW.
- Highway 22X and the associated crossroads as follows:
 - James McKeivitt Road SW;
 - 6 Street SW/Sheriff King Street SW; and
 - Macleod Trail SE.

The Contractor shall be responsible for snow and ice control of the In-Service Roads during the PNI Construction Period for In-Service Roads related to the Lands applicable to the Priority New Infrastructure and during the Construction Period for In-Service Roads related to the Lands applicable to the Remaining New Infrastructure. It is a Project Requirement that operations and maintenance of the In-Service Roads during the PNI Construction Period for In-Service Roads related to the Lands applicable to the Priority New Infrastructure and during the Construction Period for In-Service Roads related to the Lands applicable to the Remaining New Infrastructure, including but not limited to surface repair, line painting, pathways and sidewalks, signage, signal and lighting maintenance, shall be the Contractor’s responsibility and shall be conducted to meet the standards set out in the sub-paragraphs (a) to (n) below.

The following requirements, including without limitation Payment Adjustments (unless expressly stated otherwise), shall apply during the PNI Construction Period for In-Service Roads related to the Lands applicable to the Priority New Infrastructure and during the Construction Period for In-Service Roads related to the Lands applicable to the Remaining New Infrastructure starting the date that is two months after Execution of the DBFO Agreement (with such

modifications as necessary) to the In-Service Roads:

- (a) Section 400.1.5 (Imminent Danger Repairs);
- (b) Section 400.1.6 (Lane Closure) applied to any reduction of the minimum lane requirements for the In-Service Roads as set out in Section 200.2.3.23 (Detours). The provisions applicable to the Schedule of Lane Closures and telephone service shall not apply. Except with the prior written approval of the Department, acting reasonably, and except for an Excepted Lane Closure, the Contractor shall not close all lanes in either direction or close any lanes for an extended period of time (as determined by the Department acting reasonably). For planned maintenance activities on the In-Service Roads with two lanes in each direction the Contractor must have at least one lane in each direction open to traffic at all times, unless otherwise approved in writing and in advance by the Province, acting reasonably;
- (c) Section 400.2.1 (Roadway Inspection Requirements);
- (d) Section 400.2.2 (Emergency Maintenance);
- (e) Section 400.2.3 (Routine Maintenance);
- (f) Section 400.2.4 (Measuring for Compliance);
- (g) Section 400.3.1 (General). For the Winter Maintenance Standards table in Section 400.3.1, Highway 201 is deemed a Class AA roadway, and all other crossroads are deemed Class A roadways;
- (h) Section 400.3.2 (Equipment and Materials);
- (i) Section 400.3.3 (Snow Clearing and Ice Control Operations);
- (j) Section 400.4.1 (Roadway Maintenance Requirements), except for the requirements in the third bullet under Section 400.4.1.2 (Completing Repairs);
- (k) Section 400.4.6 (General Pavement Maintenance Requirements), except the requirements in Sections 400.4.6.3 and 400.4.6.4 and that the definition of localized roughness in Section 400.4.6.2 shall be modified to be any abrupt deviation in excess of 12 mm when measured with a 1.2 m straight edge;
- (l) Section 400.4.7 (Miscellaneous - Operation and Performance Requirements), except for the requirements in Section 400.4.7.9 and for any Payment Adjustments set out in Section 400.4.7.1, 400.4.7.3 through 400.4.7.9 inclusive;
- (m) Section 400.4.8 (Traffic Control Devices - Operation and Performance Requirements), except for any Payment Adjustments set out in Section 400.4.8; and

- (n) Section 400.5.2.4 (Preventative Bridge Structures Maintenance) but only the requirements of annual washings of bridge decks, sealing of all bridge decks exposed to de-icing salts and sealing of all curbs.

200.4 MISCELLANEOUS

200.4.1 LOCAL AUTHORITY

The Contractor acknowledges having reviewed a copy of the Amended and Restated Highway Transfer Agreement between the Province and the City dated May 13, 2016 (the “**City Agreement**”). The Contractor shall take all such actions, or refrain from such actions, as are necessary so as to enable the Province to comply with the Province’s obligations under the City Agreement in respect of the Project, the O&M and the Infrastructure.

200.4.2 HOURS OF WORK / WORK RESTRICTIONS

On the days Monday through Saturday, construction work on the Project shall be restricted to the period between 7:00 a.m. and 10:00 p.m. local time. On Sundays and statutory holidays, construction work on the Project shall be restricted to the period between 9:00 a.m. and 10:00 p.m. local time.

Activities exempted from these time restrictions are:

- Overhead sign structure installation;
- Girder erection;
- Concrete pours for bridge construction; and
- Line painting.

Other activities may be exempted with the prior written approval of the Department subject to the review and evaluation of the predicted levels of impact to surrounding residents.

When the Contractor’s construction work on the Project is being carried out within the jurisdictional boundaries of a particular Local Authority, then the Contractor’s construction work shall be restricted to the hours permitted by that Local Authority’s bylaws or the hours of work restrictions in the first paragraph above, whichever hours of work restrictions or parts of the restrictions are more restrictive. The Contractor may obtain a noise by-law waiver from the Local Authority (if required) and a waiver of the hours of work restrictions in the first paragraph above from the Department.

200.4.3 COORDINATION WITH LOCAL AUTHORITIES

The Contractor is responsible for coordinating all operations on crossroads with the Local Authority during construction. Should a Local Authority initiate a lane rental policy for operations on that Local Authority’s streets and roads, the policy will not apply on New Infrastructure crossroads.

The Contractor shall contact the Local Authority regarding the planned works and provide

confirmation at least 48 hours prior to commencing work on or adjacent to the Local Authority's roads.

The Contractor is responsible for obtaining any permits required by the City for work on the New Infrastructure within the City of Calgary.

The Contractor shall ensure that the appropriate permits under the *Indian Act* (Canada) have been obtained to permit it to enter onto the TTN reserve and carry out the following activities:

- stabilization of the riverbank and realignment of the Elbow River;
- stabilization of the riverbank and the realignment of Fish Creek;
- the relocation of portions of Weaselhead Road and Buffalo Run Boulevard;
- the stockpiling, at a location selected by TTN on the SE 26-23-2-W5M, of up to 1,000 cubic metres of clay for the use of the TTN; and
- the relocation of any pipelines, power lines or other improvements located in, on, over, under, across or through the TTN reserve, or reconnections to existing pipelines, power lines or other improvements.

To ensure the appropriate permits are in place, the Contractor shall contact the Department. The Department will make a written request to the TTN asking that the TTN pass a band council resolution (“**BCR**”). The TTN has committed to passing the necessary BCR within 45 days of receiving a request from the Department. The BCR is a formal request by the TTN to Her Majesty the Queen in Right of Canada, asking Her Majesty the Queen in Right of Canada to issue the permit(s) under the *Indian Act*.

The Contractor shall provide the TTN with a minimum of 48 hours notice to Darrell Crowchild, or such other person identified by the Department, prior to:

- Performing any construction or maintenance activities on the TTN reserve, as specified by permits issued under the *Indian Act* (Canada);
- Performing any construction or maintenance activities that may impact TTN infrastructure;
- Entering TTN reserve for access or other purposes, as specified by permits issued under the *Indian Act* (Canada); or
- For any work or access specified in the permits issued under the *Indian Act* (Canada).

Where the coordination of design requirements and construction phasing with the Local Authority is expressly required in the Technical Requirements, the Contractor shall be responsible for such coordination. The Contractor shall also be responsible for removal of, and for coordination with the Local Authority regarding any required road obliterations and closures in the TUC.

200.4.4 POLICE AND FIRE SERVICES

Police and fire services for any area of the Infrastructure within the boundaries of a Local

Authority will be provided by and under the jurisdiction of the Local Authority and obtained by 911 call.

The Contractor shall take all such actions, or refrain from all such actions, as are necessary to enable the police, the Local Authority, and others with statutory duties or functions in relation to the Infrastructure or adjoining roads to fulfil those duties and functions. Without limiting the generality of the foregoing, the Contractor shall permit the police, the Local Authority, and others with statutory duties or functions in relation to the Infrastructure, to carry out “Check Stops” and speed enforcement activities.

In the case of an emergency, the Contractor is responsible for installing traffic control devices, which includes without limitation the erection of barricades, establishing detours, and providing and installing emergency signage. The Contractor shall also remove debris and apply absorbent material to minor spills resulting from the emergency. All costs associated with such traffic control and such spill clean-up resulting from the emergency shall be the responsibility of the Contractor.

200.4.5 LAND ISSUES

Administration of the TUC is undertaken by Department of Infrastructure on behalf of the Province. Any individual or organization proposing to enter the TUC outside the Road Right of Way to undertake an activity or use requires at least one authorization from Department of Infrastructure. The document entitled “*Transportation/Utility Corridor (“TUC”) Program Policy*” published by Department of Infrastructure, as may be amended from time to time, explains in detail the objectives of the TUC program. Steps for obtaining Ministerial Consents and other related authorizations from Department of Infrastructure are included in this policy.

200.4.6 LAND REQUIREMENTS IN THE EXISTING TUC

By Construction Completion, the Contractor shall have installed a fence separating the Road Right of Way from the remaining utility components of the TUC (the “**TUC Outside the ROW**”). At that time, the Department of Infrastructure will desire to reassign the TUC Outside the ROW as lease areas. The Contractor will be relieved of its maintenance responsibility for those portions of the TUC Outside the ROW that the Contractor had responsibility, if the state of this land is acceptable to the Department of Infrastructure. Conditions for the handover back to the Department of Infrastructure shall require that these areas are fully vegetated and in a healthy and vigorous weed-free growing condition in accordance with the Contractor’s Environmental Management System.

Any features or appurtenances related to the roadway, such as stormwater management facilities, that may fall within the TUC Outside the ROW shall remain the responsibility of the Contractor. The Contractor shall make specific arrangements with the Department of Infrastructure to ensure that the Contractor’s maintenance of these features does not interfere with any future tenants or other land uses.

200.4.7 UNEXPLODED EXPLOSIVE ORDNANCE

The former TTN lands south of Sarcee Trail SW were historically used by the Department of National Defense (“**DND**”) as a weapons firing range.

“**Unexploded Explosive Ordnance**” or “**UXO**” means any military munitions that have been primed, fused, armed or otherwise prepared for use and which remain unexploded either by malfunction, by design or for any other reason, but for greater certainty excludes any MS (as defined below).

“**Munitions Scrap**” or “**MS**”: All non-energetic by-products resulting from the functioning of military munitions, including but not limited to spent shell or cartridge casings, projectiles, launchers, shrapnel, pieces of fuse, and all similar objects.

The following list of ordnance items were confirmed or suspected to have been used by DND in the weapons firing range on the former TTN lands south of Sarcee Trail SW over the duration of its use and may represent UXO:

- Mortars
 - 2 inch (High Explosive [**HE**]), Smoke, illuminating practice)
 - 3 inch (HE, smoke, illuminating practice)
 - 60 mm (HE, smoke, illuminating practice)
 - 81 mm (HE, smoke, illuminating practice)
- Guns and Howitzer munitions
 - 6 pounder (shot)
 - 12 pounder (HE, shrapnel)
 - 18 pounder (HE, Smoke, Shrapnel)
 - 20 pounder (HE, smoke)
 - 25 pounder (HE, smoke/illuminating)
 - 60 pounder (HE, shrapnel)
 - 76 mm (HE, smoke, practice)
 - 105 mm (HE, smoke, illuminating)
 - 155 mm (HE)
 - 4.5 inch (HE)
 - 5 inch (HE)
- Rocket Launchers and Recoilless Rifle ammunition
 - 3.5 inch (HEAT, practice)
 - 2.36 inch (HEAT)
 - PIAT (HEAT)
 - 75 mm (HEAT, practice)
 - 106 mm (HEAT, practice)
 - 66 mm (M-72) (HEAT, practice)
 - 84 mm (Carl Gustav) (practice)
- Air to Ground Rockets
 - 5 inch with 60 pound warhead (HE)

- 2.25 inch sub caliber air rocket (practice)
- Bombs
 - Various (practice)
- Miscellaneous
 - Grenades
 - Riot control projectiles
 - Flares
 - Pyrotechnics

Clearance of UXO was performed to a depth of 45 cm, and in some instances to a depth of 1 m below existing grade; however, the Contractor may encounter UXO during excavation activities.

The Contractor is responsible for identifying and dealing with UXO and MS within the Project Limits in the utmost safe manner and in accordance with applicable laws.

The Contractor is required to attend UXO Risk Education Program training provided by DND on UXO recognition and response procedures. It is the Contractor's responsibility to ensure this training is current and the Contractor shall provide UXO training to all its applicable employees and subcontractors and their employees as part of the Contractor's Safety Plan. DND will provide the Contractor with the required UXO training upon Execution of the DBFO Agreement.

The Contractor shall retain the service of qualified UXO technicians (the "**UXO Technicians**") that meet the minimum qualification requirements, namely Civilian Equivalent Qualifications for Contracted Range Clearance, as defined by DND, in accordance with CANFORGEN 106/07, A&EI#15, A&EI #17 and the B-GL-381-003/TS-000. The Contractor shall submit to the Department for written approval the name and credentials for the UXO Technicians within 90 days of Execution of the DBFO Agreement and prior to the Contractor beginning work on areas of the Road Right of Way or the TUC with potential UXO.

The Contractor's responsibilities for UXO include the following activities, as a minimum:

- UXO work plan ("**UXO WP**");
- UXO safety procedures;
- UXO training/awareness;
- UXO avoidance support and escort;
- UXO construction support;
- UXO security (if encountered/confirmed);
- UXO removal and demolition (if encountered/confirmed);
- Recovery, screening and storage of Munitions Scrap for pickup by DND; and
- Recovery, storage and disposal of Non-Munitions Scrap ("**NMS**").

The Contractor's UXO WP shall include, but not be limited to the following positions:

- UXO Assistants;
- UXO Technicians;

- UXO Technician Supervisor;
- UXO Safety Officer;
- UXO Quality Control Specialist;
- UXO Field Supervisor; and
- UXO Project Leader.

All personnel named to the aforementioned positions shall have the knowledge and experience in military ordnance, ordnance components, and identification, that will permit the safe handling, transportation and/or disposal of discovered ordnance items and meet the minimal requirements for each position as described by DND in B-GL-381-003/TS-000. The Contractor shall ensure all personnel involved in the handling and transportation of explosives and of MS and hazardous materials meet all federal and provincial requirements and will complete activities according to applicable procedures, licenses and approved processes. Changes to the Contractor's UXO personnel identified in the UXO WP shall be subject to the Department's review and approval. The Contractor shall provide in the UXO WP a written statement attesting the prerequisites.

In the event that a UXO is confirmed within the Project Limits, the Contractor shall be responsible to remove and demolish all UXO. The Contractor is required to have the applicable license to complete explosive demolition action through a Manufacture or Storage Licence issued by the Explosive Safety Division of Natural Resources Canada ("NRCan"). In addition, the Contractor will be required to source and store any donor explosives in accordance with an applicable NRCan license. All activities performed by the Contractor shall be in conformance with the *Explosives Act* (Canada). The Contractor shall ensure that any confirmed UXO items are continuously secured until a removal/demolition action is completed in accordance with the Contractor's Construction Management Plan.

The Contractor may contact DND for assistance with UXO removal/demolition. The telephone number to report possible UXO encounters and to coordinate MS storage and pick up is as follows:

Joint Task Force West (Edmonton) (780) 973-4011 ext 8319

DND has indicated a response time to complete a removal/demolition action typically ranges from two days to one week, however, response times vary depending on DND priorities and may exceed this estimate.

Any MS shall be stored in a secure container on site for DND pick-up at a later date. As a minimum, security measures must be in place to prevent the loads of screened MS from being tampered with or accessed by non-trained personnel. The Contractor shall contact DND Joint Task Force West (Edmonton) to coordinate MS storage and pick up.

The Contractor is advised that scope of services related to UXO includes access to controlled goods as defined by the *Defence Production Act* (Canada). The Contractor is advised that a "Controlled Goods Registration" is required prior to access (examination, possession or transfer) to controlled goods. The Contractor must be registered in the Controlled Goods Program of

Public Works and Government Services Canada prior to commencing work on the areas of the Road Right of Way or the TUC with potential UXO.

The Contractor shall not remove any geotechnical material from the Lands that may contain UXO. All subgrade and topsoil existing between 90 Avenue SW and Sarcee Trail shall remain within the area between 90 Avenue SW and Sarcee Trail.

Unless the Contractor undertakes a UXO survey and clearance of the Elbow River at the Weaselhead, at such time that the river realignment is completed, the Contractor shall allow DND to access and perform a UXO survey and clearance of the Elbow River at the Weaselhead, at such time that the river realignment is completed. The Contractor shall provide sufficient notice and site access for DND (or their designated contractor) to complete this work at a mutually scheduled time.

200.4.8 WORK BY OTHER FORCES

The Contractor shall coordinate all construction activities with any work that may be undertaken by utility stakeholders on their plants or facilities within the TUC or by the Local Authority at or beyond the Project Limits.

The Contractor shall coordinate all crossroad tie-ins with the Local Authority to ensure roadways are continuous and consistent across the limits of construction. This includes ensuring the roadway design, including, but not limited to, geometry, lighting, drainage, signage, sidewalks, and other appurtenances are complementary and functional across the limits of construction.

The Contractor shall cooperate and coordinate construction activities with Chinook Roads Partnership and its subcontractor, Mainroad Chinook Contracting LP, which is the operations and maintenance contractor responsible for the Southeast Stoney Trail.

The Contractor shall provide Volker Stevin Highways Ltd., Mainroad Infrastructure Maintenance, and the Local Authority, as required, with details of all temporary construction installations to be operated and maintained throughout seasonal shut-down periods. The Contractor shall provide a schedule of planned seasonal shut-down periods to the appropriate maintenance forces and update it as required. The Contractor is expected to act responsibly and professionally throughout the Construction Period and take all reasonable precautions to prevent damage to existing infrastructure.

200.4.9 VEHICLE INSPECTION SERVICES

Commercial vehicles travelling on the Alberta provincial highway system are randomly inspected and weighed by officials from the Department (currently the Vehicle Safety Branch of the Department). Commercial vehicles travelling on the Infrastructure will be inspected and weighed in a similar manner and frequency as on the rest of the provincial highway system.

The Contractor may purchase at agreed upon rates additional inspection services from the Department should the Contractor wish to increase the inspection frequency to reduce the

potential for overload commercial vehicles travelling on the Infrastructure.

The Contractor is not permitted to construct pull-out areas along the Mainline.

200.4.10 SURVEY

The Contractor shall, as soon as reasonably practical after Construction Completion, obtain at its cost but on the Department's behalf, a legal survey (the "**Survey**") of the Lands. The Survey shall be carried out by an "Alberta Land Surveyor" as defined under the *Land Surveyors Act* (Alberta). The Contractor shall provide the Department with copies of the Survey. The Contractor and the Department shall in good faith negotiate an amendment to the DBFO Agreement to describe the Lands by referencing the Survey.

200.4.11 CLEANING OF ROADWAYS

The Contractor shall not track material from the construction site onto roadways used by the public. If tracking should occur, the Contractor shall immediately remove all tracked material from the affected roadway.

200.4.12 ROADWAY OBLITERATION

All roadways, ramps, and access roads designated for removal, shall have the road structure removed, filled with clean material native to the surrounding land, landscaped neatly with slopes flatter than 5 horizontal to 1 vertical within the Road Right of Way and flatter than 6 horizontal to 1 vertical outside the Road Right of Way, culverts removed and existing drainage patterns maintained, then topsoiled and seeded in accordance with Section 200.2.9 (Topsoil and Seeding).

The Contractor shall assume ownership of all debris and salvaged materials, such as culverts, roadway lighting and traffic signals except as otherwise identified. All materials having salvage value shall be carefully removed to avoid damage to existing infrastructure that is to remain. The old pavement structures shall be removed to an existing joint or cut to a true vertical face at the tie-in locations to existing infrastructure. After removal, the Contractor shall store on site any existing lighting or traffic signal systems owned by the Local Authority and shall provide the Local Authority with written notice, and the Department with a copy of such notice concurrently, that any materials to be salvaged are to be removed by the Local Authority within 30 days. If the Local Authority has not removed the materials within 30 days from notice, the lighting systems and/or traffic signal systems become the property of the Contractor.

200.4.13 INTENTIONALLY DELETED

200.4.14 PROJECT SIGNAGE

The Contractor shall supply and install project signage applicable to projects delivered through federal and provincial partnership. The provincial signage shall be designed and fabricated in accordance with *Alberta Transportation's Design Bulletin #83 – Project Identification Sign for Capital Construction Projects* or its replacement. The federal signage shall be in accordance

with Canada's Economic Action Plan – New Building Canada Fund signage. Each of the provincial and federal project signs shall be ground mounted and measure no less than 1.2 metres by 2.4 metres. The signage shall be located within the Project Limits at the following locations with the exact locations to be determined in consultation with Department:

- Glenmore Trail & Sarcee Trail interchange (3 signs);
- Highway 22X interchange (4 signs);
- Highway 8 and Calgary Ring Road (2 signs); and
- Macleod Trail & Calgary Ring Road interchange (4 signs).

All provincial and federal signage shall be maintained in good condition during the Construction Period and for a period of twelve months after RNI Traffic Availability. The Contractor shall remove and dispose of the project signage but prior to doing so shall obtain the Department's approval.

Any additional signage within the Project Limits and not related to traffic operations shall be subject to approval by the Department.

The Contractor shall supply and install two WC-13 wildlife crossing signs 750 mm x 750 mm in size. The signs shall be located adjacent to the northbound and southbound lanes on Calgary Ring Road approximately 500 metres before the Elbow River structures and Fish Creek structures. The Contractor shall also place signs adjacent to the eastbound and westbound lanes on Highway 8 approximately 500 m before the Elbow River structures.

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300.1 INTRODUCTION

This Section covers the design and construction requirements applicable to roadways and bridge structures in the New Infrastructure.

300.2 DESIGN – GENERAL

300.2.1 GENERAL DESIGN REQUIREMENTS

The performance requirements to be met in the design of all roadways, bridge structures and other appurtenances include requirements in the areas of safety, functionality/serviceability, durability/maintainability and aesthetics. The standards to which these performance requirements are to be met are generally specified in this Schedule 18 (Technical Requirements). If a performance requirement is not specified in this Schedule 18 (Technical Requirements), the performance requirement shall be set to a standard generally being met on new roadways and bridge structures of similar type on the Department's Provincial highway system.

Bridge structures must be designed to be structurally and operationally safe in terms of accommodation of traffic, operations and maintenance activities for the duration of the design life.

All designs shall incorporate the appropriate selection of design concepts, design details, specifications, materials and construction methods and techniques.

Unless otherwise specified, bridge substructures shall not be designed to be wider than necessary to accommodate the Stage 1 superstructure.

For bridges that are to be widened in the Ultimate Stage, piers shall be proportioned so that the spacing and proportioning of shafts in the Ultimate Stage are a reasonably close match to the spacing and proportioning of shafts in Stage 1, so that the architectural integrity of the Stage 1 design is maintained in the Ultimate Stage design. The shaft spacing variation shall not exceed 10% between Stage 1 and the Ultimate Stage. Some asymmetry of pier cap cantilevers is acceptable in Stage 1, but pier cap cantilevers shall be reasonably symmetrical in the Ultimate Stage. The Ultimate Stage design shall ensure that the variation between the two cantilever ends of the pier caps do not exceed 5% of each other. In Stage 1, the Department will allow a variation of up to 20% between the two cantilevers on a pier cap. Where Stage 1 pier cap cantilevers are designed to be extended in the Ultimate Stage, the Stage 1 pier and foundation shall be designed for Ultimate Stage loading, and construction details shall be included in the Stage 1 design to facilitate reinforcement of the Ultimate Stage cantilevers, either through embedded couplers or provision for future post-tensioning.

300.2.2 RESPONSIBILITY FOR DESIGN

The Contractor is responsible for the design of all elements of the New Infrastructure including, but not limited to, all geotechnical investigations, environmental considerations and permits, topographic surveys, in-stream watercourse surveys, approvals and permits, other field investigations and technical analysis required to complete the designs in a professional and competent manner.

300.2.3 DESIGN DOCUMENTATION

Detailed design documents shall cover the full range of infrastructure required in the Project. Design documentation shall include, but not be limited to:

- Design reports for all aspects of the work including but not limited to the design decision process, criteria, and assumptions used for each aspect of the design, agreements, permits, authorizations, and special construction requirements.
- Detailed design drawings prepared in accordance with the Department’s Engineering Drafting Guidelines for Highway and Bridge Projects Version 2.0 February 2016, including availability in electronic format.
- Detailed traffic signal design drawings prepared in accordance with the traffic signal design and drawing guidelines in Package F of Appendix J.
- Comprehensive construction specifications sufficiently detailed to describe the process or end result requirements.

As a basis for this documentation, the Contractor shall further develop and finalize, as required, the design reports, plans and specifications in the Contractor’s Designs, including, but not limited to:

- Design plans and profiles;
- Design cross-sections;
- Design appurtenances;
- Signing;
- Lighting;
- Roadside hazards;
- Pavement Design Report (Section 300.4.1.8.1);
- Bridge Structures Design Report (Sections 300.5.3 and 300.5.4);
- Drainage Design Report (found in the Contractor’s Designs or in the Contractor’s Management Systems and Plans); and
- Electronic survey data with details of the format in which it was collected.

Details of design documentation requirements for these and other design issues are further expanded in this Schedule 18 (Technical Requirements).

Complete design document packages must be available prior to starting construction of the elements designed in any specific package. Any non-conformance with the Technical Requirements shall be rectified by the Contractor, whether the work has been constructed or not.

300.2.4 AESTHETICS

The Contractor is advised that the Department supports and encourages the inclusion of cost effective features to improve the overall roadway and bridge structure aesthetics.

Aesthetics shall be considered in the layout and design of all roadway elements, and the aesthetic principles outlined in the Department’s Bridge Aesthetics Study (Version 1.0, April 2005) shall be considered in the layout, shapes, details, finishes and architectural features of all bridge structures. Any proposed aesthetic features shall take into consideration routine and long-term maintenance costs and shall not lead to potential maintenance and rehabilitation problems in the

future.

Proposed twin bridge structures shall be aesthetically similar and constructed of the same material type. Twin bridge structures are structures spanning a common opening and close enough to be located on the same bridge approach fills. Twin bridge structures shall have similar head slopes and openings.

To enhance the appearance of slopes and improve maintenance characteristics, concrete slope protection shall be provided along the base of all retaining walls running alongside roadways, including at railway overpass and grade separation bridge structures that incorporate retaining walls between the abutment and the underpassing roadway/railway. The concrete slope protection shall be provided between the face of all retaining walls and a roadside/tracksid ACP lined swale.

The dimension of the concrete slope protection measured perpendicular from the ACP lined swale edge nearest the face of the wall shall not be less than 1.5 m and a larger dimension shall be provided if it is required to satisfy clear zone or other design requirements. The concrete slope protection shall slope uniformly downward positively towards the swale from the wall face at a slope not steeper than 3 horizontal to 1 vertical. The low end of the concrete slope protection, the edge adjacent to the swale, is referred to as the toe of the concrete slope protection.

An ACP swale, such as shown on Figure H7.1 (Detail A – Swale) of the Roadside Design Guide and on Standard Drawing S-1409-16 (Standard Concrete Slope Protection For Grade Separations), is required between the road shoulder edge of pavement and the toe of concrete slope protection. Notwithstanding the 2.5 m width dimension shown on Figure H7.1 (Detail A – Swale) of the Roadside Design Guide and Standard Drawing S-1409-16 (Standard Concrete Slope Protection For Grade Separations), the ACP swale shall be 3.0 m wide. For river bridges, any portion of the headslope above pathways shall be covered with concrete slope protection, while any other portions (not including any portions requiring rock riprap) shall receive appropriate treatment to prevent erosion and enhance the appearance of the headslopes.

All electrical and communications wiring for the New Infrastructure shall be underground.

300.2.5 PROVISIONS FOR FUTURE STAGES

During design of the roadway elements, the Contractor shall be cognizant of the requirement for future expansion through the addition of lanes or other elements as detailed in Section 200 (Project Specifics). Design and construction must feasibly allow for future, economical, expansion through addition of lanes and other elements.

During design of the bridge structures, the Contractor shall be cognizant of the requirement for future widening and/or lengthening of the bridge structures. When required, the initial design and construction of the bridge structures shall consider provisions that feasibly allow for future, economical, bridge structure widening and/or lengthening.

Vertical grade lines shall be set so that all vertical clearance requirements are met after any anticipated bridge structure widening and/or lengthening or roadway rehabilitation has occurred.

300.2.6 ROADWAY SAFETY AUDITS

Roadway safety audits shall be performed pursuant to the DBFO Agreement and the Contractor's Management Systems and Plans. Roadway safety audits shall follow the Transportation Association of Canada ("TAC") work scope detailed in the *Canadian Road Safety Audit Guide*, for both design and pre-opening stages. The pre-opening safety audit must be conducted after the roadway is paved and all signage, pavement markings, barriers and roadway lighting are complete. Roadway safety audits shall be an integral part of the QMS.

The Contractor shall provide the Department, as soon as practicable, with a copy of the Contractor's Response Report to each of the design and pre-opening safety audits. The Contractor shall implement, at its cost, those recommendations or suggestions in the design and pre-opening safety audits as determined by the Contractor, acting reasonably. The Contractor shall provide the Department with a written explanation as to those recommendations or suggestions in the design and pre-opening safety audits that the Contractor has decided not to implement. The Contractor shall implement or shall refrain from implementing, at its costs, those recommendations or suggestions in the design and pre-opening safety audits as directed in writing by the Department.

300.3 CONSTRUCTION - GENERAL**300.3.1 RESPONSIBILITY FOR CONSTRUCTION**

The Contractor is responsible for the supply of all management, professional and technical services, supervision services, construction quality control and quality assurance services, labour, materials, and equipment for performing all of the duties and obligations necessary for delivering all of the requirements of the Project. The Contractor is responsible for obtaining and complying with requirements of all permits and other authorizations required for the construction of the New Infrastructure.

The Contractor shall ensure that construction conforms to the requirements of the design and the Technical Requirements. All construction is to reflect a high degree of workmanship and all materials incorporated into the New Infrastructure shall be new and shall meet long-term safety, durability and functionality requirements.

Changes to the Detailed Design initiated by the Contractor made during the Construction Period shall be submitted to the Department for review in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure). Any changes to the Technical Requirements initiated by the Department shall be subject to the Change Order requirements detailed in the DBFO Agreement.

The Contractor is responsible for reclaiming all areas of the Road Right of Way, TUC and/or drainage system that have been disturbed during construction of the Project and shall obtain any required Reclamation Certificates related to these activities within 12 months of completing the reclamation activity and shall provide a copy of same to the Department forthwith.

300.3.2 TRAFFIC MANAGEMENT

The Contractor shall maintain the safe and efficient passage of traffic on existing roadways within the Road Right of Way. All detours required to meet this requirement shall be paved.

Requirements for the accommodation of traffic during construction and operation until the end of the Term are set out in Section 200 (Project Specifics) and Sections 400.1 (Operations – General).

If the Contractor elects to truck haul materials over roads that are not designated as truck haul routes by the Local Authority, the Contractor shall be responsible for obtaining written approval from the Local Authority and the Department for use of proposed haul routes within their respective jurisdictions.

300.3.3 AS-BUILT INFORMATION

The Contractor shall compile and record information on the dimensions and physical characteristics of the New Infrastructure. The Contractor shall compile and retain the As-Built Roadway Construction Report, As-Built Surfacing Information, As-Built Pavement Structural Information, and As-Built Construction Report – Bridge Structures, As-Built Traffic Signal Information, As-Built Drawings, all as described below (the “**As-Built Construction Reports**”) that include full descriptions of each phase of the work, including, but not limited to, as-built surveys, as-built drawings, and inspection and test reports.

Within 90 days of Execution of the DBFO Agreement the Contractor shall plan, schedule and host a meeting with the Department to address as-built information. The meeting shall be attended by the following members from the Contractor’s team:

- Design Engineer (those responsible for Record Drawings (as set out in Section 300.3.3.6) and As-Built Construction Reports);
- Project Quality Manager;
- design quality manager;
- Construction Quality Manager; and
- Field Review Engineers.

The Contractor shall prepare and circulate an agenda, acceptable to the Department, detailing the Contractor’s approach to gathering as-built information, and the incorporation of as-built information into the Record Drawings and As-Built Construction Reports two weeks prior to the meeting. In addition, the Contractor shall submit for review and comment the Contractor’s proposed content, layout and format of Record Drawings and As-Built Construction Reports. The Contractor’s meeting agenda shall include for discussion the Contractor’s proposed process and schedule for the submission of Record Drawings and As-Built Construction Reports, the Department’s review, and the Contractor’s process for addressing the Department’s comments.

The maximum time for completion and the providing of the stamped and sealed As-Built Construction Reports and record drawings to the Department shall be 12 months after RNI Traffic Availability.

If the As-Built Construction Reports and record drawings are not available to the Department within the specified time, a Payment Adjustment of \$20,000/month or any partial month, for every month in excess of the specified time shall apply until available.

300.3.3.1 As-Built Roadway Construction Report

The As-Built Roadway Construction Report means an as-built report that contains sufficient detail so that an independent reviewer can gain a clear understanding of the Project. The report must be in an electronic PDF format and in hard copy. The As-Built Roadway Construction Report shall contain, but not be limited to the following:

- Project title;
- Scope of the Project, Project description and site plan;
- Project staff, quality control and quality assurance staff, subcontractors, equipment and suppliers;
- Actual Project schedule and key dates;
- Work progress, problems and solutions;
- Innovative and unique aspects of the Project;
- Safety, traffic accommodation and utility relocation;
- DBFO Agreement extensions, Change Orders, or supplemental work;
- Environmental issues;
- As-built survey data;
- Photographs of key activities;
- Commentary on the materials testing results; and
- Copies of all correspondence to the Department and to the Contractor from the Department including minutes of meetings.

300.3.3.2 As-Built Surfacing Information

The Contractor shall prepare an as-built report known as the “As-Built Surfacing Information” which shall include but not be limited to the following:

Project Description - A complete description of the Project, including, but not limited to, the following:

- Highway control section number (e.g. 2:02);
- Project title;
- Project description and site plan;
- Project staff, quality control and quality assurance staff, subcontractors, equipment, and suppliers;
- Surfacing schedule and key dates;
- Work progress, problems, and solutions;
- Innovative and unique aspects of the surfacing;
- Safety, traffic accommodation, and utility relocation;
- All concrete and asphalt mix designs;
- Change Orders;
- Environmental issues;
- As-built survey data;
- Width and thickness charts;
- Photographs of key activities;
- Commentary on the materials testing results for grading and granular base course;
- Commentary and summary of asphalt pavement and hydraulic cement concrete testing

results;

- Commentary and summary of test results for all asphalt cements and asphalt materials; hydraulic cement and supplemental cementing agents; aggregate (crushed and uncrushed products) and any other mixture additives; and
- Any other information recorded as part of the QMS and required to document material properties or construction details.

300.3.3.3 As-Built Pavement Structural Information

The Contractor shall prepare an as-built report known as the “As-Built Pavement Structural Information” which shall include, but not be limited to:

Width and thickness diagrams - for each homogeneous section greater than 200 m in length, containing:

- Soil classifications;
- Subgrade additives used, if any (e.g. lime);
- The applicable plans, annotated to show any deviation from the original design;
- The results of any coring or drilling undertaken on the Project;
- The finished surface width (rounded to the nearest 100 mm);
- The constructed sideslope ratios of pavement structure and subgrade as applicable; and
- The constructed pavement structure thickness (rounded to the nearest 5 mm) including:
 - The thickness of each layer of the pavement structure; and
 - The type and grade of asphalt cement and/or type and classification of hydraulic Cement concrete used.

300.3.3.4 As-Built Construction Report - Bridge Structures

The Contractor shall prepare an as-built report known as the “As-Built Construction Report – Bridge Structures” for each bridge structure which shall contain, but not be limited to the following:

- Shop drawings for bridge material fabrication (see Section 300.3.3.7 (Bridge Shop Drawing Submission Requirements));
- Weld procedures;
- Mill reports for stressing strand;
- Stress-strain curves for stressing strand;
- Stressing calculations;
- Camber records;
- Construction Data Sheets for precast concrete girders;
- Mill certificates;
- Test reports for Charpy impact, hardness, radiography, ultrasonic, magnetic particle, and dye penetrant;
- Heat treatment records;
- Concrete and asphalt mix designs;
- Pile driving, pile drilling, foundation records;
- Location and details of remaining substructure elements from demolished structures;
- Concrete test results;
- Post-tensioning and stressing records;

- Material testing results including gradation analysis for backfill materials, clay seal, etc.;
- Any other information recorded as part of the QMS and required to document material properties or construction details; and
- All documents listed in Section 300.5.4 (Final Design Report Requirements).

300.3.3.5 As-Built Traffic Signal Information

The Contractor shall prepare an as-built report known as the “As-Built Traffic Signal Information” for all traffic signals installed. The report shall include, but not be limited to:

- Traffic signal as-built drawings;
- Traffic signal controller database (in both hardcopy format and digital format in native controller database format);
- Shop drawings of all traffic signal poles used;
- Traffic cabinet wiring drawings;
- Traffic signal pre-emption verification and testing results;
- Traffic camera programming files, if applicable; and
- Traffic camera detection field of view plots, if applicable.

300.3.3.6 Record and Construction Drawings

The Contractor shall prepare and supply record drawings (C-Drawings), known as “**Record Drawings**” to the Department for record purposes. The Record Drawings shall provide an accurate representation of the completed Project and shall be authenticated by a Professional Engineer to indicate that the construction was completed in accordance with the Detailed Designs and the Technical Requirements.

For bridges the Contractor shall also supply construction drawings (P-drawings). These drawings represent the final design for construction and shall be authenticated by the Design Engineer and the Check Engineer.

The Contractor shall supply the following Record Drawings to the Department:

Roads:

- One full-size stamped and signed set of C-Drawings on 3 mil matte polyester film as per *Engineering Consultant Guidelines for Highway and Bridge Projects - Volume 2 - Construction Contract Administration* and formatted in accordance with the linear referencing requirements of Alberta Transportation’s Transportation Information Management System (“TIMS”) available from the Department;
- Two sets of 11x17 stamped and signed C-Drawings (organized per roadway segment and placed in binders);
- One set of the electronic version of the stamped and signed C-Drawings in Microstation.dgn format;
- All XML files;
- All Ultimate Stage interchanges designs not constructed; and
- One set of the electronic version of the stamped and signed C-Drawings in .pdf format, two sets of 22 x 34 size (one set locked and one set unlocked).

Bridges:

- For each bridge structure file number assigned it is considered a standalone structure and independent of other structures. This includes bridges, overhead sign structures, bridge culverts and retaining walls. The following is to be supplied:
 - One full-size stamped and signed set of C-Drawings and P-Drawings on 3 mil matte polyester film as per Engineering Consultant Guidelines for Highway and Bridge Projects - Volume 2 - Construction Contract Administration;
 - One set of the electronic version of the stamped and signed C-Drawings series drawings in Microstation.dgn format, one per each bridge file number;
 - One set of the electronic version of the stamped and signed P-Drawings series drawings in Microstation.dgn format, one per each bridge file number;
 - One set of the electronic version of the stamped and signed C-Drawings series drawings in .pdf format, two per each bridge file number at 22 x 34 size (one set locked and one set unlocked);
 - One set of the electronic version of the stamped and signed P-Drawings series drawings in .pdf format, one per each bridge file number at 22 x 34 size (one set locked and one set unlocked); and
 - For sign structures a single drawing is to be included that shows the entire length of the New Infrastructure showing all sign structures and their identifications, drawing is to be both in Microstation.dgn format and pdf format.

300.3.3.7 Bridge Shop Drawing Submission Requirements

- Submit a complete set of shop drawings for each bridge for review, including any shop drawings that are common to more than one bridge. For final submission of shop drawings there is to be one complete standalone set including any drawings that are common to more than one bridge.
- Submit shop drawings for review in electronic file format, for printing in 8 ½” x 11” or 11” x 17” format. Minimum text height to be 2.5mm. Quality of shop drawings to be such that all details remain clearly legible in the submitted format size after black and white scanning at 300 dpi.
- Place the review stamp on the front of each shop drawing, legibly signed and dated, and positioned so that it does not obscure any drawing information.
- Place a standard Shop Drawing Identification Block close to the bottom right of every shop drawing that contains all information identified in the Sample Shop Drawing Identification Block below. Position the shop drawing identification block so that it does not obscure any drawing information.
- All supplier design shop drawings shall be authenticated according to Section 100.2.1 (Quality Management System).
- Resubmit all revised shop drawings.

Shop Drawing Identification:

Sample Identification Block

Comments on Fields

Southwest Calgary Ring Road		<i>Project Identifier must go on all shop drawings</i>
Contractor Structure No.	XXXX	<i>Supplied by the Contractor based on the Contractor bridge numbering system</i>
Design Dwg X-Ref	X	<i>Supplied by the Contractor (this is the Department's design drawing number(s) that the shop drawing relates to)</i>
Drawing No.	X	<i>Supplied by the Contractor (must be unique for each sheet, and contain revision numbers where applicable)</i>
AT Bridge File No.	X	<i>Supplied by the Department</i>
AT Structure No.	X	<i>Supplied by the Department</i>
Steel Ident No.	X	<i>Supplied by the Department (where applicable)</i>
Concrete Ident No.	X	<i>Supplied by the Department (where applicable)</i>
Sheet No.	-XXX	<i>Supplied by the Contractor – sequential number based on bridge component. Not to be intermix bridge components</i>

300.4 ROADWAYS

300.4.1 DESIGN REQUIREMENTS

300.4.1.1 Geometric Design

The design shall be undertaken in accordance with the latest edition of *Alberta Transportation's Highway Geometric Design Guide* and applicable *Design Bulletins*, Section 200 (Project Specifics) and where noted, associated reference manuals or guidelines. Where specific design elements are not included in the *Alberta Transportation's Highway Geometric Design Guide* and applicable *Design Bulletins*, the design shall be undertaken to conform to the *TAC Geometric Design Guide for Canadian Roads*. All design performed for this Project shall fully comply with the *Roadside Design Guide*.

The design shall utilize, as a minimum, the design criteria stipulated in Section 200 (Project Specifics). Where design criteria are not specified, desirable design criteria shall be utilized, except where minimum design criteria are acceptable to the safety auditor. In no circumstance will the use of combinations of inter-related minimum design criteria be accepted.

The Contractor shall consider the ultimate design identified in the Functional Plan, or as detailed in Section 200 (Project Specifics), in all design decisions in order to facilitate any additions to the New Infrastructure during the Term or later. The design shall consider future costs, throwaway costs, user costs, safety, and identify an optimal design within such constraints. Life

cycle cost considerations shall be documented in the design report to support the design decisions. The Project mainline, ramps and crossroads shall be designed for the design speeds identified in Section 200 (Project Specifics).

300.4.1.2 Intersections and Interchanges

The design of at-grade intersections shall be in accordance with *Alberta Transportation's Highway Geometric Design Guide* and any applicable *Alberta Transportation Design Bulletins* and the design requirements and design traffic volumes outlined in Packages A through E of Appendix J.

Interchanges shall be designed to the configurations established in the Functional Plan, to Section 200 (Project Specifics), or to equivalent alternative configurations accepted by the Department. The Contractor's design shall achieve the equivalent or better level of service as achieved in the Functional Plan's concept and as revised in Section 200 (Project Specifics). The traffic volumes stated in the Functional Plan and as revised in Section 200 (Project Specifics) shall be used for the purpose of analysis using an appropriate simulation method.

As part of the Contractor's submission to revise a service interchange configuration, the Contractor's submission shall address the requirements of Alberta Transportation Design Bulletin #84 – Considerations for Selection of Freeway Over/Under Configuration at Service Interchanges.

300.4.1.2.1 Traffic Simulation

The Contractor will not be required to perform traffic simulations on systems interchanges. Traffic simulation using Synchro/Sim Traffic software is required for all service interchanges and the following at-grade intersections:

1. 37 Street/Strathcona Street & Grey Eagle Drive;
2. Highway 8 & Lott Creek Boulevard;
3. Highway 8 & 101 Street SW;
4. Highway 22X & 53 Street SW/112 Street; and
5. 90 Avenue SW & Southland Drive.

The Contractor shall perform the simulations using the Packages A through E in Appendix J setting out the methodology for developing and evaluating alternatives and for confirmation/validation of designs, as outlined in Section 200.2.3 (Design Specifics). Packages A through E of Appendix J contemplate both Stage 1 and Ultimate Stage a.m. and p.m. peak hour Synchro/Sim Traffic models for each service interchange and at-grade intersection.

Specific instructions are provided in Packages A through E in Appendix J for the following:

Package A (Synchro Modeling Guidelines for Interchange Ramp Intersections):

- Criteria for Failed Operations (list of Measures of Effectiveness as well as interchange performance criteria);
- Synchro Factors
 - Signal phasing requirements and application notes;
 - Minimum traffic signal timing requirements and application notes;
 - Default Synchro/SimTraffic model parameters (parameters that are fixed and not to be modified in any way by the Contractor); and

- Allowable Synchro/SimTraffic model adjustments (parameters that can be modified by the Contractor in searching for design alternatives);
- Synchro/SimTraffic modeling approach; and
- Simulation results evaluation.

Package B (Synchro & SimTraffic Models for Interchange Ramp Intersections):

- Requirements for turn bay lengths;
- Criteria for determination of turn bay lengths at crossroad ramp intersections; and
- Examples.

Package C (Criteria for Alternative Interchange Configurations):

- Minimum requirements for Synchro/SimTraffic modeling;
- Evaluating Synchro/SimTraffic models;
- Eliminating queue failures; and
- Synchro/SimTraffic models.

If the Stage 1 or Ultimate Stage design for a service interchange proposed by the Contractor is different from the interchange configuration shown in Packages A through C in Appendix J, the Contractor shall:

- Submit Synchro/SimTraffic files which demonstrate that operation of the Contractor's Stage 1 design will meet the requirements specified in the Package under the Stage 1 a.m. and p.m. peak hour period traffic conditions;
- Submit Synchro/SimTraffic files which demonstrate that operation of the Contractor's Ultimate Stage design will meet the requirements specified in the Package under the Ultimate Stage a.m. and p.m. peak hour period traffic conditions; and
- Demonstrate that the Contractor's Stage 1 design is compatible with the Ultimate Stage design.

Specific instructions associated with at-grade intersection assessments and design changes are provided in Packages D and E in Appendix J for the following:

Package D (Synchro Modeling Guidelines for At-Grade Signalized Intersections)

- Applicable for the following at-grade intersections:
 - 37 Street/Strathcona Street & Grey Eagle Drive;
 - Highway 8 & Lott Creek Boulevard;
 - Highway 8 & 101 Street SW;
 - Highway 22X & 53 Street SW/112 Street; and
 - 90 Avenue SW & Southland Drive;
- Criteria for failed operations (list of measures of effectiveness as well as intersection performance criteria);
- Synchro factors:
 - Signal phasing requirements and application notes;
 - Minimum traffic signal timing requirements and application notes;

- Default Synchro/SimTraffic model parameters (parameters that are fixed and not to be modified in any way by the Contractor); and
- Allowable Synchro/SimTraffic model adjustments (parameters that can be modified by the Contractor in searching for design alternatives);
- Synchro/SimTraffic modeling approach; and
- Simulation results evaluation.

Package E (Synchro & SimTraffic Models for At-Grade Signalized Intersections):

- Design Volumes for at-grade intersections;
- Minimum requirements for Synchro/SimTraffic modeling;
- Evaluating Synchro/SimTraffic models; and
- Criteria for determination of turn bay lengths at at-grade intersections.

300.4.1.3 Soils

The Contractor shall undertake the grading design with due consideration for the soil types encountered. A geotechnical investigation shall be carried out by the Contractor in sufficient detail to allow for the identification of all soils issues.

The Contractor shall prepare and provide to the Department detailed geotechnical reports for the entire Project for the purpose of documenting soil conditions and the engineering recommendations for all soils issues. The reports shall be completed in accordance with the *Canadian Foundation Manual* and the Department's *Engineering Consultant Guidelines for Highway and Bridge Projects*.

300.4.1.4 Drainage

The drainage design shall prevent damage to the Road Right of Way, the TUC and the lands adjacent the TUC, caused by flooding or drainage problems.

The Contractor shall be responsible for obtaining all necessary permits and authorizations from, but not limited to, the Department of Infrastructure, Alberta Environment, the Department, Fisheries and Oceans Canada, and the Local Authority, as applicable.

The drainage design shall include temporary and permanent erosion control installations necessary for the in-situ conditions of the drainage works. The Department's *Design Guidelines for Erosion and Sediment Control for Highways* may be considered for such designs.

300.4.1.5 Hazard Protection

The use of barriers shall be limited to those areas where it is necessary to protect the travelling public from roadside hazards. All grade line design shall be such as to minimize the need for barriers.

The Contractor shall utilize the appropriate barrier configuration for providing temporary and permanent protection for roadside hazards based on safety considerations. For drainage obstructions, the Contractor shall undertake the design to minimize the need for protection. In any special circumstance where protection is required, the Contractor shall protect the public from the hazard using a barrier that has passed all required tests for *MASH*, Test Level 3, unless otherwise specified in Section 200 (Project Specifics).

The Contractor shall use barrier end treatments that have passed all required tests for *MASH*, Test Level 3.

Where barriers are required and cannot be avoided by altering design characteristics of the roadway, three beam rail shall be used. The rail, support posts, and ancillary hardware shall be specified to meet the performance requirements described in *MASH*, Test Level 3 and Section 200 (Project Specifics).

300.4.1.6 Roadway Lighting

300.4.1.6.1 General

The Contractor shall design the roadway lighting in accordance with the requirements of the *Alberta Transportation Highway Lighting Guide*. The design shall result in lighting to levels identified in Section 200 (Project Specifics) for the full length of all roadways.

300.4.1.6.2 Design

Poles and bases shall meet the requirements of the *Alberta Transportation Highway Lighting Guide*. All straight or davit type lighting structures shorter than 16 metres shall be designed in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and, Traffic Signals 6th edition, with 2015 interim revisions. Design criteria for light pole loading shall satisfy the requirements as shown on drawing TCS-E-605.2 of the *Alberta Transportation Highway Lighting Guide*.

Straight lighting poles and davit-type poles longer than 16 metres are considered high mast poles and shall be designed in accordance with Section 300.5.2.9 (Overhead Sign Structures and High-Mast Lighting Support Structures). For high mast poles the bottom of the hand hole shall not be less than 350 mm and no more than 500 mm above the top of the concrete base.

All designed systems shall be in accordance with the *Canadian Electrical Code* and the regulations of the electrical inspection department having jurisdiction. The Contractor shall prepare shop drawings of all electrical components as part of the design. The drawings shall include, at a minimum, poles, luminaires, distribution enclosures and bases. Shop drawings shall be stamped and signed by a Professional Engineer.

The Design Engineer shall certify that the design and installed street light infrastructure such as luminaires, pole, frangible base, and foundations satisfy the Technical Requirements.

300.4.1.6.2.1 Pole Alignments

All light standards shall be located in the centerline median or off the right side of the roadway for Mainline illumination and generally off the right side of the roadway for illumination of connectors, ramps and C-D roads. Light standards may be installed on both sides of crossroads at interchanges and wide gore areas where design standards cannot be achieved by lighting from one side. The Department may, at its sole discretion, allow the placement of poles on the left-hand side of connectors, ramps, and C-D roads where complex road configurations exist and such pole placement provides better lighting for motorists. The Contractor must provide written justification for any such proposed arrangements along with design alternatives for review and acceptance by the Department.

300.4.1.6.2.2 Pole Offsets

The Roadside Design Guide shall be used to determine clear zone requirements. Light poles located within the clear zone shall be on break-away bases. Light poles located outside the clear zone are not required to be on breakaway bases. Street light poles positioned behind a barrier must be outside of the barrier design deflection and the zone of intrusion as per the Roadside Design Guide and must not be fitted with breakaway bases.

300.4.1.6.2.3 Miscellaneous Requirements

- Refer to Section 300.5.2.9 for high mast structure functional requirements.
- All electrical systems shall be designed and constructed in accordance with the *Canadian Electrical Code, Part 1, 2015* and the regulations of the electrical inspection authority having jurisdiction.
- All poles and associated hardware shall be hot-dip galvanized in accordance with Section 24.2.2.6 (7) (Galvanizing) of the *Alberta Transportation Standard Specifications for Bridge Construction*. Where two or more galvanized sections will be placed in close proximity, the finished appearance of each section shall be similar to the adjacent galvanized section(s).
- All permanent electrical, communications or traffic signal cables and/or conduits shall be buried underground and properly separated from any adjacent utility systems.
- Temporary wiring for detours may be strung overhead.
- The maximum spacing between temporary poles carrying un-guyed (slack span) wires shall not exceed 30 m.
- Non-frangible poles for temporary lighting must be positioned outside of clear zone unless they are protected by barriers.
- Screw-in bases are not permitted.

300.4.1.6.3 Installation

Lighting components shall be installed in accordance with Alberta Transportation's *Highway Lighting Guide* Section E6 (Lighting Components). The projection of concrete light foundations above compacted grade after landscaping shall be as follows:

- All Davit Poles:
 - 100mm
- High Mast:
 - 450mm
- On sloping ground the projection measurement shall be taken on the uphill side of the foundation
- Tolerance on foundation projection shall be +/- 50mm

Poles and bases that do not meet these criteria must be reset to the specified criteria.

300.4.1.6.4 Lighting Equipment

300.4.1.6.4.1 Breakaway Bases

Breakaway bases shall meet the requirements of section 12 (Breakaway Supports) of "AASHTO-Standard Specifications For Structural Supports For Highway Signs, Luminaires, and Traffic Signals" (5th edition) and be an Approved Product.

300.4.1.6.4.2 Luminaires

- Luminaires shall not emit any direct light in the zone above 90⁰ from nadir, as verified by published photometric data. Luminaire backlight, up-light and glare (“**BUG**”) rating for up light (“**U**”) shall be 0. Luminaires intended for use under bridges and in underpasses may have an up light rating greater than 0 *provided* it can be demonstrated conclusively by calculation that the bridge or underpass structure physically blocks all up-light from the luminaires.
- Ingress protection required on high-pressure sodium (“**HPS**”) luminaire optical chamber shall be IP65 or better; protection for the electrical compartment shall be IP54 or better.
- Luminaire slip fitter shall accommodate a 2 ³/₈ inch OD (60 mm) tenon and shall be fitted with provision to deter wildlife from entering the luminaire.
- Luminaire construction shall meet “Abnormal” Conditions for Vibration (3G).
- Tilt limits shall be +5⁰ to -5⁰ from horizontal. Tilting method may be continuously variable or by steps of 2.5⁰.
- Luminaire mass and EPA values shall not exceed those that would cause the maximum permitted loading for Alberta Transportation standard davit poles to be exceeded.
- Luminaires shall be properly certified for sale and use in Canada (see Alberta STANDATA listing for accredited certifying agencies).
- All luminaires shall display the external NEMA wattage label and the internal product details label.
- Luminaires shall have the lowest glare rating consistent with satisfying the lighting design parameters specified in Section 200.2.6 for each roadway type. Glare rating (“**G**”) shall be applied independently to specific luminaire zones as follows:
 - Zones BVH and FVH.....G shall not exceed 3
 - Zone BH.....G shall not exceed 3
 - Zone FHG shall not exceed 4
 Refer to IES TM-15-11 for definitions of the zones and associated distribution angles.
- Refer to Section 300.4.1.6.4.4 below for additional specifications pertaining to LED luminaires.

300.4.1.6.4.3 HPS Lamps

Long-life lamps are required, minimum average rated life shall be 30,000 hours. Minimum initial light output shall be 29,000 lumens. The use of dual arc tube lamps is not permitted.

300.4.1.6.4.4 LED Luminaires**300.4.1.6.4.4.1 Physical Properties**

- Luminaires shall be pressure die cast or extruded aluminium; copper content by weight to be less than 0.4%, silicon content by weight to be less than 7.0%. All joints in extrusions shall be water tight.
- Only passive thermal management is permitted. Exterior profile and heat sink fin arrangement shall be designed to promote run-off and deter the build-up of debris.
- Ingress protection required:
 - LEDs and/or optical enclosure
 - IP66 or better

- Electrical compartment
 - IP 54 or better
- Luminaire finish shall be natural aluminium. A polyester triglycidyl isocyanurate super-durable powder coat finish or equal may be accepted entirely at the Department's discretion. Minimum coating thickness to be 2 mils and minimum pull-off strength to be 1000 PSI. The finish shall be free of wrinkles, cracking, orange peel, pin holes, blisters and other visual defects. Prior to installation any luminaire found to have coating imperfections or damage shall be returned to the supplier for repair. Minor coating damage occurring during installation shall be repaired according to the coating manufacturer's specifications.
 - Luminaires shall achieve a rating of 5 or better at 1000 hours in a Salt/Fog test. The Contractor shall supply full testing data.
 - The housing must be fitted with a NEMA standard 7 pin photo receptacle complete with polarized shorting cap. Access to the luminaire electrical compartment shall be achievable without the use of tools.
 - Luminaires with fin arrangement(s) that produce wind-generated noise are not permitted.

300.4.1.6.4.4.2 Electrical Properties

300.4.1.6.4.4.2.1 Electrical Connections

- Internal screws and fasteners shall be electro plated; external fastening hardware shall be stainless steel. Captive screws are required for any component that requires future maintenance. The use of thread-locking compound is not permitted.
- The main terminal block shall accommodate #8 through #16AWG feeders and luminaire wiring.
- LED driver wiring shall be fitted with polarised quick disconnects to facilitate driver removal in future. Permanent connections within the luminaire shall be high spring tension, push-in type or equal approved.

300.4.1.6.4.4.2.2 Line Voltage

- Luminaires shall be capable of accommodating LED drivers operating at 347 V or self-adjusting 120 V to 240 V. The Luminaire manufacturer shall supply technical information and test data as appropriate for both voltage options.
- Luminaire electrical components shall operate at a power factor of 90% or better and shall accommodate line voltage variations of -10% to +6%.

300.4.1.6.4.4.2.3 Dimming

- All luminaires shall have 0 -10 V dimming capability installed.
- Minimum dimming range shall be 20% to 100% of full output, the Contractor shall supply dimming curves to the Department.

300.4.1.6.4.4.2.4 Surge Suppression

- All luminaires shall be protected to a minimum surge suppression level of 10 kA and 10 kV. The Contractor shall provide written verification that the luminaires have successfully passed Ring Wave, Combination Wave and Electrical Fast Transient tests pursuant to IEEE

C62.41.2-2002 and IEEE C62.45-2000 requirements.

300.4.1.6.4.4.2.5 LED Driver Properties

- A high reliability lighting system is required where design features and component sets provide for a minimum 88,000 hour effective life expectancy at 20⁰ C external ambient temperatures.
- Luminaire power supplies shall have open circuit and short circuit protection and shall be designed for reliable operation at external temperatures of -40⁰ C to +40⁰ C.
- Drivers shall be rated for damp or wet locations and shall be positioned in the luminaire for ease of access. Drivers shall be field-replaceable.
- Driver maximum Total Harmonic Distortion (THD) permitted shall be 20% at full power across the specified voltage range(s).
- The Contractor shall obtain from the luminaire supplier the list of the full range of drive currents available for a specific luminaire configuration. All temperature and performance testing associated with that luminaire configuration shall be based on conditions directly related to the actual drive current selected.
- The Contractor shall ensure the luminaire manufacturer determines a Luminaire Ambient Temperature Factor applicable to the specific product(s) proposed by the Contractor when operating at a nominal +10⁰C.
- The Contractor shall ensure the luminaire manufacturer supplies all test data necessary to demonstrate that the maximum driver case temperature in the luminaire does not exceed the rated maximum case temperature for an 88,000 hour service life.
- The Contractor shall perform in-situ system temperature measurement testing within one year of Traffic Availability to ensure that final operating temperatures match LED and power supply operating criteria. The Contractor shall ensure the manufacturer supplies test results for conformance review.

300.4.1.6.4.4.2.6 LED Properties

- Equivalent colour temperature of the emitted light shall be 4,000⁰ K +/- 300⁰ K. The Contractor shall ensure the supplier provides QC documentation to show how colour temperature and temperature tolerance are controlled.
- A Rated Lumen Maintenance Life (“**RLML**”) (L₇₀) of 88,000 hours is required. The L₇₀ life shall be determined from the last 50% of data obtained by an accredited independent lab (NVLAP or equivalent) from life testing of 15,000 hours or longer in duration.
- Extrapolations used to establish the RLML shall not exceed six times the life test duration. The Contractor shall ensure the luminaire manufacturer supplies life test and extrapolation data in support of its RLML claims.
- Luminaire configurations that appear to yield an L₇₀ greater than 88,000 hours may be considered acceptable at the Department’s sole discretion. The Contractor shall provide the Department with a complete package of testing and extrapolation data for analysis.
- The Contractor shall replace LED luminaires at 88,000 operational hours unless the Department, at its sole discretion and after analysis of the Contractor’s data, determines that a longer service period can be accepted without compromising the minimum lighting system performance requirements.

300.4.1.6.4.2.7 Optical Properties

- LED luminaires shall be capable of providing light distributions formerly described as IES Type 2 and Type 3 for general lighting tasks. The flexibility that LED luminaires have to deliver a variety of other light distribution shall be exploited where such light distributions would simplify the lighting of complex road configurations or would contribute to greater system efficiency by allowing longer pole spacing's.
- Typical pole setbacks dictate that the majority of available light should be directed forward towards the road. LED luminaires shall have a BUG rating for back light ("B") no greater than 3.
- No part of the optical system shall be constructed of polycarbonate material unless it is fully UV protected. Discoloration of polycarbonate material will be deemed a product failure requiring replacement of the luminaire.

300.4.1.7 Landscaping

All non-hard surfaced areas within the Road Right of Way and other disturbed areas within the TUC shall be topsoiled and seeded to grass as noted in Section 200 (Project Specifics).

300.4.1.8 Pavement Structure

The Contractor shall design the pavement structures in accordance with recognized design procedures on the basis of actual soil parameters for the roadway subgrade. Use of subgrade additives (such as cement or lime) shall not result in a decreased pavement structure compared to the untreated subgrade soils. Standard design procedures and terminology used by the Department are described in the Department's *Pavement Design Manual, Design Bulletin #77*, and related Design Bulletins. The Department does not consider the AASHTO *Mechanistic-Empirical Pavement Design Guide* ("M-EPDG") as a recognized design procedure, however its use for design confirmation purposes is acceptable.

The pavement structures for all roadways within the New Infrastructure shall be designed with no reduction of or restrictions to allowable legal load(s), during spring time thawing conditions or at any other time. For pavement designs such as final-stage paving and rehabilitation, the Contractor's design methodology shall utilize back-calculated layer moduli values that the Contractor shall determine based on non-destructive testing. The non-destructive data shall be no more than four years old at the time of the planned activity.

Materials for the roadway surface may be asphalt concrete pavement or hydraulic cement concrete pavement. All travelled lanes and full shoulder widths shall be paved. Shoulder and lane materials do not have to be the same, however the potential for future widening must be addressed in the design such that increased cost to the Department does not result at the time of any future widening. The subgrade widening at tie-ins to existing roadways shall be constructed to avoid disruption of drainage along the subgrade surface and base course layers and shall protect the integrity of the existing pavement structure. Pavement structure variation for New Infrastructure shall be introduced beyond the tie-in point to preserve subgrade drainage and structural integrity of existing roads.

Pavements to be placed adjacent to curb and gutter or raised medians or below bridge structures present problems in providing future overlays and maintaining proper curb heights and clearances. The Contractor shall design and construct pavements using materials and increased thicknesses to meet a long-life standard such that future rehabilitation will involve mill and

replace activities only with no requirement for structural strengthening or overlays. The Department considers the traffic loading of a minimum 50-year design period combined with materials selected for the applicable environmental conditions as meeting a long-life standard.

The pavement structure design shall account for the Ultimate Stage and future widening as stipulated in the Functional Plan and Section 200 (Project Specifics). The subgrade for the Ultimate Stage shall be designed and constructed to accommodate the pavement structures for the Ultimate Stage indicated in the Functional Plan. For portions of the Project requiring grading for the future Outer Ring Road, the subgrade shall be designed and constructed to accommodate a pavement design equal to that shown in the Functional Plan. The design shall identify how the future expansion will be accomplished in a cost effective manner. The pavement design shall provide for the shoulder thickness on the side(s) proposed for future widening to match the pavement structure of the adjoining travel lane.

The granular base shall be extended across the full width of the road embankment and daylighted onto the side slopes for drainage.

300.4.1.8.1 Pavement Design Report

The Contractor shall prepare and provide, to the Department, a pavement design report, for both new construction and subsequent preservation and rehabilitation strategies that shall include, as a minimum:

- All pertinent design inputs such as traffic volumes and characteristics, soils characteristics, characteristics of the proposed construction materials, environmental inputs to the design and for rehabilitation designs, the existing pavement structure;
- Site plan showing the limits of the roadway covered by the design report;
- Discussion of the inputs used to arrive at design recommendations and the rationale used in selecting the recommended design strategy;
- Typical cross section drawings for the recommended pavement design strategy; and
- For final-stage and rehabilitation designs, graphical presentation of calculated layer moduli, overlay needs, and existing cross sections.

300.4.1.9 Traffic Control Devices

300.4.1.9.1 Signs

Sign patterns for standard signs shall conform to the *Alberta Transportation Sign Catalogue, Design Bulletins #44, #50, #74 and #76*. For signing not addressed by the *Alberta Transportation Sign Catalogue*, sign patterns shall conform to the *TAC Uniform Traffic Control Devices of Canada Sign Pattern Manual*. All lettering on signs shall conform to the series Type Highway Font from the *Standard Alphabet for Highway Signs*, available from the Federal Highway Administration (CHTO-20), Washington, D.C., 20590, unless otherwise specified by the *Alberta Transportation Sign Pattern Manual* or the *TAC Uniform Traffic Control Devices of Canada Sign Pattern Manual* for the applicable signs.

300.4.1.9.2 Traffic Signals

All traffic signal installations, including pedestrian controls, shall be designed in accordance with Alberta Transportation Standard Specifications for Highway Construction, as amended by Specification Amendments and Supplemental Specifications for Highway and Bridge

Constructions, and any applicable Design Bulletins, including Design Bulletin #32. Signal phasing and timing designs shall be based on the practices outlined in the current edition of the TAC Manual of Uniform Traffic Control Devices for Canada, and the Institute of Transportation Engineers Canadian Capacity Guide for Signalized Intersections. The traffic signal design shall be as per the design traffic volumes identified in Packages A through E of Appendix J. The traffic signals shall be installed prior to the Traffic Availability, unless otherwise specified in Packages A through E of Appendix J. The Contractor shall identify, as part of the Contractor's Designs, any planned staging of signal installations (the "**Planned Future Signal Installations**") based on traffic volumes at other locations on the New Infrastructure. The Contractor shall verify annually the signal warrants for any unsignalized intersection within the Road Right of Way using the procedures outlined by the new TAC method in the document "Traffic Signal Warrant Handbook" which applies the Canadian Traffic Signal Warrant Matrix Procedure. The Contractor shall submit the warrant calculations to the Department as soon as practicable after verification. If the Total Priority Points requirement (as defined in the TAC Traffic Signal Warrant Handbook) has been met (minimum 100 cumulative warrant points) and if instructed to do so in writing (the "**Notice**") by the Department, the Contractor shall install traffic signals at such applicable intersection(s) within 12 weeks after the Notice (the "**Installation Deadline**").

If the Contractor fails to complete the Planned Future Signal Installations on or before the Installation Deadline, the "first occurrence of a non-functioning signal location" of the Payment Adjustments set out in Section 400.4.8.2.3 (Traffic Signals – Payment Adjustments) at an amended rate of \$600/day or any partial day, until rectified shall apply as if the Planned Future Signal Installations had been completed but for 24 hours per day the deemed installed signals were not at all operational. For the purpose of applying such Payment Adjustment, the time stipulated for completing repairs as set out in Section 400.4.8.2.2 (Traffic Signal – Completing Repairs) shall be deemed to have expired on the Installation Deadline. The foregoing Payment Adjustment shall continue to accrue and be payable until such time as the Contractor completes the Planned Future Signal Installations.

The Contractor shall design the traffic signals to allow for time-based signal coordination, if needed, to provide for traffic progression and interaction of traffic signal coordination timings with the adjacent traffic signals belonging to the Local Authority. The Contractor shall initiate contact and cooperate with the Local Authority to meet all of the requirements of the Local Authority's signal timing design along the corridor, while still meeting the signal timing and phasing requirements of the Department. The guidance provided in Package F in Appendix J shall be followed for traffic signal design and drafting.

The Contractor is required to prepare a minimum of eight time-of-day signal timing programs at each signal location. The timing plans shall be developed using realistic traffic volumes. The Detailed Signal Timing Preparation Requirements are provided in Package F of Appendix J. The Contractor shall prepare initial signal timings using the approach recommended in Package F, followed by post-commissioning 24-hour turning movement count data collection and subsequent signal timing adjustments. The methods and timeline for the post-commissioning traffic count data collection shall be as per the requirements outlined in Package F in Appendix J.

All signal timing plans shall be submitted to the Department as per section 2.5 (Design and Plan Submission) of Schedule 5 (Design and Plan Certification Process and Review Procedure) to the DBFO Agreement. Where signal timing involves the Local Authority, the Contractor shall review those plans with the Local Authority and receive the Local Authority's written

acceptance prior to submission to the Department. Acceptance by the Local Authority shall not absolve the Contractor from failing to satisfy the Technical Requirements.

All signal systems shall be similar in appearance to those used by the Local Authority on roadways of the same standard in adjacent areas.

The following project acceptance requirements are applicable for traffic signal installations.

Detailed inspection requirements are provided in Package F of Appendix J of Schedule 18:

1. Tests
 - 1) The Contractor shall carry out various tests required by Alberta Transportation's *Standard Specification for Highway Construction*, Specification 2.26 (Traffic Signals).
 - 2) Traffic Signal Specifications
 - 3) Signal pre-emption testing and certification
 - 4) Test results shall be documented and submitted to the Department as part of the documentation requirements for traffic signal installations
2. Inspection
 - 1) The Contractor shall carry out inspections of traffic signal installations as detailed in Package F of Appendix J.
 - 2) The documentation of completed inspection shall be submitted to the Department as part of the documentation requirements for traffic signal installations. Inspections needed include:
 - i. Traffic signal below ground installations inspection
 - ii. Traffic signal above ground installations inspection
 - iii. TC cabinet bench test
 - iv. Traffic signal pre-commissioning inspection
 - v. Traffic signal construction completion inspection
3. Documentation
 - 1) The following documentation shall be submitted by the Contractor to the Department:
 - i. Drawings
 - a) Complete set of as-built red line markup plans (quality of markup shall be legible and to scale)
 - b) Record drawings for traffic signal installations in both hardcopy and digital pdf format (stamped and signed)
 - c) Clearance measurements (mark on pole elevation drawing the distance from the bottom of fixtures on the mast arm to the pavement surface)
 - d) Cabinet schematic (in cabinet and in digital format)
 - ii. Serial Numbers
 - a) TC Cabinet
 - b) PD Cabinet
 - c) Controller
 - d) MMU
 - e) Detector
 - iii. Tests and Permits

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- a) Cable megger test report
 - b) Electrical safety codes inspection permit
 - c) Concrete test results (for pole bases) – both field slump and air test, and cylinder compressive strength tests
- iv. Equipment and Settings
 - a) Controller database printout and digital file (in both raw controller database format and in pdf format)
 - b) MMU programming chart
 - c) MMU manufacturer's certification
 - d) Cabinet bench test report and record
 - e) Cabinet field test record and report
 - v. Operations and Maintenance Manuals
 - a) Log book (in cabinet)
 - b) Controller operations manual (in digital format)
 - c) Controller maintenance manual (in digital format)
 - d) Malfunction management manual (in hardcopy, place in cabinet, also in digital format)
4. Commissioning
- 1) Commissioning of the traffic signal shall be carried out in the presence of the representatives of the Department
 - 2) When the signal pole and the signal heads are installed, all signal displays shall be bagged for a minimum of seven days
 - 3) The traffic signals shall not be placed into a flash mode before commissioning. Instead, when the traffic signal is ready for full operation, the Department shall give permission to the Contractor to start up the signal. The signal display shall be unbagged at such time.
 - 4) Commissioning or start-up of the traffic signal shall be scheduled between 9 a.m. and 3 p.m.
 - 5) The following requirements shall be met before the start-up of the traffic signal
 - i. Backfilling completed along all trenched areas and around pole bases, cabinets and junction boxes
 - ii. All signal related traffic control signs are installed
 - iii. All detection devices are installed and in operation
 - iv. All signal timings are programmed
 - v. Documentation provided
5. Traffic Signal Project Acceptance
- 1) The traffic signal installation is considered accepted by the Department if all the above requirements are met, and
 - 2) The traffic signal has been in operation for 28 days without any operational or equipment problems. The 28 day period is called the “burn in” period for the traffic signal.
 - 3) The Contractor shall rectify any traffic signal equipment or operations problems reported within 28 days after the traffic signal is commissioned, and

then notify the Department so the correction can be verified through a field visit.

- 4) The same 28 day burn in period will then apply. If no traffic signal equipment or operation problems are reported in the following 28 days, the traffic signal installation is then considered accepted by the Department.

300.4.1.9.3 Pavement Markings

The Contractor shall design, install and maintain painted or durable pavement markings with or without "cat eye reflectors" in conformance with the *Alberta Transportation Pavement Marking Guide*, as amended by related *Design Bulletins*, and the *Alberta Transportation Highway Geometric Design Guide*. The placement and details of chevron paint markings in gore areas shall be in accordance with the Department's Recommended Practice for Chevron Gore Pavement Markings, which can be found on the Department's website.

On roadways with design speed less than or equal to 70 km/h, urban pavement marking arrows shall be used in accordance with Figures TCS-C-401.1, TCS-C-405 and TCS-C-405.1 of the Department's *Highway Pavement Marking Guide* (March 2003). On roadways with a design speed greater than 70 km/h, rural pavement marking arrows shall be used in accordance with Figure TCS-C-401 of the Department's *Highway Pavement Marking Guide* (March 2003).

The final roadway surface shall be free of any defects or markings made by previous or temporary pavement markings.

300.4.1.10 Miscellaneous

300.4.1.10.1 Fencing

Fencing shall be designed and installed along the entire length of the Lands and around any stormwater management facilities related to the New Infrastructure outside the Lands but inside the TUC, as specified in Section 200 (Project Specifics).

300.4.2 MATERIALS

The Contractor shall select the materials to be used for construction and ongoing maintenance to meet the Technical Requirements. Where materials, such as culverts and ducting, have an expected life of greater than 30 years, the selection of the appropriate materials shall be based on a minimum of a 50 year life for the material.

Except for reclaimed asphalt pavement ("RAP") materials, all construction materials shall be new materials specifically manufactured for their intended purposes.

300.4.2.1 Topsoil

Topsoil shall consist of a natural, friable surface soil of organic character, suitable for agricultural purposes. Topsoil shall be substantially free of sub-soil, roots, stones and other deleterious substances.

300.4.2.2 Aggregates

Aggregates for hydraulic cement concrete shall be suitable for use in concrete, shall exhibit suitable long term performance characteristics and shall conform to the requirements of CSA Standard 3-A23.1. Specifically, aggregates for use in concrete pavements or appurtenances shall

exhibit suitable resistance to alkali-aggregate reactivity.

Aggregates for use in asphalt concrete shall be selected to provide suitable long term performance. Asphalt-aggregate compatibility shall be evaluated as part of the asphalt mix design process and during construction using AASHTO T-283 “Resistance of Compacted Hot Mix Asphalt to Moisture-Induced Damage”. Mixes with a tensile strength ratio less than 0.75 shall be considered as moisture susceptible and are to be treated with lime or an appropriate liquid anti-strip agent.

300.4.2.3 Hydraulic Cement Concrete

Materials for hydraulic cement concrete and hydraulic cement shall meet the requirements of specification 5.5 (Supply of Portland Cement Concrete) and specification 5.11 (Supply of Portland Cement) of Alberta Transportation’s *Standard Specifications for Highway Construction*. Section 5.5.6 (Measurement and Payment) and section 5.11.3 (Measurement and Payment) of Alberta Transportation’s *Standard Specifications for Highway Construction* shall not apply. All references to Portland cement shall be understood to refer to hydraulic cement.

Hydraulic cement concrete for use in roadway elements including pavements, curbs, gutters, sidewalks, barriers or other appurtenances shall consist of a mixture of hydraulic cement, supplementary cementing materials, fine aggregate, coarse aggregate, water and admixtures where required, in proportions to meet the requirements of the design.

Hydraulic cement concrete designed for any application that will be in contact with winter maintenance materials shall consist of materials shown to provide adequate resistance to scaling and other freeze thaw damage.

300.4.2.4 Asphalt

Asphalt binders shall meet the requirements of Alberta Transportation’s specification 5.7 (Supply of Asphalt), as stated in its *Standard Specifications for Highway Construction*, and any relevant “Specification Amendments” issued by the Department as of the deadline for the submission of SR Package 2. Section 5.7.5 (Measurement and Payment) of Alberta Transportation’s *Standard Specifications for Highway Construction* shall not apply.

300.4.2.5 Fencing Materials

Fencing materials shall meet the requirements of specification 5.14 (Supply of Fence Material), of Alberta Transportation’s *Standard Specifications for Highway Construction* except as otherwise specified in Section 200.2.15 (Fencing). Section 5.14.4 (Measurement and Payment) of Alberta Transportation’s *Standard Specifications for Highway Construction* shall not apply.

300.4.2.6 Reinforced Concrete Pipe

Reinforced concrete pipe shall meet the requirements of specification 5.16 (Supply of Reinforced Concrete Culvert) of Alberta Transportation’s *Standard Specifications for Highway Construction*. Section 5.16.4 (Measurement and Payment) of Alberta Transportation’s *Standard Specifications for Highway Construction* shall not apply.

300.4.2.7 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall meet the requirements of specification 5.17 (Supply of Polyvinyl Chloride Pipe), of Alberta Transportation’s *Standard Specifications for Highway Construction*.

Section 5.17.9 (Measurement and Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

300.4.2.8 Smooth Walled Steel Pipes

Smooth wall steel pipe materials shall meet the requirements of specification 5.22 (Supply and Install Smooth Wall Steel Pipes) of Alberta Transportation's *Standard Specifications for Highway Construction* except as otherwise specified in Section 200 (Project Specifics). Specification 5.22.4 (Measurement and Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

300.4.2.9 Corrugated Metal Pipe And Pipe Arches

Corrugated metal pipe and pipe arch materials shall meet the requirements of specification 5.23 (Supply of Corrugated Metal Pipe and Pipe Arches) of Alberta Transportation's *Standard Specifications for Highway Construction*. Section 5.23.4 (Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

In addition, corrugated metal pipe and pipe arches up to 1400 mm equivalent diameter shall be selected to ensure a minimum design life of 50 years for the soil conditions in which they are to be installed. Any pipe diameter of 1500 mm or larger is considered a bridge structure.

During installation, any damaged protective coating shall be recoated with the appropriate material in accordance with CSA G401.

300.4.2.10 Curbs, Gutters, Medians, Traffic Islands, Sidewalks and Other Appurtenances

All curbs, gutters, raised medians, traffic islands, sidewalks and other appurtenances shall be constructed with hydraulic cement concrete.

300.4.2.11 Permanent Highway Signs, Posts and Bases

Materials for permanent highway signs, posts and bases shall meet the requirements of specification 5.18 (Supply of Permanent Highway Signs, Posts and Bases) of Alberta Transportation's *Standard Specifications for Highway Construction*. Section 5.18.3 (Measurement and Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

Sign panels shall be shipped, stored and installed in a manner to prevent damage to any sign panels. All damaged signs shall be repaired or replaced by the Contractor. The installed sign panels shall be new, clean, and not bent or twisted. The reflectorized surface shall be free of scratches, marks, blemishes, blisters, tears or other defects.

Sign posts on rural cross-sections, including but not limited to the mainline facility, shall meet the material and breakaway requirements set forth in Section H8 of the Roadside Design Guide. The material and breakaway requirements for sign posts on urban cross-sections may be selected to match adjacent existing urban sign post materials, provided that the material selected for all single posts is the same.

300.4.2.12 Pavement Marking Materials

The Contractor shall supply pavement marking materials that will meet the requirements of the design and the performance requirements in Section 400.4.8.3 (Pavement Markings). Re-

application shall meet the same performance requirements.

Transverse lane markings at all signalized intersections shall be permanent or durable pavement markings. These shall include stop lines, crosswalk lines, pavement arrows (in the vicinity of the intersection or within 100 m of the intersection) and left turn guide lines.

300.4.2.13 Guardrail and Posts

Guardrail and post materials shall meet the requirements of specification 5.25 (Supply of Thrie Beam and W-Beam Guardrail) of Alberta Transportation's *Standard Specifications for Highway Construction* except as otherwise specified in Section 200 (Project Specifics). Section 5.25.5 (Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

300.4.2.14 Intentionally Deleted

300.4.2.15 Flexible Guide Post Traffic Delineators

Material for flexible guide post traffic delineators shall meet the requirements of *Alberta Transportation Standard Specifications for Highway Construction*, specification 5.28, (Supply of Flexible Guide Post Traffic Delineators). Section 5.28.3 (Measurement and Payment) of Alberta Transportation's *Standard Specifications for Highway Construction* shall not apply.

Traffic delineators are required on all interchange ramps and shall be spaced appropriately for the design speed and horizontal curvature of the ramps.

300.4.2.16 Intentionally Deleted

300.4.2.17 Underground Electrical Conduit and Cable Ducts

Underground conduits for electrical utility use shall conform to the latest edition of CSA C22.3 No 7-10 "Underground Systems" or as otherwise permitted under the Alberta Electrical Utility Code. Conduits for telecommunication company use shall conform to CSA Standard B196.3 "PVC Underground Telecommunication Cable Ducting and Fittings" M1983, 2011 edition, and latest update. Conduits for Department lighting, signals and miscellaneous circuits shall conform to *Alberta Transportation Standard Specifications for Highway Construction* Specification 2.25.3.1 (Conduit) or as permitted under the Canadian Electrical Code, Part 1 2015 edition.

300.5 BRIDGE STRUCTURES

300.5.1 GENERAL

300.5.1.1 Existing Reference Documents

The standards set out in the following documents shall be followed in the design, build, and rehabilitation of the New Infrastructure, except as noted elsewhere in this Schedule 18:

- *Canadian Highway Bridge Design Code* (CAN/CSA Standard S6) (the "**Bridge Design Code**");
- *Bridge Welding Code* (AWS D1.5) (the "**Bridge Welding Code**");
- *Alberta Transportation's Engineering Drafting Guidelines for Highway and Bridge Projects Version 2.0 February 2016* (the "**Drafting Guidelines**");

- *Alberta Transportation’s Design Guidelines for Bridge Size Culverts* (the “**Design Guidelines for Bridge Culverts**”);
- *Alberta Transportation’s Roadside Design Guide* (the “**Roadside Design Guide**”); and
- any related Design Bulletins.

300.5.2 DESIGN CRITERIA

300.5.2.1 Design Codes

Except where indicated otherwise in the Technical Requirements, the Contractor shall complete all bridge structure design in accordance with the Bridge Design Code, which may be supplemented with other relevant codes and recognized current engineering practices and specifications, with the prior written approval of the Department. Exceptions to the Bridge Design Code requirements are noted in this Section 300.5.2 (Design Criteria).

Bending moments and shear forces used for girder design shall not be less than those obtained by using the simplified methods of analysis specified in clause 5.6 in the Bridge Design Code, unless an alternate method is otherwise specifically agreed to in writing by the Department in advance of using an alternate method. If a bridge does not satisfy the criteria that allow the simplified methods of analysis to be used, the bending moments and shear forces used for girder design shall not be less than those that would have been determined if the bridge had met these criteria. The equivalent number of wheel lines/girder necessary to achieve these forces shall be shown in the Detailed Designs.

Notwithstanding clause 1.4.2.5 of the Bridge Design Code, approval will not be given for the use of single load path structures. Exceptions to this are piers with three columns or less, and straddle bents, so long as the requirements of Section 300.5.2.10 (Substructure/Foundations) are met. Except for pedestrian bridges only, slab and girder bridge structures shall have a minimum of four girder lines.

In clause 4.4.3.2 Site properties, *Table 4.1*, of the Bridge Design Code, delete Note (2) and replace it with:

- (2) *Where \bar{V}_s has been measured in-situ, the $F(T)$ values for Site Class A derived from Tables 4.2 to 4.7 are permitted to be multiplied by the factor*

$$0.04 + (1500/\bar{V}_s)^{1/2}$$

In clause 4.4.3.3 Site coefficients, of the Bridge Design Code, the eight provided tables, i.e. *Tables 4.2 to 4.9*, shall be replaced in their entirety with the following tables:

Table 4.2
Values of $F(0.2)$ as a function of Site Class and PGA_{ref}
(See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(0.2)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.69	0.69	0.69	0.69	0.69
B	0.77	0.77	0.77	0.77	0.77

C	1.00	1.00	1.00	1.00	1.00
D	1.24	1.09	1.00	0.94	0.90
E	1.64	1.24	1.05	0.93	0.85
F	*	*	*	*	*

**Site-specific evaluation is required to determine F(T), F(PGA), and F(PGV) for Site Class F.*

Table 4.3
Values of $F(0.5)$ as a function of Site Class and PGA_{ref}
(See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(0.5)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.57	0.57	0.57	0.57	0.57
B	0.65	0.65	0.65	0.65	0.65
C	1.00	1.00	1.00	1.00	1.00
D	1.47	1.30	1.20	1.14	1.10
E	2.47	1.80	1.48	1.30	1.17
F	*	*	*	*	*

**Site-specific evaluation is required to determine F(T), F(PGA), and F(PGV) for Site Class F.*

Table 4.4
Values of $F(1.0)$ as a function of Site Class and PGA_{ref}
(See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(1.0)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.57	0.57	0.57	0.57	0.57
B	0.63	0.63	0.63	0.63	0.63
C	1.00	1.00	1.00	1.00	1.00
D	1.55	1.39	1.31	1.25	1.21
E	2.81	2.08	1.74	1.53	1.39
F	*	*	*	*	*

**Site-specific evaluation is required to determine F(T), F(PGA), and F(PGV) for Site Class F.*

Table 4.5
Values of $F(2.0)$ as a function of Site Class and PGA_{ref}
 (See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(2.0)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.58	0.58	0.58	0.58	0.58
B	0.63	0.63	0.63	0.63	0.63
C	1.00	1.00	1.00	1.00	1.00
D	1.57	1.44	1.36	1.31	1.27
E	2.90	2.24	1.92	1.72	1.58
F	*	*	*	*	*

**Site-specific evaluation is required to determine $F(T)$, $F(PGA)$, and $F(PGV)$ for Site Class F.*

Table 4.6
Values of $F(5.0)$ as a function of Site Class and PGA_{ref}
 (See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(5.0)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.61	0.61	0.61	0.61	0.61
B	0.64	0.64	0.64	0.64	0.64
C	1.00	1.00	1.00	1.00	1.00
D	1.58	1.48	1.41	1.37	1.34
E	2.93	2.40	2.14	1.96	1.84
F	*	*	*	*	*

**Site-specific evaluation is required to determine $F(T)$, $F(PGA)$, and $F(PGV)$ for Site Class F.*

Table 4.7
Values of $F(10.0)$ as a function of Site Class and PGA_{ref}
 (See Clause 4.4.3.3 and Table 4.1.)

Site Class	Values of $F(10.0)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.67	0.67	0.67	0.67	0.67
B	0.69	0.69	0.69	0.69	0.69
C	1.00	1.00	1.00	1.00	1.00
D	1.49	1.41	1.37	1.34	1.31
E	2.52	2.18	2.00	1.88	1.79
F	*	*	*	*	*

**Site-specific evaluation is required to determine $F(T)$, $F(PGA)$, and $F(PGV)$ for Site Class F.*

Table 4.8
Values of $F(PGA)$ as a function of Site Class and PGA_{ref}
(See Clause 4.4.3.3.)

Site Class	Values of $F(PGA)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.90	0.90	0.90	0.90	0.90
B	0.87	0.87	0.87	0.87	0.87
C	1.00	1.00	1.00	1.00	1.00
D	1.29	1.10	0.99	0.93	0.88
E	1.81	1.23	0.98	0.83	0.74
F	*	*	*	*	*

**Site-specific evaluation is required to determine $F(T)$, $F(PGA)$, and $F(PGV)$ for Site Class F.*

Table 4.9
Values of $F(PGV)$ as a function of Site Class and PGA_{ref}
(See Clause 4.4.3.3.)

Site Class	Values of $F(PGV)$				
	$PGA_{ref} \leq 0.1$	$PGA_{ref} = 0.2$	$PGA_{ref} = 0.3$	$PGA_{ref} = 0.4$	$PGA_{ref} \geq 0.5$
A	0.62	0.62	0.62	0.62	0.62
B	0.67	0.67	0.67	0.67	0.67
C	1.00	1.00	1.00	1.00	1.00
D	1.47	1.30	1.20	1.14	1.10
E	2.47	1.80	1.48	1.30	1.17
F	*	*	*	*	*

**Site-specific evaluation is required to determine $F(T)$, $F(PGA)$, and $F(PGV)$ for Site Class F.*

300.5.2.2 Design Load

(a) Highway Bridges

Highway bridges shall be defined as all bridges carrying vehicular traffic with or without pedestrian traffic.

The minimum highway bridge live load shall be the Bridge Design Code CL-800 plus Dynamic Load Allowance. Truck axle and wheel loads shall be proportioned from the CL-625 truck. No adjustments are required for the 9 kN/m uniformly distributed load for lane load.

In clause 5.6.8 of the Bridge Design Code the width (B) of the bridge may be assumed to be reduced to a width that provides a value of $B < 10$ m. The number of design lanes (n) shall be reduced as required and shall be consistent with the assumed bridge width (B).

As it relates to clause 3.4.4 of the Bridge Design Code, the anticipated degree of pedestrian use for all highway bridges with sidewalks shall be “occasional pedestrian use”.

(b) Pedestrian Bridges

The minimum pedestrian bridge live load shall be in accordance with clauses 3.8.9 and

3.8.11 of the Bridge Design Code. For flexible structures, dynamic response including vertical and/or side sway motions that could cause discomfort to pedestrians shall be avoided.

(c) Traffic Barriers

In clause 3.8.8.1 of the Bridge Design Code the provided table, *Table 3.7 Loads on traffic barriers*, shall be replaced in its entirety with the following table:

Table 3.7
Loads on traffic barriers
(See [Clauses 3.8.8.1](#) and [12.4.3.2.5.](#))

Performance level	Transverse load, kN	Longitudinal load, kN	Vertical load, kN
TL-1	25	10	10
TL-2	50	20	10
TL-4	100	30	30
TL-5	210	70	90

(d) Fatigue

All new bridges shall be designed to comply with the Bridge Design Code Class A Highway requirements (clause 1.4.2.2 of the Bridge Design Code). Fatigue stress ranges shall be determined using the CL-800 truck. In addition, in clause 10.17.2.2 of the Bridge Design Code, the C_L factor shall always be taken equal to 1.0. These requirements shall apply to all bridge components for considerations of structural fatigue.

(e) Vehicle Collision Load on Bridge Piers

Bridge structural supports located less than 10 m from the edge of the Ultimate Stage pavement shall be designed for ULS Combination 8 loading for a vehicle collision load. For roadways with a design speed < 80 km/hr, an unfactored static vehicle collision load of 1400 kN shall be applied in accordance with the Bridge Design Code clause 3.15. For roadways with a design speed \geq 80 km/hr, the unfactored static vehicle collision load shall be increased to 1800 kN, and applied in any direction in a horizontal plane located 1.2 m above ground.

(f) Straddle Bents

1. A straddle bent shall mean a substructure unit, situated along the length of and between the two abutment ends of a bridge, that supports the bridge superstructure and which has any portion of the substructure located over top of an under passing roadway or above any portion of the under passing roadway’s right and or left clear zones.
2. Straddle bents shall include both conventional and integral straddle bent girders, and all associated bearings, columns, footings and piles.
3. Straddle bent girders shall be designed to have zero tension in top and bottom flanges over their design life under SLS Combination 1 loading.
4. All elements of straddle bents shall be designed for ULS Combination 8 loading for a collision load applied as a point load acting at any location along the straddle bent girder above the under-passing roadway and within the full extent of the right and left clear

zones. The collision load shall not be less than either one of the following cases, with the one causing the most severe effects adopted for use in the design:

- a. An unfactored static load of 1250 kN. This load shall be applied anywhere in the design impact zone of the straddle bent girder and acting in any orientation in a plane parallel to the under-passing roadway, such that it produces the maximum load effects; or
 - b. An unfactored static load of 625 kN. This load shall be applied anywhere in the design impact zone of the straddle bent girder and acting in any orientation in a plane normal to the under-passing roadway, such that it produces the maximum load effects.
5. All elements of the straddle bent from point of contact down to and including the foundation shall be designed to withstand the collision load.
 6. SLS Combination 1 loading for bearing design shall include an additional static load of not less than 625 kN applied at any location along the straddle bent girder above the under-passing roadway and within the full extent of the right and left clear zones.
 7. All elements of straddle bents shall be designed with adequate post-collision capacity to carry CL-625 loading at ULS Combinations 1 and 2. Post-collision capacity shall be based on the Design Engineer's engineering assessment of potential damage modes. Local experience suggests that at least the following conditions could be expected due to over-height collisions:
 - a. Straddle bents or straddle bent girders pushed off their bearings and or supporting column(s);
 - b. Punching failure through girder webs at point of impact;
 - c. Bending failure in webs just below top flange due to transverse load applied to bottom flange;
 - d. For pretensioned girders loss of pretensioning strands in area of impact; and
 - e. Local loss of web or flange section near the point of impact.

300.5.2.3 Hydrotechnical

Unless otherwise noted, the provisions of the Bridge Design Code with reference to clause 1.3.4 (Hydraulic Definitions) and clause 1.9 (Hydraulic Design) shall not apply to the Project.

The technical requirements set out in the following Department publications form part of the Technical Requirements:

- Bridge Conceptual Design Guidelines;
- Design Guidelines for Bridge Size Culverts;
- Design Bulletin #45; and
- Bridge Best Practice Guideline #7.

For proposed bridge structures over watercourses, including bridge size culverts (1.5 m diameter or larger), the Contractor's hydrotechnical design shall comply with the Department's current "*Bridge Conceptual Design Guidelines*" document.

Bridge deck drainage shall be considered starting in the preliminary design phases and is further addressed in Section 300.5.2.20 (Bridge Drainage).

Stream realignments shall be designed to be similar in length, slope, cross-section, and sinuosity

as the natural watercourses. Further requirements are described in Section 200.2.13 (Environmental).

Bridge structure openings on watercourses shall be sized and protected so that over the design life of the structure they do not:

- Restrict, impede or deflect watercourse flow or cause an unacceptable level of flooding on neighbouring flood sensitive lands and developments;
- Cause any flooding of the highway road surface;
- Have a negative impact on local channel stability; and
- Cause erosion affecting the stability of the bridge structure or roadway fills.

300.5.2.3.1 Minimum Freeboard for Stream Crossings

Bridges shall be designed to have a minimum 1.0 m freeboard under design flow conditions, unless otherwise specifically noted.

Bridge size culverts shall be designed to have a minimum freeboard of one-sixth the culvert rise (to a maximum of 1.0 m) and a minimum invert burial depth of one-quarter the culvert rise (to a maximum of 1.0 m).

300.5.2.4 Geotechnical

Bridge structure foundations shall be designed in accordance with the Bridge Design Code. Geotechnical boreholes shall extend a minimum of 3 m below the estimated pile tip elevation.

The selection of representative or “characteristic” geotechnical parameters used to determine foundation capacity shall be based on the results of appropriate field and laboratory investigations (to be provided to the Department upon request) and shall represent the Contractor’s Design Engineer’s “best estimate” of the likely values of the parameters, taking into account all the factors that may have influence on the soil properties, in accordance with the Canadian Foundation Engineering Manual, 4th Edition, Chapter 8.5.

Silt material specified as “ML” or “MH” material (in accordance with the “**Modified Unified Soil Classification System**”) shall neither be used in the design and construction of the bridge headslopes and approach fills, nor in the roadway embankments. The global stability of bridge headslopes and approach fills, including the effects of retaining walls, shall be designed for a minimum factor of safety against failure of 1.5.

The design of the bridge approach fills and retaining walls shall account for stability, long-term settlements and wall deformations. Stability analyses (to be provided to the Department upon request and as required in design report submissions) shall be carried out to determine that head slopes and retaining walls have acceptable short term and long term stability and will satisfy ultimate and serviceability limit states design criteria. Deformations of the embankment and wall (including settlement and lateral movements) shall be determined using appropriate deformation analyses, with representative soil parameters derived from site specific geotechnical investigations and local experience. The expected range of embankment and wall displacements including settlement and lateral movements shall be taken into account in the design of the bridge and shall provide for acceptable structural and aesthetics performance of the embankments and walls as well as the bridge. In addition to Bridge Design Code requirements, differential settlement between the bridge structure and the approach fills shall not cause a deviation of more than 0.5% from the roadway design grade. Tire-derived aggregate backfill is

not permitted for use in bridge approach fills or retaining walls.

300.5.2.5 Geometrics

Unless otherwise noted, the provisions of the Bridge Design Code with reference to clause 1.5 Structure Geometry shall not apply to the Project.

Where practical, bridges shall be located on tangent horizontal alignments.

For deck drainage purposes, the Department considers a minimum longitudinal grade of 1% to be desirable and a maximum longitudinal grade on a bridge structure shall not exceed 3% as specified in Section 200.2.2 (Geometric Design). However, the Department recognizes that grade line constraints for grade separation structures may require crest curves that result in portions of the bridge deck having a grade of less than 1%. Wherever possible, the tops of crest curves shall not be located on bridges and shall be located beyond the ends of the bridge approach slabs. For sag curves situated on bridges the slope at the low end shall not be less than 0.4%.

Bridge deck widths shall as a minimum have the same width as the clear roadway on the bridge approaches, except where the approaching roadway shoulders on the Mainline are 3.7 m wide to accommodate future traffic lanes, in which case the minimum shoulder widths on bridge structures shall not be less than 2.5 m on inside shoulders and 3.0 m on outside shoulders. Shoulders on bridge decks shall be designed wider where required to meet shy distances, minimum sight lines, drainage requirements, or as otherwise defined in the Technical Requirements.

Bridge decks shall have a 2% cross fall away from crown lines unless the grade line over the bridge structure is super-elevated. The tops of sidewalks and medians shall slope 2% towards the roadway. The tops of abutment seats, pier caps, curbs and barriers shall have a wash slope of 3%.

Bridge decks shall not incorporate longitudinal joints. The clear distance between nominally parallel bridges shall not be less than 3 m.

Top of bridge finished ground headslope fill widths shall be outside of bridge structure to outside of bridge structure width plus at least 2.0 m. Furthermore, the top of headslope shall extend out beyond the outer most surface of the wingwall on each side and at both ends of the bridge by at least 1.0 m. The minimum 1.0 m widening shall be measured perpendicular to the faces of the wingwalls. The minimum 1.0 m widening shall extend away from the bridge ends and transition into the roadway sideslope zone in accordance with the Technical Requirements. Refer to drawing SK-20 in Appendix B for illustrations of this requirement. In cases where transition barriers are not required beyond the ends of the wingwalls at a bridge end, the width transition from the top of headslope to the top of roadway sideslope shall taper at a rate of 30:1.

The width of the fill required at the end of the wingwall shall be continuous along the bridge wingwalls and abutment seats, extending down the slope along and parallel to each of the wingwalls and abutment seats in an alignment that intersects with the top of the headslope or the backside of any MSE wall coping/swale, on both sides of the abutment. Refer to drawing SK-20 in Appendix B for illustrations of this requirement. The wingwall design shall ensure that it penetrates below the top surface of the headslope fill a minimum of 600mm depth of bury at all locations. Refer to drawings SK-9 to SK-12 in Appendix B for illustrations of this requirement.

Corner transitions between the bridge headslopes and the sideslopes shall use an elliptical curve at the elevation of the toe of the headslope.

Bridge structure supports, including abutments, piers, retaining walls and sign structure columns, shall not be located within the clear recovery zone of the under-passing roadway and shall allow for all required sight distances to be met, for both Stage 1 and Ultimate Stage.

Design vertical clearances are different than the minimum vertical clearances that shall be posted on the vertical clearance signs. The design vertical clearances for highway bridges, railway bridges, pedestrian bridges, and sign structures shall be as specified in Section 200.2.2 (Geometric Design). The vertical clearance posting for all of these structures shall be in accordance with the Department’s process for determining the vertical clearance posting, as follows:

- Measure minimum vertical clearance between the roadway surface and lower bottom edge of the girder/structure within roadway width including shoulders to the nearest centimetre (i.e. 5.56 m);
- Round down to the nearest decimetre (i.e. 5.5 m); then
- Subtract one decimetre for tolerance (i.e. Post vertical clearance as 5.4 m).

Vertical clearance measurements shall be made in accordance with chapter 7 – Vertical Clearance Measurements (VLC2) of the Alberta Transportation *Bridge Inspection and Maintenance System – Level 2 Inspection Manual (Version 1.1)*.

The minimum vertical clearance postings shall be as follows:

- Roadway - underside of superstructure to top of roadway5.4 m Min.
- Roadway - underside of straddle bent to top of roadway5.9 m Min.
- Roadway – underside of high load corridor superstructure to top of roadway.....9.0 m Min.
- Railway over roadway - underside of superstructure to top of roadway5.4 m Min.
- Sign structures – roadway surface to underside of sign panel5.9 m Min.
- Pedestrian overpass - underside of superstructure to top of roadway.....5.9 m Min.

The minimum vertical clearance below structures shall be maintained through future overlays either by initially providing additional vertical clearance or by milling and filling under structures with appropriate transition paving to the overlaid portion leading up to the bridge.

Advance vertical clearance signs are required for all bridge structures.

300.5.2.6 Preferential Bridge Deck Icing

Bridge decks that anywhere have a resultant slope of 4% or greater due to roadway grade and cross-slope, or that are located in areas where changes in traffic speed are required, shall be designed with systems that can either prevent preferential bridge deck icing or predict its occurrence in advance so that preventative measures can be taken.

300.5.2.7 Durability

Design Life

Minimum design life of bridge structures shall be:

Bridges including tunnels and bridge size culverts**	75 years
MSE walls.....	100 years
Overhead sign structures.....	50 years

**Metal culverts may be designed with a service life of 50 years providing that they are oversized to allow for future lining. Cathodic protection is not permitted.

The level of maintenance, rehabilitation and/or repair required during the design life of the bridge structures shall be consistent with or better than that generally anticipated to be required for other bridge structures of similar age and type on the Provincial highway system.

Bridge Deck and Protection

Unless specified otherwise in Section 200 (Project Specifics), the bridge deck and protection system shall consist of:

- Class HPC concrete deck;
- Stainless steel deck reinforcing bars; and
- A deck waterproofing system.

The Department's standard deck waterproofing system as shown on Standard Drawings S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2) shall be used on all bridge decks, roof slabs and approach slabs. Bridge decks with waterproofing membranes shall have provision made along the gutter lines to allow for the controlled drainage of water that penetrates the asphaltic wearing surface, and accumulated water discharge at the bridge ends only. No intermediate discharge locations are permitted. The asphalt mix type and grade shall conform to an Alberta Transportation Type H2 Asphalt Mix using a PG58-28 asphalt cement grade.

Bridge decks shall be constructed to the full width of Stage 1 with no longitudinal construction joints in the deck. Similarly, waterproofing and ACP shall both be placed full width of Stage 1 without any longitudinal cold joints.

Protection from Bridge Deck Drainage

Bridge deck drainage shall not be allowed to discharge onto any exposed sub-structure concrete surfaces, nor to discharge within 4 m of piers and abutments or pedestrian pathways, pedestrian bridges or multi-use trails, or to be directed onto the road pavement beneath. Joints around abutments and approach slabs shall be sealed at the surface and kept sealed throughout the life of the structure with proper maintenance. Any steel elements (including buried elements) that may potentially be exposed to leakage of salt contaminated moisture shall be protected by an approved impervious waterproofing membrane.

Deck Joints

The number of deck joints shall be kept to a minimum. Bridge superstructures shall be continuous for live load over the piers and deck joints shall not be used in these locations. All deck joints shall include provision to capture and manage deck drainage such that it does not come into contact with other concrete and steel surfaces of other bridge elements other than concrete slope protection or drain troughs.

Splash Zone Surfaces

Splash Zone Surfaces are surfaces subject to or potentially subject to roadway splash or spray, and as a minimum shall include the following:

- Top surfaces of all pier and abutment concrete that project beyond the bridge deck/bridge

abutment footprint, to a horizontal distance of 6 m from inside edge of the bridge barrier/curb. This includes the affected members of trellis structures and straddle bents.

- Vertical or near vertical faces of substructure elements, monolithic concrete protection barriers, tunnel walls, culvert walls, or MSE wall precast concrete fascia panels that fall within a horizontal distance of 6 m of edge of lane of under-passing roadway.
- Concrete slope protection or drain troughs are not included.

Concrete Slope Protection

All concrete slope protection shall be constructed in accordance with Standard Drawing S-1409-16 (Standard Concrete Slope Protection For Grade Separations), except that the width of the swale shall be 3.0 m.

Sealer

A Type 1c sealer that is an Approved Product shall be applied to all concrete surfaces that are susceptible to deterioration by water and or de-icing salts, as detailed in Section 300.5.7.17 (Type 1c Sealer) unless the surface has been otherwise specified to receive a Type 3 sealer. Refer to drawing SK-1 in Appendix B for minimum sealer requirements.

Pedestrian Bridge

The pedestrian bridge shall have an HPC concrete deck and curbs reinforced with stainless steel reinforcing bars, and galvanized steel bridge rail. Any exposed structural or miscellaneous steel components and or steel hardware shall be galvanized. Sealers shall be applied to exposed concrete in accordance with drawing SK-1 in Appendix B, with the sidewalk, curb and girder surfaces treated as indicated for the sidewalk portion of highway bridges (i.e. Detail P or Detail S).

Concrete Tunnels and Concrete Culverts

The entire top slab of concrete tunnels and concrete culverts (“**concrete tunnels**”) over which one or more traffic lanes are situated shall consist of HPC concrete. When the depth of fill above the **upper surface** of the top slab is less than 1.2 m the top slab shall be reinforced with stainless steel bars, otherwise the reinforcing shall consist of carbon steel or stainless steel bars. All material placed on or above the upper surface of the top slab (including roadway structure, soil and granular backfill) shall be considered in determining the fill depth with the exception that styrofoam or any other lightweight fill materials (e.g. any material with unit weight less than 80% of compacted granular fill) when placed on or above the upper surface of a tunnel shall not be included in the determination of depth of fill.

The entire bottom slab of concrete tunnels over which one or more traffic lanes are situated shall consist of HPC concrete. When the depth of fill above the upper surface of the bottom slab is less than 1.2 m the bottom slab shall be reinforced with stainless steel bars, otherwise the reinforcing shall consist of carbon steel or stainless steel bars. All material placed on or above the upper surface of the bottom slab (including roadway structure, soil and granular backfill) shall be considered in determining the fill depth with the exception that styrofoam or any other lightweight fill materials (e.g. any material with unit weight less than 80% of compacted granular fill) when placed on or above the upper surface of the bottom slab of a tunnel shall not be included in the determination of depth of fill.

A waterproofing membrane with protection board shall be placed on the upper surface of the top slab and on the exterior surfaces of the walls of all tunnels through which one or more traffic lanes are situated. The extent of the waterproofing and protection board shall be limited to locations where the tunnel is to be backfilled. The waterproofing membrane and protection board shall conform to requirements of Section 300.5.15 (Bridge Deck Waterproofing and Asphalt Concrete Pavement) excluding aspects related to asphalt.

Concrete Classes

Classes of concrete shall be as detailed in Section 300.5.7.5 (Class and Composition of Concrete). The following gives concrete classes that shall be used in the specified locations on structures.

- Class HPC concrete:
 - cast-in-place decks, curbs, barriers, sidewalks, and medians;
 - abutment and pier diaphragms;
 - deck joint blockouts;
 - upper portion of abutment backwalls (300mm minimum vertical dimension);
 - the entire trellis beam, straddle bent girder, straddle bent column, pier cap, or pier shaft/column where any portion of the element is a Splash Zone Surface;
 - abutment roof slabs, approach slabs, and sleeper slabs;
 - precast concrete partial depth deck panels;
 - MSE wall precast concrete fascia panels;
 - MSE wall anchor blocks, MSE wall backing blocks,
 - MSE wall cast-in-place coping;
 - all concrete located within a depth of 300 mm of a Splash Zone Surface; and
 - all tunnel concrete required to be HPC as described in this Section 300.5.2.7 (Durability).

- Class C concrete:
 - pile caps;
 - substructure elements and monolithic concrete protection barriers other than concrete specified as Class HPC;
 - sign structure foundations (with the exception that cement shall be High Sulphate Resistant Type HS or HSb);
 - drilled caissons above the frost line;
 - concrete slope protection;
 - concrete drain troughs;
 - MSE wall levelling pads; and
 - all tunnel concrete not required to be HPC as described in this Section 300.5.2.7 (Durability).

- Class Pile concrete:
 - pipe pile infill concrete; and
 - drilled caissons below the frost line.

- Precast bridge girder concrete shall conform to Section 300.5.9 (Precast Concrete Units and Post-Tensioning).

Concrete for underground components that are exposed to chemicals shall also meet the requirements of CSA A23.1.

Clear Concrete Cover

The following clear concrete cover and placing tolerances for reinforcing steel, pretensioning strands, and post-tensioning ducts shall be specified on the Detailed Designs, unless noted otherwise on Department Standard Drawings. The clear concrete cover values shall be the basis for design. Where more than one concrete cover reference is inferable for a given situation the greater clear concrete cover value and associated tolerances shall govern. The clear cover and placing tolerances for anchorages and mechanical connections shall be those specified for reinforcing steel.

Clear Concrete Cover and Placing Tolerances for Cast-in-place Concrete Components

Location	Clear Concrete Cover	Allowable Placing Tolerances
Concrete cover to reinforcing steel unless noted otherwise.	60 mm	+/- 10 mm
The bottom layer of approach slab on clean granular fill and polyethylene sheeting.	50 mm	+/- 10 mm
The top layer of cast-in-place decks and slabs protected with waterproofing membrane and ACP wearing surface.	60 mm	+/- 10 mm
The bottom layer of suspended decks and slabs.	40 mm	+10 or -5 mm
Concrete components which are not protected by a waterproofing membrane and ACP wearing surface, that will come into contact with de-icing salts, including Splash Zone Surfaces, but excluding the near vertical traffic faces of curbs, medians and barriers.	70 mm	+/- 10 mm
Near vertical traffic faces of curbs, medians and barriers.	100 mm	+/-10 mm
Soffits of cast-in-place concrete straddle bent:		
– measured to reinforcing steel.	60 mm	+/-10 mm
– measured to post-tensioning ducts.	90 mm	+/- 10 mm
Vertical surfaces of cast-in-place concrete straddle bent:		
– measured to reinforcing steel.	70 mm	+/-10 mm
– measured to post-tensioning ducts.	100 mm	+/- 10 mm
Concrete cast in contact with soil (no form).	100 mm	+/- 25 mm

Note: Concrete covers in the above table measured to reinforcing steel unless noted otherwise.

Clear Concrete Cover and Placing Tolerances for Precast Concrete Components

Location	Clear Concrete Cover	Allowable Placing Tolerances
Concrete cover unless noted otherwise.	50 mm	+/- 5 mm
Precast concrete girder with 28 day compressive strength greater than or equal to 65 MPa: <ul style="list-style-type: none"> – measured to reinforcing steel. – measured to pretensioning steel. – measured to post-tensioning ducts. 	30 mm 45 mm 45 mm	+/- 5mm +/- 5 mm +10 or -5 mm
Precast concrete girder with 28 day compressive strength less than 65 MPa: <ul style="list-style-type: none"> – measured to reinforcing steel. – measured to pretensioning steel. – measured to post-tensioning ducts. 	30 mm 50 mm 50 mm	+/- 5mm +/- 5mm +10 or -5 mm
Soffits of precast concrete straddle bent: <ul style="list-style-type: none"> – measured to reinforcing steel. – measured to pretensioning steel. – measured to post-tensioning ducts. 	50 mm 65 mm 70 mm	+/- 5mm +/- 5 mm +10 or -5 mm
Vertical surfaces of precast concrete straddle bent: <ul style="list-style-type: none"> – measured to reinforcing steel. – measured to pretensioning steel. – measured to post-tensioning ducts. 	50 mm 70 mm 75 mm	+/- 5mm +/- 5 mm +10 or -5 mm
Precast concrete partial depth deck panels – measured to pretensioning steel.	40 mm	+/- 3 mm
MSE wall precast concrete fascia panels – measured to reinforcing steel.	50 mm	+/- 5mm

Steel Reinforcing Type by Location

The following gives steel reinforcing types that shall be used in the specified locations on bridges unless otherwise specified in Section 200 (Project Specifics). Unless otherwise specified, the requirement is for all reinforcement in the member:

- Stainless Steel Reinforcing Bars

- full depth cast-in-place decks and partial depth cast-in-place decks composite with and cast on precast concrete partial depth deck panels;
 - reinforcing bars projecting from precast concrete partial depth deck panels;
 - curbs and barriers above the deck/wingwall construction joint, including dowels projecting through the construction joint;
 - sidewalks and medians;
 - deck joint blockouts;
 - abutment roof slabs, approach slabs, sleeper slabs;
 - corbels and dowels connecting approach slabs to corbels;
 - all reinforcing bars in a trellis beam, straddle bent or pier cap where any portion of the element is a Splash Zone Surface;
 - located within 300 mm of the tops of abutment backwalls, diaphragms and wingwalls;
 - located within 300 mm of Splash Zone Surfaces, unless otherwise specified; and
 - all tunnel reinforcing bars required to be stainless steel as described in this Section 300.5.2.7 (Durability).
- Stainless Steel Reinforcing Bars, or Low Carbon/Chromium Steel Reinforcing Bars
 - stirrups projecting from precast or cast-in-place concrete girders into deck slabs.
 - Epoxy Coated Steel Reinforcing Bars
 - MSE wall precast concrete fascia panels.
 - Carbon Steel Reinforcing Bars
 - precast concrete girders, excluding stirrups projecting from precast concrete girders into deck slabs; and
 - all locations not otherwise specified.

300.5.2.8 Materials

a) Concrete:

Materials for concrete shall be as detailed in Section 300.5.7.4 (Materials).

b) Reinforcing Steel:

Stainless steel reinforcing bars shall conform to the requirements of ASTM A276/A276M and ASTM A955/A955M including Annex 1.2 or 1.3 with a minimum yield strength of 420 MPa. The design and proportioning of the stainless reinforcing steel, including hooks, development lengths and bar splices, shall be based on a yield strength of 420 MPa.

Low carbon/chromium steel reinforcing bars shall conform to ASTM A1035/A1035M Grade 690 with a minimum yield strength of 690 MPa based on 0.2% offset and contain a minimum of 9% chromium. The design and proportioning of the low carbon/chromium steel reinforcing bar, including hooks, development lengths and bar splices, shall be based on a yield strength of 500 MPa.

Epoxy-coated steel reinforcing bars shall meet the requirements of carbon steel

reinforcing bars and shall be prepared and coated according to the requirements of ASTM A775 and the Ontario Provincial Standard Specification (“OPSS”) 1442, Material Specification for Epoxy-coated Steel Reinforcement for Concrete unless specified otherwise.

Carbon steel reinforcing bars shall conform to CSA G30.18M Grade 400W with a minimum yield strength of 400 MPa.

Deformed welded wire reinforcement shall conform to ASTM A1064/A1064M Grade 485 with a minimum yield strength of 485 MPa based on 0.2% offset.

c) Prestressing Steel:

For use in pretensioned and post-tensioned concrete, prestressing strand shall conform to the requirements of ASTM A416/A416M Grade 1860 for low relaxation strand with a minimum tensile strength of 1860 MPa.

Prestressing rods shall conform to the requirements of ASTM A722/A722M with a minimum tensile strength of 1035 MPa.

d) Structural Steel:

1) For girders and all materials welded to steel girders.	CSA G40.21M Grade 350AT CAT 3 or ASTM A709 Grade 345WT Type B with Charpy value of 27 J @ -30° C
2) For ungalvanized bearing materials and all ungalvanized bracing materials bolted to girders.	CSA G40.21M Grade 350A or ASTM A709 Grade 345 Type B
3) For galvanized bearing materials not welded to girders and galvanized bracing materials.	CSA G40.21M Grade 300W galvanized in accordance with ASTM A123/A123M
4) For miscellaneous steel including deck joints (except for finger plates, see below)	CSA G40.21M Grade 300W
5) For structural bolts for weathering steel applications	22 mm diameter A325M - Type 3 weathering steel
6) For structural bolts for galvanized steel applications	22 mm diameter A325M - Type 1 galvanized in accordance with ASTM F2329.
7) For galvanized bridge rail materials	All plate steel and structural shapes shall conform to CSA G40.21M Grade 350 or ASTM A36 except structural tubing shall conform to ASTM A500B. All plate steel and structural shapes shall be galvanized in accordance with ASTM A123/A123M.
8) Finger plates for finger plate deck joints	CSA G40.21M-Grade 350A

e) Anchor rods:

1) For bearing anchor rods in contact with black steel	Stainless steel AISI Type 316 (Fy = 290 MPa based on 0.2% offset)
2) For galvanized bearing anchor rods in contact with galvanized steel base plates	CSA G40.21M Grade 300W or ASTM A307 galvanized in accordance with ASTM F2329
3) For galvanized high strength anchor rods in contact with galvanized base plates (e.g. bridgerail post base plates)	ASTM A193 Grade B7 (Fy = 725 MPa and Fu = 860 MPa). Note galvanizing of high strength material requires special procedure, see Standard Drawing S-1642-00

f) Steel “H” piling:

Steel "H" piling shall meet the requirements of CSA G40.21M Grade 350W or ASTM A36.

g) Steel pipe piling:

Steel pipe piling shall meet the requirements of ASTM A252 Grade 2, except that hydrostatic testing is not required.

h) Other:

Refer to other sections of the Technical Requirements for material requirements not identified in this Section 300.5.2.8.

300.5.2.9 Overhead Sign Structures and High Mast Lighting Support Structures

Overhead sign structures and high mast lighting support structures with a height greater than 16m (high mast poles), shall be designed in accordance with the requirements of AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, latest edition plus interims (the “**AASHTO Standard Specs**”) and the following additional criteria:

- Equation 3-1 of AASHTO Standard Specs section 3.8.1 shall be modified as follows:

$$P_z = 2.5 q K_z C_d$$

- where q shall be taken from *CAN/CSA S6*, Table A3.1.1 for a return period of 50 years;
- The design ice thickness for ice accretion shall be the value given in *CAN/CSA S6*, Figure A3.1.4;
- The Fatigue Importance Factors in Table 11-1 of the AASHTO Standard Specs shall be based on Fatigue Category I;
- Further to AASHTO Standard Specs section 11.7 “Fatigue Design Loads”, a dynamic analysis of the structure will not be accepted in lieu of using the equivalent static pressures

- provided in the AASHTO Standard Specs;
- Further to AASHTO Standard Specs section 11.7.1 “Galloping”, the Department will not approve the use of vibration mitigation devices in lieu of designing to resist periodic galloping forces. Furthermore, the Department requires that galloping loads be considered for the fatigue design of all overhead cantilevered sign support structures regardless of their configuration;
 - Further to AASHTO Standard Specs section 11.8 “Deflection”, the vertical deflection for sign structures shall not exceed 200 mm regardless of their configuration;
 - Structural steel plate material shall conform to CSA G40.21M Grade 300W* or 350W* or ASTM A572 GR. 50. However, the yield strength of the steel plate shall be limited to 300 MPa when designing for fatigue regardless of the material used. The silicon content shall be less than 0.04% for the shafts, whereas for flanges, base plates, and tenons the silicon content shall be either less than 0.04% or between 0.15% to 0.25% inclusive. Steel shafts, structural flange plates, base plates and any material welded to the structure shall meet a Charpy V-Notch minimum average absorbed energy of 20J at -20 degrees Celsius. Charpy V-Notch testing shall be in accordance with CSA G40.20. All other structural shapes except HSS incorporated in the design shall conform to CSA G40.20M Grade 300W or 350W with silicon content less than 0.04%;
 - HSS members shall conform to CSA G40.20M 350W Class H with silicon content less than 0.04%. The steel for HSS members shall meet a Charpy V-Notch minimum average absorbed energy of 20J at -20 degrees Celsius. Charpy V-Notch testing shall be in accordance with CSA G40.20;
 - All bolts shall conform to ASTM Standard F3125, Grade A325/A325M. The nuts shall be heavy hex style and conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M. Certified mill test reports for the fastener material shall be provided;
 - Anchor rods shall be manufactured from smooth rods conforming to the requirements of ASTM F1554 Grade 55 ($F_y = 380$ MPa). The anchor rod assembly shall consist of, but not limited to: anchor rods complete with nuts and washers, top temporary templates complete with clamping nuts, bottom anchor plates complete with anchor nuts and clamping nuts;
 - For sign structures, the design sign panel area shall be taken as the largest of:
 - Stage 1 sign panels;
 - Ultimate Stage sign panels (Ultimate Stage shall consider any potential changes due to safety audits, which changes and audits are the Contractor’s responsibility); and
 - Area of 3.5 m x 60% of horizontal span length (span length includes portion of arm over clear zone), placed in any position along the span to create the most critical load effects;
 - Sign structures shall have a minimum permanent vertical camber of $L/200$ where L is the span of the horizontal arm of the sign structure;
 - Cantilever arm lengths shall not exceed 20 m;
 - Sign structure structural framing shall be at least 600 mm above the bottom edge of sign panels;
 - For sign structures and for high mast poles that do not include a breakaway support, the tops of the concrete foundations shall project from 700 mm to 850 mm above the adjacent ground surface on the traffic side. The exposed portion of the foundation shall be of finished concrete with circular cross-section; and

- The Contractor shall prepare a general layout drawing for each individual sign structure in accordance with Standard Drawing S-1721-07 (Sign Structure Sample General Layout).

High mast poles shall additionally meet the following requirements:

- High mast poles and associated components shall be designed to withstand and operate continuously without hindrance under the prevailing climatic conditions of the Province of Alberta;
- The design wind profile for each high mast pole and attached luminaire shall be used in calculating wind induced forces. However, the minimum design effective projected area shall be taken as not less than 0.4m^2 for each luminaire;
- High mast pole designs shall accommodate a minimum of 2 and maximum of 8 luminaires with a design minimum luminaire mass of 45kg per luminaire;
- High mast poles shall be designed with a uniformly tapered polygonal cross-section comprised of a minimum of 12 sides;
- The minimum thickness of high mast pole base plates shall be 38mm. A suitable conductor entrance hole centred on the base plate shall be provided;
- Conventional lowering devices shall be either:
 - A bottom-latching arrangement where the weight of the luminaire assembly is supported by mechanical latches integral with the pole and backed-up by a safety chain secured to the structure. A self-sustaining single drum winch and winch cable is sufficient for servicing purposes provided that each winch and lifting cable is capable of supporting the luminaire ring load with a minimum safety factor of five based on the yield strength of each cable; or
 - A fully rated self-sustaining multi-drum direct suspension (nonlatching) system where the luminaire assembly is supported by two or more cables in tension, each of which shall be capable of supporting the luminaire ring load with a minimum safety factor of five based on the yield strength of each cable.

Top latching systems which require the luminaire ring to rotate in order to engage with latches or rests will not be permitted.

- Access doors and intrusions into poles shall be heavily reinforced so as to restore the structural integrity of the pole;
- Main access doors shall be a minimum 254mm wide and 711mm high or such size to permit the installation or removal of the winch and electrical components;
- All access doors shall be tamper-proof and be provided with a hasp and staple or other means of padlocking;
- Unless otherwise indicated in the Technical Requirements, the pole access doors and intrusions shall be oriented such that personnel working at the doors or intrusions are facing oncoming traffic;
- A grounding boss shall be provided inside each pole at 90 degrees from the access door;
- Electrical components shall be positioned in the foot of the pole so as to be accessible for safe operation without obstructing the lowering device or the motor drive. All components shall be readily accessible for maintenance purposes;
- Each pole shall have four attachments welded to the shaft 1.8 metres above the base plate.

These attachments shall be sited 90 degrees apart radially about the shaft and will permit the insertion of brackets to support the luminaire ring when it is in the lowered position. One set of brackets shall be provided for each portable power tool required for the Project.

- High mast poles, head frame and luminaire ring:
 - The head frame assembly shall be weather proof and maintenance free for the life of the lowering device. The head frame assembly shall also be designed to prevent birds from entering the mechanism or the interior of the pole. Head frame, luminaire ring and hoisting attachments shall be pre-assembled by the supplier and shipped to site in a form which can be easily handled and matched to the pole. Pulleys shall be of non-corrosive material and run on self-lubricating bearings with stainless steel shafts. Each luminaire ring shall be manufactured with the exact number of tenons or mounting pads for the luminaires as indicated in the Detailed Designs. The luminaire support rings shall be complete with 50 mm IPS Schedule 40 luminaire arms. The number and arrangement of luminaire arms supplied shall be as indicated in the Detailed Designs. Arms required for mounting floodlights shall be modified to support the luminaire yoke and to permit horizontal panning of the floodlight. The luminaire support ring shall be balanced assembly; counter-balancing hardware shall be supplied as part of the ring assembly wherever necessary. One weatherproof junction box, complete with receptacle and terminal blocks shall be incorporated in the ring wiring circuitry. In the case of a dual support ring, an additional weatherproof junction box complete with terminal blocks shall be incorporated in the wiring circuitry of the second ring. Additional wiring shall be used to interconnect the terminal blocks of the separate junction boxes as required. The receptacle is required to enable testing of the luminaires in the lowered position. Rollers or bumpers shall be provided on the inside of the luminaire ring to help align the ring during operation of the winch and to minimize damage to the surface of the pole.
- High mast poles, winches and cables:
 - Winches shall have a minimum lifting capacity of 750 kg at 1.5 meters per minute. In the event of a power or winch drive device failure, the winch shall be capable of maintaining the luminaire support ring in a fixed position at any height on the pole. Winches shall be covered to prevent the ingress of foreign material and to minimize maintenance requirements. Winch drums shall be supported at both ends and shall have grooves or mechanical keepers to ensure that the cable re-spools on the drum properly without jumping or “bird-nesting”;
 - Lipped flanges, guide bars or other mechanical attachments shall be fitted to prevent the wire rope from over running. Drum capacity shall be a minimum of 40 m of 6-mm diameter wire rope for the 25-m, 30-m and 35-m poles and 50 m of 6-mm diameter wire rope for any 40-m poles. A minimum of six complete wraps of the winch cable shall remain on the drum when the luminaire ring is on the rest brackets. All winch and hoisting cables shall be continuous 7x19 flexible aircraft quality;
 - Stainless steel cord sized for the tension and shock loading likely to be encountered in high mast lighting systems. Lifting cables and associated hardware shall, so far as is practicable, be preassembled by the supplier to eliminate tangling and twisting during installation and operation;

- Threaded quick-links are not permitted. Attachments shall be made using clevis pins, compression connectors, or other rated mechanical methods approved in advance and in writing by the Department.

High mast poles, latching system requirements:

- The following requirements are for latching systems and are not applicable to direct suspension systems:
 - Latches may be top or bottom mounted and shall be simple in construction to have consistent, trouble-free operating characteristics. Latch operation shall not be impaired by the formation of ice.
 - All top-latch system devices shall be equipped with suitable indicator(s) to show when the carriage is in the fully raised and latched position. Indicators shall be plainly visible from ground level.
 - All latching systems shall be equipped with a safety chain anchored to a lug at the pole base.
 - Winch drum gearing for latching system shall be self-sustaining with a ratio of not less than 30 to 1.

High mast poles, direct suspension system requirements:

- The following requirements are for direct suspension systems and are not applicable to latching systems:
 - Lifting cables shall be factory cut and pre-rigged. The cables shall not be twisted during installation.
 - Winches shall be self-sustaining and have a gear ratio of not less than 50:1.
 - Winch drive spindles shall be positively locked when not in use. Lock out shall be automatic.

High mast poles, portable power tools:

- The Contractor shall supply two portable power tools if the number of high mast poles installed is 15 or less, plus one additional tool for every ten high mast poles installed thereafter. These tools shall be capable of operating from a 120-volt source as well as from the power feed located in the base of each pole. The reversing switch to operate the tools shall be fitted with a 6m cord to allow for remote operation. A mechanical torque-limiting device shall be attached to the power tools. This device is to be suitable for operation through a temperature range of –40 degrees C to +50 degrees C and the maximum torque output shall not be sufficient to cause damage to the lowering device. The combined weight of each power tool and torque limiter and associated transformer shall not exceed 100 lbs (45 kg). The portable tools shall also be fitted with shear pins designed to fail at loads between 50 and 100 percent above the rating at which the torque limiter is designed to slip. Safety instructions for operating the luminaire ring shall be provided for permanent installation inside of the pole hand-hole cover. Such instructions shall be inscribed on a non-deteriorating material and the lettering shall be of sufficient size to be easily discernible. A complete set of manufacturer's instructions for handling and assembling high mast structures, including minimum requirements for cribbing to support the complete assembly prior to erection shall be provided.

High mast poles, electrical:

- A NEMA1 enclosure complete with a 3p-15 amp breaker shall be installed in the bottom of each pole. The enclosure location shall be accessible for ease of switching but shall not interfere with winch operations. Full schematic and electrical system wiring diagrams are to be supplied with the shop drawings. The breaker box shall be fitted with a flexible cord and cord connector to operate the portable winch drive tool and to power the luminaire ring when it is in the lowered position. A NEMA3 box complete with male receptacle is required on the luminaire ring to plug in the breaker box power supply cord when the ring is down. The box shall be positioned so as not to hinder raising / lowering operations or to contact any part of the structure during its travel. Internal pole cable shall be 5c#10 SOOW or equal heavy duty flexible cable complete with “Twist-lok” or equivalent cord connectors. The electrical cable shall maintain flexibility and withstand ambient temperatures of -40 degrees Celsius to +40 degrees Celsius without mechanical or electrical failure. The electrical cable shall have a mechanical strain relief attachment at the luminaire carriage capable of supporting the cable weight. All Kellems grips installed in the pole shall be clamped to eliminate creepage of the cable when the grip is in an un-tensioned position. The Contractor shall handle, assemble and erect high mast structures in strict accordance with the procedures and instructions provided by the component manufacturers. Joints are to be assembled parallel to and effectively centered on the longitudinal axis of the pole sections. All sections for the individual poles shall be checked to ensure matching as intended and all sections shall align ensuring that the identification marks provided are aligned. Each section shall meet the overlap limits marked on the pole such that the completed high mast pole complies with the permitted overall tolerances. Any deviations where by the overlap limits marked on the pole are not met shall be reported and addressed in an acceptable manner to the Department.

300.5.2.10 Substructure/Foundations

Piling

All welded pile splices whose tensile or flexural capacity is critical to the structural integrity of a bridge or structure (for example in integral abutment bridges), shall be identified as tension splice welds on the Detailed Designs. These welds shall be tested during fabrication and installation using non-destructive testing techniques.

Dynamically cast-in-place piles (Compacto piles) are not permitted.

For substructure elements founded on driven steel H-Piles, series HP 310 or larger pile sizes shall be used.

Bridge Piers

Piers in stream crossings shall not be founded on spread footings, but shall be founded on driven piles or drilled cast-in-place concrete piles. All piles supporting piers in stream crossings shall have a minimum penetration of 5 m into competent material.

Land piers may be founded on piles or spread footings, but spread footings shall not be used unless founded directly on competent bedrock.

Each end of pier cap cantilevers shall have a cast-in stainless steel drip strip across the full underside width of the pier cap located 300mm from the end of the pier cap to prevent staining of substructure concrete.

Piers with one or two columns shall have columns each with a minimum cross-sectional area of 2.8 m². Piers with three or more columns shall have columns each with a minimum cross-sectional area of 2.8 m², or alternatively may have smaller columns that are connected together with a solid strut that is equal in width to the columns and is 2.4 m in height. The connecting strut shall be embedded 1.0 m below the finished ground surface situated immediately adjacent to the pier. For piers with three or more columns connected by a solid strut in no case shall any single column have a cross-sectional area less than that associated with a 1.5 m diameter column. Columns in multi-column piers shall all have the same shape and cross sectional area unless Department approval is otherwise granted.

Straddle bent girders supporting over-passing superstructures shall be of heavy post-tensioned concrete construction to reduce relative damage when subject to over-height or over-dimension vehicle collisions. Plain, non-stressed reinforced concrete or structural steel shall not be used for straddle bent girders.

For monolithic pier diaphragms which are cast around girder ends, the girders shall be erected on a minimum 150 mm high plinth to provide sufficient clear space between the girder under side and previously cast supporting concrete, to facilitate flow and consolidation of concrete under the ends of the girders.

The upstream face of river piers shall be protected by an embedded galvanized nose plate.

Bridge Abutments

Drawings SK-9 to SK-19 in Appendix B further clarify a number of the requirements set out in the text of this Bridge Abutments part of Section 300.5.2.10 (Substructure/Foundations).

(a) General

Bridge ends shall be supported on piles.

Bridge ends shall have cast-in-place wingwalls oriented parallel to the over-passing roadway.

- For abutments without roofslabs, these wingwalls shall be cantilevered from the abutment seat or the superstructure end diaphragm (as illustrated in the elevation views on drawings SK-9 to SK-11 in Appendix B);
- For abutments with roofslabs, these wingwalls shall be cantilevered from the gradebeam (as illustrated in the elevation view of drawing SK-12 (Standard Details for Conventional Abutment with Roof Slab) in Appendix B);
- For conventional abutments, when these wingwalls are over 10m in length they shall be designed with roof slabs and gradebeams;
- For integral abutments, those wingwalls shall meet the additional requirement of Section 300.5.2.10(d) (Integral Abutments) below; and
- For abutments with roofslabs, access to the cavity below the roofslab shall be provided through the abutment backwall, with access positioned between girders and accessible through the abutment diaphragm, in compliance with the requirements provided on Detail S “Access Door” on drawing SK-12 in Appendix B.

EPS foam and MSE walls shall not be used behind abutments, and soil reinforcement shall not be attached to abutment foundations, abutments, abutment seats, abutment backwalls or abutment wingwalls to resist or reduce lateral pressures.

Inspection access shall be provided at all abutments. The inspection walkway shall be accessible

from both sides with the exception of bridges with retaining wall arrangements that have skew angles greater than 45 degrees, as depicted in SK-17, in which case inspection access from one side shall be provided. Each abutment and inspection access shall not require the use of ladders or any equipment including fall protection.

- For bridges with conventional open headslopes:
 - Provide minimum 0.6 m wide bench at grade in front of abutment seats for inspection access;
 - Proportion conventional abutments with maximum abutment seat height of 1.8m above grade (as illustrated in Section A (Headslope Option) on drawings SK-11 and SK-12 in Appendix B);
 - Proportion integral and semi-integral abutments such that the maximum height from top of grade to underside of girders is 1.5 m (as illustrated in Section A (Headslope Option) on drawings SK-9 and SK-10 in Appendix B);
- For abutments behind retaining walls:
 - Provide a concrete walkway suitable for inspection access not less than 1.0 m wide (minimum dimension clear between abutment face and safety rail) in front of the abutment seat. This walkway shall be a concrete slab, monolithic with the abutment retaining wall coping. The walkway shall include a minimum 600 mm wide swale and 3 percent wash slopes directing water away from the abutment seat and away from the face of the retaining wall towards the swale. The walkway swale shall be detailed so that it drains longitudinally with a minimum 0.5% grade towards the grassed swales outside of the bridge abutments;
 - Provide a continuous safety railing at the outside edge of the walkway, designed as a “guard” in accordance with Part 9 of the Alberta Building Code (2014), having a minimum height of 1070 mm and consisting of vertical posts and not less than two horizontal rails. Chain link fence is not permitted;
 - Proportion conventional abutments with maximum abutment seat height of 1.8m above the walkway (as illustrated in Section A MSE Wall Option on drawings SK-11 and SK-12 in Appendix B); and
 - Proportion integral and semi-integral abutments such that the maximum height from walkway to underside of girders is 1.5 m (as illustrated in Section A MSE Wall Option on drawings SK-9 and SK-10 in Appendix B).

Further to the above, for side-by-side girder or solid slab bridges used in combination with integral or semi-integral abutments, abutments shall be proportioned such that the height from top of grade or top of walkway to underside of girders/slab shall be nominally 1.5 m.

Minimum abutment seat and wingwall embedments into adjacent fill are illustrated on drawings SK-9 to SK-12 in Appendix B.

- For cast-in-place wingwalls parallel to the over-passing roadway, extend wingwalls not less than 0.6 m beyond top of fill line, and provide an embedment of not less than 0.6 m below top of grade at all locations;
- For conventional headslopes provide a minimum abutment seat embedment of 0.5 m below top of bench; and
- For abutment seats behind independent retaining walls, provide a minimum abutment seat

embedment of 0.5 m below top of walkway.

Bridge plaques and bench mark tablets shall be provided at bridge abutments in accordance with Standard Drawings S-1477-04 (Standard Large Bridge Plaque Installation Details), S-1617-04 (Standard Large Bridge Plaque Casting Details (Drafting Standards)) and S-1478 (Standard Bridge Bench Mark Tablet Installation).

Drainage details shall be incorporated into the design of abutments and shall include the following:

- The joints around the approach slab shall be well sealed to prevent water infiltration (Reference Standard Drawings S-1411-87 (Standard Concrete Joints), S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2));
- A secondary system consisting of granular backfill, sheet wall drains and sub-soil weeping drains shall be provided to collect, channel and remove any seepage;
- Except for MSE wall abutments with steel soil reinforcement, sheet wall drains shall be provided and spot-glued (nails shall not be used to fasten wall drains to concrete surfaces) to the earth face of the abutment seat and wingwalls to intercept and channel seepage into a perforated weeping drain with a minimum positive drain slope of 2% that is day-lighted on the headslope or through the sideslope;
- Clean, well graded, crushed granular backfill with a maximum aggregate size of 25 mm (Des 2, Class 25) shall be provided behind abutment seats and wingwalls complete with perforated weeping drains under the abutment seat and wingwalls. The Contractor shall design and construct the Des 2, Class 25 abutment granular backfill such that the granular backfill is not less than 600 mm in thickness at any location behind the abutment seat and wingwalls. Des 2, Class 25 granular backfill with a minimum thickness of 300 mm shall be provided beneath the entire area of all approach slabs and sleeper slabs;
- Concrete drain troughs and drains shall be placed in accordance with Section 300.5.2.20 (Bridge Drainage);
- For MSE wall abutments see Section 300.5.2.22 (Mechanically Stabilized Earth (MSE) Walls) for additional details; and
- Closed cell foam of adequate thickness to accommodate thermal movements shall be provided between concrete headslope/walkway and integral concrete bridge abutments. A 10 mm thick asphalt impregnated fibre board shall be placed between concrete headslope/walkway and semi-integral or conventional concrete bridge abutments.

Headslopes and retaining walls at bridge abutments shall be designed such that approach slabs, deck joints, bearings, barriers, and integral abutment piles in casings will operate as intended by the design without imposing excessive stresses on the structure, or requiring premature replacement of any bridge superstructure or substructure components as a result of ongoing or longterm movements of abutment seats. The structural design shall include soil structure interaction analysis where appropriate. Mitigating measures such as early fill placement, temporary surcharges, wick drains, stone columns, lightweight fill, or soil reinforcement shall be used where necessary to limit long-term movements.

Conservative estimates of the long term vertical, longitudinal and lateral movements of headslopes and retaining walls that will follow after completion of construction shall be made.

These movements shall be estimated at the elevations of deck joints, bearings and tops of piles as applicable. Joints, bearings and piles shall be designed to accommodate these long term movements over and above cyclical movements and girder shortening, in addition to an allowance for construction tolerances. The long term movements incorporated into the design shall be identified on the Detailed Designs.

(b) Layout of Retaining Walls at Abutments

This Section applies to the layout of independent high retaining walls at abutments adjacent to roadways and railways, and shall be read in conjunction with drawings SK-16 and SK-17 in Appendix B. For the purpose of determining the wall layout, the skew angle shall be measured as the angle formed between a line perpendicular to the centreline of the over-passing roadway or railway and the shoulder line or railway track centreline passing beneath. Walls shall have one of the following layouts:

- Layout 1 (illustrated on drawing SK-16 (Wall Layout and Site Drainage for Skew Angles $\leq 45^\circ$) in Appendix B). For all skews up to and including 45 degrees, retaining wall wingwalls shall be placed parallel to the under-passing roadway at all locations, except that the retaining wall wingwall on the approaching traffic side for the under-passing roadway shall be flared away from traffic at a flare rate of 20:1 and the end of the retaining wall wingwall shall be buried into the ground. For walls parallel to under-passing railways, the retaining wall wingwalls shall be flared away from the track at both sides of the abutments at a flare rate of 20:1; or
- Layout 2 (illustrated on drawing SK-17 (Wall Layout and Site Drainage for Skew Angles $> 45^\circ$) in Appendix B). This layout shall only be used for skews greater than 45 degrees. For this layout:
 - At the acute angled corner of the bridge only, the retaining wall shall be turned back parallel to the over-passing roadway, and the exterior face of the retaining wall wingwall shall be set-back behind the exterior face of the traffic barrier along the top of the wall. Notwithstanding Section 300.5.2.11 (Retaining Walls), the height of the turned-back portion may exceed 8 m, but shall not exceed 12 m as illustrated on drawing SK-18 (Turned Back Wingwall Details for Skew Angles $> 45^\circ$) in Appendix B, and notwithstanding Section 300.5.2.10 (c) “Approach Slabs”, the barrier may be integral with the approach slab over the turned back retaining wall wingwall;
 - If a roof slab is required, both wingwalls shall be cast-in-place concrete and cantilevered off the gradebeam;
 - Conventional abutments with deck joints shall be used. Integral abutments are not permitted;
 - Other than for walls adjacent to under-passing railways, at all locations other than at the acute angled corner of the bridge, retaining wall wingwalls shall be placed parallel to the under-passing roadway except that the retaining wall wingwall on the approaching traffic side for the under-passing roadway shall be flared away from traffic at a flare rate of 20:1 and the end of the retaining wall wingwall shall be buried into the ground; and
 - For walls adjacent to under-passing railways, at all locations other than at the acute angled corner of the bridge, retaining wall wingwalls shall be placed parallel to the under-passing railway except that the retaining wall wingwall shall be flared away from the track at a flare rate of 20:1 beyond the abutment.

For both layouts, where the length of retaining wall wingwall on the approaching traffic side for the under-passing roadway extends more than 20 m beyond the abutment, only the end 20 m of the retaining wall wingwall shall be flared.

(c) Approach Slabs

Approach slabs shall be in accordance with the provisions of clause 1.7.2 of the Bridge Design Code except as otherwise noted:

- Approach slabs shall have sufficient length to limit their rotation due to settlement to 0.5%, and shall have a minimum length of 6000 mm (measured parallel to centreline of roadway);
- Approach slabs shall not be constructed with integral barriers or curbs, except for the barrier over the turned-back portion of an independent high retaining wall wingwall at the abutment;
- Approach slab thickness shall be as required by the Design Engineer and shall have a thickness not less than 300 mm;
- Approach slab reinforcement shall be as required by the Design Engineer but in no case shall the reinforcing steel be less than: the bottom mat reinforcing steel shall not be less than 20M @ 150 mm placed parallel to centreline of roadway and 15M @ 150 mm placed parallel to abutment backwall, and the top mat reinforcing steel (parallel to the bottom mats) shall not be less than 15M @ 300 mm each way;
- Approach slabs shall be connected to the bridge in a manner that provides for free hinging slab rotation at the connection without causing restraining moments and forces; and
- Approach slabs shall receive a 90 mm thick ACP deck protection and wearing surface system as per Standard Drawings S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2) unless otherwise approved in advance and in writing by the Department.

(d) Integral Abutments

This Section applies to integral abutments, and shall be read together with drawings SK-9, SK-10, SK-13 and SK-15 in Appendix B. Integral abutments shall include both fully integral and semi-integral abutments. Integral abutments shall not be used for bridge spans greater than specified in “Table - Maximum Thermal Spans” below. In addition to the general requirements for abutments, integral abutments shall also be designed to meet the following requirements:

- (a) The effects of skew and potential for twisting of superstructure on plan shall be analyzed and accounted for;
- (b) The amount of structure and earth that have to move with the abutment during thermal movement of the superstructure shall be minimized. Abutment seat heights above grade shall not exceed 1.5 m. Turned back wingwalls shall be parallel to the over-passing roadway and shall not exceed 8 m in length measured from the back of the abutment seat/abutment diaphragm to the end of the wingwall, cantilevered off the back of the abutment;
- (c) Additional deck reinforcement shall be provided for resisting negative bending moments at and near the ends of the superstructure due to flexural continuity of the girder-to-pile connection and the related torsional restraint of the stiff abutment diaphragms;

- (d) For fully integral abutments the abutment foundation shall be a single row of H-piles oriented for weak axis bending wherever possible. For large movements exceeding the movement range of Type C1 control joints or when surrounding soils will restrict pile movement, piles shall be installed inside of permanent steel casings (refer to drawing SK-13 (Cycle Control Joint Details for Integral Abutments)). The casings shall be filled with Styrofoam beads. Styrofoam beads shall be new “Storopack” virgin polystyrene 14.4 kg/m³ (0.9 pounds per cubic foot) filler bead nominal diameter of 5 mm, or approved equivalent - regrind or recycled polystyrene material is not acceptable and shall not be used. Steel casings shall be designed to last the same life as the bridge, and an appropriate sacrificial corrosion thickness and/or galvanizing shall be provided. The H-piles shall be embedded a minimum distance of two times the pile depth into the abutment seat;
- (e) Cycle control joint types C1 and C2 shall be located at least 1.125 m beyond the ends of the wingwalls by extending the length of the approach slab (refer to drawing SK-13 (Cycle Control Joint Details for Integral Abutments) and SK-15 (Drain Trough Details for Integral Abutments)). Wick drains from the deck wearing surface and cycle control joints shall be day-lighted onto the sideslopes or connected to positive drainage;
- (f) The installation of expansion foam material behind integral abutments for the purpose of relieving earth pressures shall not be permitted;
- (g) Integral approach slabs shall not be designed to move longitudinally in and out between stationary and parallel non-integral wingwalls;
- (h) Two layers of polyethylene sheet shall be provided under the approach slab to minimize frictional forces due to horizontal movement. The connection between the approach slab and the superstructure shall be designed to resist these forces;
- (i) The thrie beam approach rail transition shall be rigidly attached to the ends of bridge barriers, regardless of whether the barrier ends are stationary or moving;
- (j) Where barriers are permitted to be constructed integral with approach slabs, the design shall be such that loss of barrier height due to settlement and overlay does not exceed 30 mm over the life of the structure. The joint between the barrier on the approach slab and the barrier beyond the approach slab shall be kept sealed; and
- (k) Provision shall be made for thermal movement between integral abutments and slope protection or inspection walkways. Gaps shall be protected against moisture ingress.

“Table - Maximum Thermal Spans” below provides allowable maximum thermal spans for joint types C1 and C2 (refer to drawing SK-13 (Cycle Control Joint Details for Integral Abutments) in Appendix B). The difference in concrete and steel bridge lengths reflects the effect of the greater thermal mass of concrete and the greater sensitivity of steel in reacting to ambient temperature changes.

The thermal span shall be taken as the distance measured from the superstructure location that

experiences zero longitudinal movement under temperature changes to the centreline abutment bearings/centreline piles.

Table - Maximum Thermal Spans

Joint type	Maximum Thermal Span for Steel Girder Bridges	Maximum Thermal Span for Concrete Girder Bridges
C1	22.5 m	30 m
C2	45 m	60 m

Joint types C1 and C2 shall be designed and detailed as shown on drawing SK-13 (Cycle Control Joint Details for Integral Abutments) in Appendix B, and as follows:

Joint type C1 - The pavement shall be saw-cut at the end of the approach slab for crack control.

Joint type C2 - A sleeper slab shall be provided under the end of the approach slab. The trench excavated for the installation of the sleeper slab and the granular base shall be extended across the full width of the road embankment and day-lighted onto the sideslope for drainage. The ends of the trench shall be integrated with the abutment drain troughs if they are present.

- (1) For monolithic abutment diaphragms which are cast around girder ends, the girders shall be erected on a minimum 150 mm high plinth to provide sufficient clear space between the girder bottom and previously cast concrete, to ensure proper flow of concrete under the ends of the girders. This is illustrated in Detail Q on drawing SK-9 in Appendix B.

300.5.2.11 Retaining Walls

This Section 300.5.2.11 (Retaining Walls) shall apply to all retaining wall types and locations, even those retaining walls not located at or in conjunction with bridge structures.

Non-mechanically stabilized earth retaining walls shall be designed in accordance with the provisions of the Bridge Design Code.

Mechanically Stabilized Earth retaining walls shall also be designed in accordance with Section 300.5.2.22 (Mechanically Stabilized Earth (MSE) Walls). If a conflict results between the two Sections, the most conservative requirement shall govern.

Limits on retaining wall height are given in Section 200.2.18 (Aesthetics).

All walls shall be designed so that in the final position, they will be battered back against the retained soil from a vertical plumb line by a ratio of 50V to 1H.

Any bridge components located behind retaining walls, such as abutment seats, integral cantilevering wingwalls, abutment deck joints, abutment bearings and traffic barriers, shall be designed to accommodate any movements resulting from lateral wall displacements.

In locations where traffic runs adjacent to the top of, and nominally parallel to a retaining wall, a rigid barrier shall be provided. For the purpose of determining the appropriate Test Level requirements for the rigid barrier, the retaining wall shall be considered to be a structure and the applicable provisions of Section 200.2.2 (Geometric Design) shall apply. The retaining wall shall be designed to fully resist the collision loads applied to the barrier, and loads from any attachments such as signs and lamp posts. Approach rail transitions shall be provided at the ends of the rigid barrier.

In locations where a sidewalk or a combined pedestrian/cyclist use pathway runs adjacent to the top of, and nominally parallel to a retaining wall, a pedestrian/cyclist railing shall be provided. The retaining wall shall be designed to fully resist the loads applied to the railing, and loads from any attachments such as signs and lamp posts.

Unless a traffic barrier, pedestrian rail or bicycle barrier is mounted directly on top of a retaining wall, a safety railing shall be mounted on the top concrete surface of all retaining walls and shall be designed as a “guard” in accordance with Part 9 of the *Alberta Building Code* (2014). Safety railings shall have a minimum height of 1070 mm and shall consist of vertical posts with not less than two horizontal rails. Chain link fence is not permitted. Safety railing anchorage assemblies shall be cast into the top concrete surface and shall not be field drilled. Retaining walls shall be designed to resist the loads from all barriers fastened to the walls. All steel components for safety railings shall be galvanized in accordance with ASTM A123/A123M and F2329. All steel components for safety railings shall conform to CSA G40.21M Grade 300W, except that anchor rods conforming to ASTM A307 are also acceptable.

Toe slopes in front of retaining walls that are nominally parallel to the adjacent roadway shall be covered with concrete slope protection and shall have a maximum slope as specified in Section 200.2.2 (Geometric Design) to allow for safe vehicle recovery. If the Detail Design incorporates an arrangement where the distance from the face of the MSE wall is greater than 1,000 mm from the face of the abutment, then the 1,000 mm portion of the headslope nearest the wall shall be designed and constructed in accordance with Section A “MSE Wall Option” of SK-9 to SK-12 in Appendix B, and the remaining portion of the headslope nearest the abutment shall be designed and constructed based upon Standard Drawing S-1409-16 (Standard Concrete Slope Protection for Grade Separations) in Appendix B.

In locations where traffic runs adjacent to the top of, and nominally parallel to a retaining wall, roadway drainage and the allowable encroachment of rain runoff into adjacent traffic lanes shall be accommodated in the same manner as on bridges and in accordance with Section 300.5.2.20 (Bridge Drainage).

Dry cast and stacked concrete and/or masonry block walls with or without soil reinforcement are not permitted and shall not be used.

300.5.2.12 Ducts and Conduit Systems

Ducts and conduit systems shall be fully detailed on the appropriate bridge Detailed Design drawings (e.g. abutment drawings, pier drawings, deck and barrier drawings, etc.).

(1) Utility Ducts in Curbs and Barriers

The Contractor shall provide one 75 mm nominal diameter utility duct on each side of the bridge deck for the future accommodation of utilities. The purpose of these ducts is to allow for unforeseen utility needs that are not part of the Project Requirements. For bridges that are to be widened at Ultimate Stage, a duct will not be required on the side on which widening occurs. However, if widening takes place on both sides, a duct will be required on one side, and the side will be identified by the Department. The utility ducts shall be placed within the bridge curbs and/or barriers and shall be extended beyond the ends of the abutment wingwalls and terminated into a junction box of suitable size, installed flush with the finished ground, to allow the termination of the conduit and allowance for future connections. The junction box shall be placed behind the roadway approach rails in a location where they can be accessed without

damage to any road or bridge construction. The utility duct termination location shall be dimensioned on the Detailed Design abutment drawings.

If additional utility ducts are required for the utility needs of the Project and the O&M, they may be placed within bridge curbs/barriers which will not be removed at the Ultimate Stage, provided they do not impact the strength of the barriers. Utility ducts shall not be placed within the thickness of the bridge deck, attached to the bridge girders, or attached to the underside of the bridge deck.

Waterproof O-ring expansion fittings shall be provided at all bridge expansion joints and at locations where sidewalk curbs or barriers could undergo rotational settlement (e.g. sidewalk/roadway barrier over corbel supported approach slabs). Loose fit or tape connections are not permitted.

All utility ducts cast into curbs/barriers shall be rigid PVC DB2, meeting the requirements of CSA C22.2 No. 211.1 and in accordance with the rules of the Canadian Electrical Code, Part 1. Coupling shall be solvent bell ends (SBE). Pull strings shall be installed and secured at each end of all ducts/conduits for future installations.

(2) Conduit Systems for Under-bridge Lighting

Any conduits required for wiring to under-bridge lighting systems shall be cast within the bridge piers and pier caps and shall not be routed through abutment ends. If, at a specific bridge structure, no piers exist or other conditions exist that prevent routing of conduits for electrical supply through the piers, an alternative routing shall be proposed for review and acceptance by the Department in writing and in advance of design completion and prior to construction of affected bridge elements.

The conduit system shall be concealed and shall comprise rigid PVC conduit having a minimum trade size of 41 mm, together with industry-standard junction boxes and fittings. The system shall provide a continuous concrete-proof and weatherproof conduit arrangement from below ground to the top surface of each pier cap.

Conduits shall be placed as follows:

- (a) Conduits shall enter the bridge structure a minimum 1000 mm below finished ground elevation at the exterior of the pier as necessary and shall bend up to connect with a PVC junction box to be recessed on the exterior surface of the pier shaft 1000 mm above finished ground elevation. Minimum clear inside dimensions of this PVC junction box shall be 150 mm x 150 mm x 150 mm. The junction box may be larger if necessary for the proper connection and bonding of bridge wiring to incoming supply cables according to Canadian Electrical Code (“CEC”) requirements. The PVC junction box is to be set flush with the surface of the pier shaft and shall be fit with a gasketed weatherproof securable cover.
- (b) A riser conduit shall then extend up to a weather proof PVC access junction box secreted in the top surface of the pier cap. This box shall be sized for the number of luminaire conduits and wires to be accommodated at that point. For bridge structures where a concrete pier diaphragm precludes placement of an access junction box in the top of the pier cap, it may, subject to the Department’s written acceptance of Detailed Design, be

placed unobtrusively in the face of the pier cap near its top edge. For bridge structures with integral pier cap/diaphragms, the riser conduit shall extend into the pier cap/diaphragm and up to the weather proof PVC access junction box secreted in the side surface of the pier cap/diaphragm.

- (c) Additional weather proof access junction boxes may be installed in the pier cap as required by the width of the bridge and the number of luminaires to be serviced. These additional access junction boxes shall be supplied by a rigid PVC conduit not less than 27 mm trade size cast horizontally within the pier cap/diaphragm.
- (d) Rigid conduits exiting the access junction boxes to service under-bridge luminaires shall be the minimum diameter consistent with CEC requirements for the number and sizes of wires employed and the availability of attachment support points, but not less than 16 mm inch trade size.
- (e) Luminaire conduits shall be run in neat vertical and horizontal alignments, supported as necessary to comply with CEC requirements and to mitigate the effect of vibrations induced in the bridge by passing traffic.
- (f) Luminaires shall be mounted on bridge pier caps or steel diaphragms as required. Where it is necessary to install a horizontal conduit run to access a luminaire, the conduit or any necessary conduit support tray or truss supports shall be fixed to the vertical face of the bridge girder haunches. No attachments shall be fixed to the girders or to the underside of the bridge deck. For solid slab superstructures or similar superstructure systems that do not have girder haunches for attachment locations an alternative fastening method shall be proposed for review and acceptance by the Department in writing and in advance of design completion and prior to construction of the affected bridge elements.
- (g) Luminaires conduits and/or conduit support equipment that are supported on the superstructure shall be located within interior girder bays. For solid slab superstructures or similar superstructure systems that do not have interior girder bay locations an alternative shall be proposed for review and acceptance by the Department in writing and in advance of design completion and prior to construction of the affected bridge elements.
- (h) Luminaire conduits and/or conduit support equipment shall be attached to the bridge structure with anchors cast into the haunch concrete at appropriate locations. For solid slab superstructures or similar superstructure systems that do not have girder haunches for attachment locations an alternative fastening method shall be proposed for review and acceptance by the Department in advance of design completion and prior to construction of the affected bridge elements.
- (i) In the event that partial depth precast concrete deck panels are utilized, anchors for the purpose of supporting lighting conduits shall be cast into the underside of the precast deck panels. These anchors shall be positioned at the edges of the precast deck panel so that the conduits are located within 100 mm of the edge of the girder top flange. Spacing between anchors in the precast deck panels and between anchors on adjacent precast deck panels shall not exceed the maximum conduit support distance allowed in the CEC.
- (j) All wiring to under-bridge luminaires shall be RW90 of appropriate number and gauge to

comply with voltage drop limitations. A continuous ground wire is required in all under-bridge lighting conduits to ensure the whole system is properly bonded. Conduits shall be sized to accommodate the noted wiring requirements.

- (k) Prior to the wiring being installed, all conduits shall be proven to be free and clear of obstructions.

300.5.2.13 Signing

Notwithstanding vertical clearance signs, no other signs may be attached to highway bridges, pedestrian bridges or retaining walls.

300.5.2.14 Intentionally Deleted

300.5.2.15 Deck, Curbs, Medians, Concrete Barriers, Sidewalks

This Section 300.5.2.15 (Deck, Curbs, Medians, Concrete Barriers, Sidewalks) provides design information for decks, curbs, medians, concrete barriers and sidewalks. Additional design information related to bridge barriers is provided in Section 300.5.2.19 (Barriers).

- (a) Cast-in-place concrete deck slabs for slab-on-girder bridges shall be designed using the empirical method in accordance with clause 8.18.4 of the Bridge Design Code, and in all cases shall have a minimum slab thickness equal to the greater of the girder spacing divided by 15.0, or 225 mm. Use of this method requires composite action between the slab and girder over the entire girder length.
- (b) All cast-in-place concrete decks, even for the case where a deck is supported on side-by-side girder units with little or no slab span resulting, shall have a slab thickness not less than 225 mm. All cast-in-place concrete decks shall be reinforced with both upper and lower layers of reinforcing. Each layer of reinforcing shall consist of two reinforcing directions, one direction that can resist longitudinal or primarily longitudinal forces and one direction that can resist transverse or primarily transverse forces.
- (c) Clause 5.7.1 of the Bridge Design Code covers bending moments in concrete deck slabs. For the Project, any references to CL-625 in clause 5.7.1 shall be replaced with CL-800 and all stipulated forces and moments presented in clause 5.7.1 shall be pro-rata increased by a factor equal to the ratio of 800/625.
- (d) Deck and curb reinforcement required to develop the capacity of bridgerail post anchors are site specific designs. Guidance for design of decks supporting bridgerail posts is available from AASHTO *LRFD Bridge Design Specifications*, Appendix A13.
- (e) Deck systems using precast concrete partial depth panels shall meet the requirements of Section 300.5.2.23 (Deck Systems Using Precast Concrete Partial Depth Deck Panels).
- (f) Full depth precast concrete deck panel construction is not allowed.
- (g) Stay in place corrugated metal, timber or other deck soffit formwork types are not allowed and formwork shall not remain in place as part of the structure. Use of any formwork system

or components shall not reduce design dimensions as required by the Technical Requirements or Detailed Designs, in that order.

- (h) Concrete curbs and barriers shall have crack control joints as shown on the Department's Standard Drawings for barriers and curbs. These control joints shall have a maximum longitudinal spacing of 3 m and shall be centred between bridgerail posts where bridgerail posts are used, with the exception of the standard TL-4 barriers which have a maximum crack control joint spacing of 2.3 m. Longitudinal reinforcing in the curbs and barriers shall be discontinuous at the joints. Control joints shall extend down to the top of the concrete deck and shall be caulked prior to application of deck waterproofing membrane in accordance with Standard Drawings S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2).
- (i) Concrete paving lips along the edge of ACP are not permitted.
- (j) The portion of the structural deck slab under sidewalks and raised concrete medians shall be protected by a waterproofing membrane and protection board. The sidewalk slab or raised concrete median shall be poured after the membrane and protection board have been applied to the structural deck slab. The top slab surface of sidewalks and medians shall have transverse tooled joints aligned perpendicular to and at a spacing matching adjacent curb/barrier control joints.

The sidewalk shall have a curb projecting 100 mm above the finished top of the sidewalk along the outside edge. If the roadway has a normal crown and the sidewalk is higher than the adjacent road surface, the sidewalk shall drain through slots in the traffic separation barrier onto the roadway gutter (see Standard Drawings S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2)). If a sidewalk is located on the high side of a superelevated roadway, the sidewalk shall drain to the outside edge and the drainage shall be carried longitudinally down the edge of the sidewalk and acceptably discharged at the end(s).

- (k) For sidewalks and raised concrete medians, barrier curbs may conflict with road barrier or barrier cushion end performance, and the use of mountable or semi-mountable curbs may be required. For more detailed guidance, refer to section H4.3 and H11.3 of the Roadside Design Guide. Required median width (lip of gutter to lip of gutter) transition from roadway to bridge shall be maintained with lane markings.
- (l) [Intentionally Deleted]
- (m) A minimum of two electrical connections are required on bridge decks to accommodate the copper sulphate electrode (“CSE”) or half-cell testing as identified in Section 400.5.1.3.3 (Specialized Level 2 Inspections) without damaging the deck waterproofing membrane.

The first electrical ground connection and associated hardware shall be located on the soffit of the deck overhang at the corner of the bridge identified as the CSE test origin in the

Department's *Level 2 Bridge Inspection Manual* section 3.3.1. The second electrical ground connection shall be located at the opposite end and opposite soffit of the bridge. Ground connections must be a #12 RW90 wire (or approved equal) welded to the top mat reinforcing and connected through a waterproof PVC junction box 100x100x75 mm and must be accessible by foot and without the use of specialized equipment such as ladders, man-lifts, cranes, snooper trucks etc.

- (n) Concrete finishes on decks, curbs, medians, barriers and sidewalks shall be in accordance with Section 300.5.7.16 (Concrete Surface Finish).

300.5.2.16 Bearings

- (1) Bearings shall consist of one of the following types: (a) steel reinforced elastomeric bearing pads with or without stainless steel and Teflon sliding surfaces; (b) fixed steel plate rocker bearings; (c) proprietary pot bearings; or (d) plain unreinforced elastomeric bearing pads without sliding surfaces. Requirements for the use of these bearing types are provided in this Section 300.5.2.16 (Bearings).
- (a) Steel reinforced elastomeric bearings with or without stainless steel and Teflon sliding surfaces shall be designed to accommodate the loadings, translations and rotations specified on the Detailed Designs, in accordance with the requirements of the Bridge Design Code, and be in accordance with the Technical Requirements. Steel reinforced elastomeric bearings with or without stainless steel and Teflon sliding surfaces shall incorporate the following standard features:
- Steel sole plates and base plates shall be provided;
 - All bearings shall be grouted in prior to casting deck concrete;
 - Bearings pads shall be designed for all rotations that take place after the bearings are grouted, plus an allowance for uncertainties of at least 0.005 radians at SLS;
 - Notwithstanding clause 11.6.6.2.2 of the Bridge Design Code, cured elastomeric compounds shall be low temperature Grade 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06 and Shore A durometer hardness of 60;
 - Elastomeric pads shall be restrained from walking out from the design position by means of 10 mm high corner keeper bars bolted to the top of the base plate, as shown on Standard Drawing S-1761-08 (Typical Expansion Bearing Details);
 - A single self-rocking pintle welded under the base plate shall be used to ensure uniform contact between the elastomeric bearing pad and the girder bottom flange at erection. Where double pintles are shown on the Detailed Designs, the pintles shall be centred beneath the bearing along a line perpendicular to the longitudinal axis of the girder. The pintle or pintles shall be supported on galvanized steel shim stacks of the appropriate thickness to achieve the correct bearing elevation and the appropriate size to support the loads applied prior to grouting the baseplate;
 - The entire bearing assembly, between the sole plate and the base plate shall be replaceable without damage to the structure and without removal of any concrete, welds or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm. Bearings shall not be recessed into plates that are permanently attached to the structure;
 - Typical expansion bearing details shall be in accordance with the Standard Drawing S-1761-08 (Typical Expansion Bearing Details). Sliding surfaces shall allow

- translation by sliding of a stainless steel surface against a mating polytetrafluoroethylene (“PTFE”) element. The flat PTFE sheet shall be recessed and bonded into a 2.5 mm deep recess in the top of a 10 mm thick galvanized steel plate. The galvanized plate shall be vulcanized to the top of the elastomeric pad. The galvanized steel plate shall have the same plan dimensions as the elastomeric pad and act as the top laminate in the elastomeric bearing. The stainless steel sliding surface shall conform to AISI Type 304, No. 8 finish and shall be welded to the bottom of the sole plate as shown on Standard Drawing S-1761-08 (Typical Expansion Bearing Details); and
- The PTFE element shall be a 5.0 mm thick unfilled, unlubricated flat PTFE sheet.
- (b) Fixed steel plate rocker bearings shall be designed to accommodate the loadings and rotations specified on the Detailed Designs, in accordance with the requirements of the Bridge Design Code, and in accordance with the Technical Requirements. Fixed steel plate rocker bearings shall incorporate the following standard features:
- Fixed steel plate rocker bearings consist of a curved steel rocker plate and a base plate, connected with anchor rods or pintle pins;
 - The curved surface of the rocker plate and the top central 250 mm width of the base plate shall be machined to a surface finish of 6.4 μm and a flatness tolerance of 0.001 x bearing length;
 - The entire bearing assembly, between the rocker plate and the base plate shall be replaceable without damage to the structure and without removal of any concrete, welds or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm;
 - Base plates are installed level on galvanized steel shim stacks, and shall be grouted prior to casting deck concrete; and
 - Notwithstanding clause 11.6.1.1 of the Bridge Design Code, fixed steel plate rocker bearings shall be designed for all rotations that take place after grouting, plus a fabrication and construction tolerance of 0.005 radians plus an allowance for uncertainties of at least 0.005 radians at ULS.
- (c) Proprietary pot bearings shall be designed for the loadings, translations and rotations specified on the Detailed Designs, in accordance with the requirements of the Bridge Design Code, and in accordance with the Technical Requirements. Proprietary pot bearings shall incorporate the following features:
- Provision for translation shall be through sliding of a stainless steel surface against a mating PTFE element. The translational capacity in an unrestrained direction shall be as specified on the Detailed Designs;
 - Provision for rotation about any horizontal axis shall be by means of a single disc of confined elastomer. Brass rings shall not be considered in determining the effective thickness of the elastomeric disc. The effective thickness of the elastomeric disc to evaluate the rotational capacity shall be limited to the thickness of the disc excluding the brass rings;
 - The rotational capacity about any horizontal axis shall be as specified on the Detailed Designs. The rotational capacity about the vertical axis through the centre of the bearing shall be as specified or $\pm 1^\circ$, whichever is greater;
 - Rotational bearings shall be capable of resisting the specified lateral loads in any

- direction in combination with the applicable vertical loads;
- Brass sealing rings shall be flat and smooth on all surfaces and conform to the requirements of the Bridge Design Code;
 - The depth of the pot wall shall be such that a minimum vertical distance of 2.5 mm remains between top of the pot wall and the closest point of contact of the brass sealing rings with the pot wall upon rotating the piston an amount equal to the specified rotation at ULS;
 - The pot and piston surfaces in contact with the confined elastomer shall be lubricated with silicone grease. The bearing shall be sealed by a one-piece continuous preformed closed-cell compressible ring against entry of dirt, dust, and moisture between the elastomer and the pot and piston contact surfaces. Any joint in the ring shall be bonded and the strength shall be at least equal to the strength of the ring;
 - Sliding surfaces shall allow translation by sliding of a metal surface against a mating PTFE element. For plane surfaces, the metal surface shall be stainless steel. The metal surface shall overlap the PTFE by at least 25 mm at extremes of movement on each side and, except for guides for lateral restraint, shall be positioned above the PTFE element;
 - Except when used as mating surfaces for guides for lateral restraint, the PTFE resin shall be virgin material and shall be used as unfilled sheets and shall contain spherical reservoirs for lubricant pressed into its surface. The diameter of the reservoirs shall not exceed 8 mm measured at the surface of the PTFE, and the depth shall not be less than 2 mm nor more than half the thickness of the PTFE. The reservoirs shall be evenly distributed across the surface of the PTFE and shall occupy 20% to 30% of the surface. PTFE used as mating surface for guides for lateral restraint shall not be dimpled or lubricated. All PTFE elements shall be fully bonded and recessed in a rigid backing material;
 - All PTFE surfaces except those that act as mating surfaces for guides for lateral restraint or that are subjected to a contact pressure of less than 5 MPa shall be permanently lubricated with silicone grease;
 - Notwithstanding clause 11.6.3.6 of the Bridge Design Code, for PTFE elements filled with up to 15% by mass of glass fibres and used to face mating surfaces of guides for lateral restraint, the maximum average contact pressure for ‘all loads’ shall not exceed 45 MPa at SLS and 55 MPa at ULS.
 - The coefficient of friction between stainless steel sliding surfaces and lubricated virgin PTFE shall be as per section 14.7.2.5 and Table 14.7.2.5-1 of the 2012 AASHTO LRFD Bridge Design Specifications;
 - Pot bearings shall be installed on an underside-level base plate on galvanized steel shim stacks, and grouted in prior to casting deck concrete;
 - Notwithstanding clause 11.6.1.1 of the Bridge Design Code, pot bearings shall be designed for all rotations that take place after grouting, plus a fabrication and construction tolerance of 0.005 radians plus an allowance for uncertainties of at least 0.005 radians at SLS and ULS;
 - Notwithstanding clause 11.6.5.4 of the Bridge Design Code, the average stress in the Elastomer at serviceability limit states loads shall not exceed 30 MPa.;
 - Notwithstanding clauses 11.6.5.2 and 11.6.6.2.2 of the Bridge Design Code, cured elastomeric compounds shall be low temperature Grade 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06 and Shore A durometer

- hardness of 50;
- Fasteners, anchorages and translational elements with lateral restraints shall at least be capable of resisting either of the following lateral loads:
 - a) For bearings with a capacity of 5,000 kN or less at serviceability limit state, 10% of the vertical load capacity;
 - b) For bearings with a capacity over 5,000 kN at serviceability limit state, 500 kN plus 5% of the vertical load in excess of 5,000 kN;
- Guides for lateral restraint shall be arranged to permit the required rotations about both the horizontal and vertical axis. The translational elements of guides for lateral restraint shall be faced with stainless steel and shall provide lateral restraint by sliding against mating surfaces faced with PTFE;
- The beneficial effect of friction shall be neglected in proportioning fasteners and anchors, except for slip resistant connections which shall be designed to the requirements of clause 10.18.2 of the Bridge Design Code;
- The entire bearing assembly, between the sole plate and the base plate shall be replaceable without damage to the structure and without removal of any concrete, welds or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm. Bearings shall not be recessed into plates that are permanently attached to the structure;
- Bearings shall be designed to prevent moisture and dirt from entering the internal surfaces. The bearings shall be fabricated from materials that are durable and are protected against corrosion so as to perform acceptably over the service life of the bridge;
- Notwithstanding clause 11.6.3.6 of the Bridge Design Code, the average contact pressure for unfilled PTFE elements, based on the gross area of the PTFE, shall not exceed the values given in the following table:

Average Contact Pressure for unfilled PTFE Elements

Limit State	Permanent Load (MPa)	Total Load (MPa)
SLS	25	35
ULS	40	55

- The maximum contact pressures at the extreme edges of flat and curved PTFE elements shall not exceed 1.2 times the values indicated in the table above.
- (d) Plain unreinforced bearing pads without sliding surfaces shall be designed for the loadings, translations and rotations specified on the Detailed Designs, in accordance with the requirements of the Bridge Design Code, and in accordance with the Technical Requirements. This bearing type shall only be used for support of girders where total movement range of the bearing in any direction over the life of the bridge does not exceed 25 mm or for temporary erection stage bearings for integral bridge girder supports. Temporary erection stage bearings shall not be included in the design of girder-to-substructure connections for dead and live load support during the in-service life of the

bridge. Plain unreinforced bearing pads without sliding surfaces shall incorporate the following features:

- For permanent bearings, the bearing support surfaces on the substructure shall be fully detailed in the Detailed Designs with control elevations given on a plan layout;
- For permanent bearings, the bearing pads shall have full contact on both the underside of the girders and on the substructure supports with consideration given to girder camber and other geometric conditions;
- Plain unreinforced elastomeric bearing pads shall be moulded individually, cut from moulded strips or slabs of the required thickness, or extruded and cut to length;
- Cured elastomeric compounds for plain unreinforced elastomeric bearing pads used as permanent bearings shall be low temperature Grade 5 and meet the physical and low temperature brittleness requirements listed in Table X1 and section 8.8.4 of AASHTO M251 *Plain and Laminated Elastomeric Bridge Bearings* (AASHTO M251) and shall have a Shore A durometer hardness of 60;
- Cured elastomeric compounds for plain unreinforced elastomeric bearing pads used as temporary supports during erection stage shall be low temperature Grade 3, 4, or 5 and meet the physical and low temperature brittleness requirements listed in Table 1 and section 8.8.4 of AASHTO M251 and shall have Shore A durometer hardness of 50.

(2) Expansion bearings shall provide an excess travel capacity in each direction of at least 25% of the theoretical thermal movement (in accordance with the Bridge Design Code), but not less than 25 mm, beyond that required for theoretical travel. An allowance shall be made for additional movement if required for concrete creep and shrinkage and foundation movements. The stainless steel plate shall be wider than the elastomeric pad by at least 10 mm on each side and shall be longer than the theoretical travel distance by at least 25 mm on each end.

(3) Bearings shall be set level by using tapered sole plates and uniform thickness base plates, with the following two exceptions:

- When finger plate abutment expansion joints or cover plated abutment expansion joints are used, the sole plates and/or base plates shall be tapered such that the sliding plane of the abutment expansion bearings is parallel to the roadway grade for proper functioning of the joint. Effects of longitudinal forces generated by the inclined sliding bearings on the structure shall be addressed;
- Tapered sole plates are not typically required for fixed steel plate rocker bearings due to their large rotational capacity.

(4) Bearing finishing and attachments:

- Sole plates, rocker plates, and base plates shall be hot-dip galvanized;
- For steel girders, sole plates or rocker plates shall be bolted to the bottom flange. Bolts attaching sole plates or rocker plates to the girder bottom flange shall be galvanized;
- For precast girders, shoe plates cast into the girders and sole plates shall be hot-dip galvanized. Sole plates shall be attached to shoe plates by field welding. All galvanizing damaged by field welding shall be metallized after welding. The weld design size shall account for weld contamination effects if the galvanizing is not

- removed in advance of welding. This typically results in at least an increase in the weld size;
- Attachment of the sole plate to the girder flange or shoe plate by welding shall be in the longitudinal direction along the edge of the girder. Transverse overhead welding shall not be permitted. Transverse ends not welded shall be sealed with Sikaflex 1a or an approved caulking material;
 - Other than surfaces of bolts or bolt holes, galvanized surfaces shall be isolated from ungalvanized steel surfaces by painting two coats of epoxy mastic paint;
 - Galvanized surfaces in contact with concrete or cementitious grout shall have the contact surfaces protected by a barrier coating; and
 - Pot bearing components, other than those in contact with the elastomer, shall be metallized or galvanized and shall be attached to galvanized plates by bolting.
- (5) Preparation of load bearing plates in contact:
- Steel load bearing plates in contact shall be machined to a surface finish of $6.4\ \mu\text{m}$ and a flatness tolerance of $0.001 \times$ bearing dimension;
 - Contact surfaces with elastomeric pad and grout or cast-in-place concrete do not require machining; and
 - Where required, machining shall be performed prior to hot-dip galvanizing. Where the galvanizing process may cause distortion, metalizing shall be used instead.
- (6) An 80 mm nominal thickness grout pad shall be provided under bearing base plates. The grout should sit in a grout pocket recessed 40 mm into the top of the substructure. The grout pocket shall extend 75 mm larger than the base plate around the base plate perimeter.
- (7) Bridge designs requiring uplift bearings are not permitted and uplift bearings shall not be used. This requirement shall apply at all temporary and permanent stages and for both serviceability limit state and ultimate limit state loading.
- (8) Shim plates used for shim stacks shall be hot-dip galvanized and shall be sized to suit the applied loads.
- (9) Bridges and bearings shall be designed and detailed to allow for bearing replacement. Each entire bearing assembly, between the sole plate and the base plate, shall be replaceable without damage to the structure and without removal of any concrete, welds or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm. Bearings shall not be recessed into plates that are permanently attached to the structure. Typical bearing replacement includes simultaneously jacking all girder lines, and supporting them in the raised position while bearings are replaced one at a time with overhead traffic on the bridge being directed away from the bearing being replaced. Locations for future jacking shall be shown on the Detailed Designs and shall be based on estimated jack and distribution plate sizes. Details of the designed bearing replacement procedure shall be noted on the Detailed Designs, together with the unfactored dead load and live load jacking force that will be required for bearing replacement.
- (10) Wherever practical, reinforced concrete shear keys independent of bearings shall be used to transfer lateral loads between the superstructure and the substructure, in accordance with

Standard Drawing S-1761-08 (Typical Expansion Bearing Details).

300.5.2.17 Girders

300.5.2.17.1 General

The Technical Requirements have been developed for use with precast-prestressed concrete NU girders or other similar I-shaped precast-prestressed concrete girders, precast-prestressed concrete box girders not exceeding 1.2m in width and not exceeding 0.9m in depth, welded steel plate girders, and welded steel box girders. Unless prior written acceptance is obtained from the Department to use other girder types, girders shall consist of one of these girder types. To obtain written acceptance from the Department, the Contractor shall submit the following information as a minimum: preliminary drawings that present typical details associated with the proposed girder type including mid-span section with reinforcing arrangement, girder end section with reinforcing arrangement, bearing details and support diaphragm system, intermediate diaphragm system, girder spacing, and the deck system(s) proposed; information on all the materials to be used in the fabrication of the girder and specifications for fabrication and construction; applicable design methodology/guidelines as well as any design and fabrication considerations unique to the girder type (e.g. special considerations associated with cracking, unique reinforcing details required, etc.); minimum of three examples of constructed bridges where the proposed girder is presently in service including owner's name and contact information, fabricator's name/location, bridge location, bridge age, span lengths and bridge widths, girder continuity, bearing and diaphragm systems, wearing surface systems, traffic volumes and any available summaries of girder bridge performance including bridge inspection reports, photos and text summary.

Attachment of utilities to bridge girders or other primary load carrying members shall not be permitted.

Vertical clearance signs shall be provided on all bridge structures at the locations of underpassing roadways and shall be mounted on the lower half of the 'upstream' fascia girder. Shop drilled holes for steel girders or cast-in inserts for concrete girders shall be incorporated during girder fabrication.

Except for integral abutment designs, abutment diaphragms shall be steel brace type to provide open access for inspection and maintenance of bearings and abutment deck joints.

Continuous bridges shall have the same number of girders on adjacent spans or adjacent segments to be spliced in the field, such that each individual girder line is fully continuous from end to end of the structure.

Precast concrete and steel girders that are designed as composite girders shall be designed such that the non-composite girders carry the deck slab dead load in an unshored condition.

Slab and girder bridge structures shall have a minimum of four girder lines.

300.5.2.17.2 Precast-Prestressed Concrete Girder Bridges

Precast-prestressed concrete girder bridges shall be designed to meet the following requirements:

- (a) For NU girders, typical girder details shall be in accordance with Standard Drawings S-1757-08 and S-1758-08 (NU Girder Bridges - Typical Details Sheet 1 and 2).

- (b) Pier diaphragms shall be continuous cast-in-place concrete diaphragms and shall be either pinned, fully monolithic with the pier top, or permit free expansion. Positive moment connections of girders over the piers shall consist of either one or a combination of grouted unstressed continuous tendons, lapped and bent-up strands, or lapped cast-in hooked rebar. For NU girders and other “I” shaped girders, the minimum separation between girder ends on common supports shall be 150 mm with grouted continuous tendons only, and 300 mm with bent strands or hooked rebar. For side-by-side girders, the minimum separation between girder ends on common supports shall be 400 mm with bent strands or hooked rebar. For pier diaphragms with a pinned or expansion connection to the pier, ends of both girders shall be supported on separate bearings. For pier diaphragms connected monolithically to the pier top, girder ends may be supported on plain elastomeric pads temporarily, during construction stage only.
- (c) The minimum age for girders prior to executing the field cast continuity connection shall be 60 days. Girder and deck design and detailing shall consider the effects of differential camber between girders. Girder design strength for girders with haunches shall be based on the nominal girder depth and assuming a haunch height of not more than 13 mm at mid-span.
- (d) Appropriate allowance for girder shortening due to prestress losses (pre-tension and post-tension) shall be included in the fabricated length of the girders.
- (e) Stirrup projections from the top of precast girders into the deck shall meet all Bridge Design Code requirements for lap splicing with vertical stirrups, and anchorage requirements for developing full composite action. All stirrups shall have 135° hooks around longitudinal deck bars. When projection of stirrups is less than 40 mm above the underside of the bottom mat of deck bars, additional hat shape extension bars shall be lapped with the stirrups to tie the slab and the deck haunch together and ensure full composite action with ductility in the connection between the girder and the deck. When precast concrete partial depth deck panels are used, stirrups projecting from the top girder flange shall project above the top surface of the precast partial depth deck panels and provide at least 25 mm clearance between the underside of the stirrup tops and the top of the precast partial depth deck panels. Stirrup projections shall not interfere with the top mat of deck reinforcing. If the variation of girder camber is significant, the height of stirrup projection shall vary along the length of the girder to ensure that conflict with the top mat of deck reinforcing is avoided. Longitudinal deck bars shall be detailed with a bar centred directly over the girder webs and the remaining bars spaced evenly between girder centre lines.
- (f) Horizontal interface shear design for composite action shall satisfy the requirements from the Bridge Design Code or AASHTO LRFD Bridge Design Specifications, whichever is more stringent. The longitudinal distribution of shear forces shall be taken to be the same as the ULS shear envelope unless a more demanding shear flow condition can exist based on analysis.
- (g) For NU girders and other “I” shaped girders, the area of additional stirrups for end crack control shall be calculated in accordance with the Bridge Design Code clause 8.16.3.2. The end stirrup shall be located as close to the end of the girder as cover permits. For pre-tensioned girder ends without thickened end blocks, the concrete cover to the end stirrup may

be reduced to 30 mm for girder end crack control. For girder ends to be encased in field cast concrete diaphragms, the end cover can be reduced to 25 mm for girder end crack control.

- (h) For NU girders and other “I” shaped girders, 10M closed ties shall be provided in the bottom flange to confine the pre-tensioning strands. Within the distance ‘h’ from the end of the girder, closed ties shall be provided as required for confinement, however spacing of closed ties shall not exceed 150 mm. Beyond the distance ‘h’ from the end of the girder, closed ties shall be provided at a minimum spacing of 300 mm. Closed ties are normally fabricated in two pieces with full tension lap splices. The top of the ties can be left open in the mid-span region where ever there is conflict with post-tensioning cables.
- (i) For post-tensioning ducts in pre-cast concrete girders with 28 day concrete strength greater than or equal to 65 MPa, the inside duct diameter shall not exceed 50% of the web thickness and the inside duct area shall be $\geq 250\%$ of the strand area.
- (j) For conventional abutments with deck joints, abutment girder ends shall be designed as part of the abutment steel brace diaphragm system for transfer of lateral forces.
- (k) For NU Girders and other “I” shaped girders all girder ends shall have cast-in shoe plates anchored into the girders. Shoe plate design shall account for the different support conditions at the abutments and piers.
- (l) For NU Girders a minimum of four bonded pretensioning strands shall be incorporated in the top flange to assist in controlling stresses during transportation and deck construction.
- (m) For connecting diaphragms in exterior girders, no connection components shall be visible on the exterior surface of the girders.
- (n) For girders containing pretensioning strands, clause 8.15.4 of the Bridge Design Code states “The number of stands where the bonding does not extend to the ends of the member shall not exceed 25% of the total number of strands.” This requirement shall apply to pretensioned only as well as combined pretensioned and post-tensioned girders. For combined pretensioned and post-tensioned girders, the 25% limit shall be applied to the total number of pretensioning strands only. In addition, the number of debonded strands in any horizontal row shall not exceed 40% of the strands in that row, and not more than 40% of the debonded strands, or four strands, whichever is greater, shall have the debonding terminated at any section. Debonded strands shall be symmetrically distributed about the centerline of the girder. Debonded lengths of pairs of strands that are symmetrically positioned about the centerline of the girder shall be equal. Exterior strands in each horizontal row shall be fully bonded and shall not be debonded at any location.

The effect of debonding shall be such that all limit states are satisfied with consideration of the total developed resistance at any section being investigated.

- (o) All miscellaneous steel that is attached to or embedded into girders, and has exposed surfaces, shall be galvanized. All intermediate steel diaphragms, including all associated plates, washers and bolts, shall be galvanized.

- (p) Side-by-side girder bridges are defined as bridges having precast girder units with little or no slab spanning transversely between girder units. In addition to the above, side-by-side precast girder bridges shall also meet the following requirements:
- i. Side-by-side girder bridges shall be composite with a 225 mm thick cast-in-place concrete deck with two mats of orthogonal deck reinforcement.
 - ii. Side-by-side girder bridges, fully monolithic with abutment and or pier substructure, may be erected on unreinforced elastomeric erection stage bearings on abutment and piers so long as permanent connection with the substructure is made through cast-in-place diaphragms - between and under girder ends at piers and behind and under girder ends at abutments.
 - iii. Where permanent lateral distribution diaphragms are not incorporated prior to deck placement, the Contractor shall design and provide temporary measures to ensure lateral stiffness and load distribution is acceptable during deck placement and during all phases of construction, prior to the full strength and stiffness of the combined girder and deck system are achieved. The temporary measures and provision for inclusion of these measures during construction shall be considered in the girder and superstructure design and details. The measures to control differential deflection between girder units and to distribute deck placement and other construction loads during construction shall be adequate to prevent adverse effects to the specified properties and locations of deck, or barrier, or deck and barrier, or other reinforcement that can be affected by superstructure construction activities. Furthermore, the measures to control differential deflection between girder units and to distribute deck placement and other construction loads during construction shall be adequate to prevent concrete cover and thickness variations from design requirements.

300.5.2.17.3 Steel Girder Bridges

Welded steel plate girder bridges shall be designed to meet the following requirements:

- (a) Typical welded steel plate girder details shall be in accordance with Standard Drawings S-1759-08 and S-1760-08 (Steel Plate Girder-Typical Details Sheet 1 and 2).
- (b) Vertical stiffeners and girder ends shall normally be square to the girder flanges. Abutment detailing dimensions shall account for the effects of girder end tilt.
- (c) Stiffened plate girder webs shall in no case have intermediate transverse stiffeners spaced at greater than 1.5 times the girder depth.
- (d) All welded steel girders, regardless of span, shall be cambered for 100% of dead load deflection and roadway gradeline profile.
- (e) All bearing stiffeners shall be “fit to bear bottom” and “fit only top”, and then fillet welded to both top and bottom flanges and to the web.
- (f) For long bridges with large expansion movements, the use of multiple bearing stiffeners shall be considered.

- (g) Jacking stiffeners for bearing replacement shall be provided on all girders at all supports. Location of jacking stiffeners shall be based on estimated jack sizes required for bearing replacement, plus sufficient clearance to the edge of the abutment seat or pier cap.
- (h) Diaphragm connector plates and intermediate stiffeners at stress reversal locations shall be welded to both top and bottom flanges. Corner cope of plates shall normally be 80 mm vertical x 35 mm horizontal for web thicknesses of 14 to 20 mm. Intermediate stiffeners, other than at stress reversal locations, shall be welded to the compression flange only, and cut short of the tension flange with web gap meeting the requirement of clause 10.10.6.4 of the Bridge Design Code.
- (i) Corners of stiffener plates projecting past the outside edge of flange plates shall be coped 45°.
- (j) No intersecting welds are allowed. Where horizontal stiffeners and vertical stiffeners intersect on the same side of the web, the horizontal stiffener shall run continuously through a slot in the vertical stiffener. The cut edges of the vertical stiffener at the intersection shall be corner coped (25 mm x 25 mm) adjacent to the web, and be welded to the horizontal stiffener. Refer to Standard Drawing S-1760-08 (Steel Plate Girder Bridge Typical Details – Sheet 2) for details.
- (k) All weld ends for stiffeners, gussets, and other attachments to girders shall terminate 10 mm from the edge or end of plates.
- (l) Gusset plates for attachment of horizontal bracing shall be bolted and not welded to girders.
- (m) Material properties for steel girders and attachments, bracing and bolts shall be as per Section 300.5.2.8 (d) (Materials - Structural Steel). All weathering steel shall be uncoated.
- (n) The following features shall be used to prevent staining of sub-structure concrete:
 - At pier locations, the exterior edge of the bottom flange of exterior steel girders shall have a 19 x 19 x 8000 mm long rubber strip centred over the pier, in accordance with Standard Drawing S-1760-08 (Steel Plate Girder Bridge Typical Details – Sheet 2).
 - At abutments, exterior steel girders shall have the same rubber strip attached around the bottom flange at 2000 mm from the face of the abutment walls. Where steel girders are cast into fully integral abutments, a second rubber strip shall be applied all around the bottom flange of all girders immediately in front of the concrete abutment face.
- (o) Changes in girder flange widths shall be tapered at a taper of 2.5 (longitudinal):1 (transverse) or provided with a 600 mm radius as shown on Standard Drawing S-1760-08 (Steel Plate Girder Bridge Typical Details – Sheet 2).
- (p) Shear stud projections from the top of girder flanges into the deck shall meet all Bridge Design Code requirements for stud development and anchorage requirements and ensure full composite action in accordance with design requirements. When the shear stud projection, measured from the underside of the head of the stud to the top of the bottom transverse deck

reinforcement, is less than 25mm, additional hat shaped reinforcement shall be provided and designed as shear friction reinforcement for a horizontal shear plane at the deck/girder haunch interface. When precast concrete partial depth deck panels are used, shear studs attached to the girder top flange shall project above the top surface of the precast partial depth deck panels and provide at least 25 mm clearance between the underside of the shear studs and the top of the precast partial depth deck panels.

- (q) Stainless steel rub plates shall be welded to the sides of steel girder flanges or bearing plates that will come into contact with the sides of concrete shear blocks.

300.5.2.17.4 Intermediate Diaphragms

- (a) Typical intermediate diaphragm locations and details shall be in accordance with Standard Drawings S-1757-08 (NU Girder Bridges Typical Details – Sheet 1) to S-1760-08 (Steel Plate Girder Bridge Typical Details – Sheet 2) inclusive.
- (b) Intermediate diaphragms are required for all slab-on-girder bridge structures. Intermediate diaphragms for slab-on-girder bridge structures with steel girders shall have a maximum spacing of 8.0 m. Intermediate diaphragms for slab-on-girder bridge structures with precast concrete girders shall have a maximum spacing of 13.0 m. Notwithstanding the above requirements, intermediate diaphragms for bridge structures with other than NU Girder superstructures or Steel Plate Girder superstructures shall be determined in accordance with the Bridge Design Code.
- (c) Intermediate diaphragms for Steel Plate Girder superstructures or Precast Concrete NU Girder superstructures with 1200 mm deep or shallower, shall be channel or W shape of at least 1/3 and preferably 1/2 the girder depth. For girders deeper than 1200 mm, full depth X or K bracing with top and bottom horizontals shall be provided.
- (d) Intermediate diaphragms and girders shall be designed for construction loads during deck concrete placement in accordance with clause 3.16 of the Bridge Design Code and other Bridge Design Code requirements. Specifically, diaphragms, exterior steel and precast girders carrying deck overhangs shall be checked to ensure sufficient strength and stability to handle concentrated loads from deck finishing machines, work bridges, fog misting equipment, and loads from formwork, wet concrete and temporary walkways. Loads assumed for such design shall be based on realistic estimates for each bridge and shall be shown on Detailed Designs. Diaphragms provided shall become part of the permanent structure and be left in place for possible future maintenance, i.e. widening, rehabilitation, etc.

300.5.2.18 Deck Joints

- (a) New structures shall be fully continuous from end to end. Deck joints shall only be permitted at abutment ends of bridges.
- (b) The following standard deck joints shall be used unless prior written acceptance is obtained from the Department to use other deck joints: (note that joint movement perpendicular to the deck joint has been designated “normal movement”, and joint movement parallel to the joint has been designated “shear movement”).

Department Standard Drawing	Joint Type	Maximum Permissible Normal Movement	Maximum Permissible Shear Movement ¹
S-1810-12 to S-1812-12 (Type I Strip Seal Deck Joint - Sheets 1 to 3)	Multi-cell strip seal	$115 - 60 = 55$ mm	13 mm
S-1638, S-1639, S-1640 (Standard Finger Plate Deck Joint Assembly)	Finger plate joint	n/a	n/a
S-1800-11 to S-1802-11 (Cover Plated V-Seal Deck Joint) ⁽³⁾	Cover-plated V-seal (102 mm V-seal)	$90 - 60 = 30$ mm	20 mm ⁽²⁾
S-1800-11 to S-1802-11 (Cover Plated V-Seal Deck Joint) ⁽³⁾	Cover-plated V-seal (125 mm V-seal)	$115 - 60 = 55$	25 mm ⁽²⁾
S-1800-11 to S-1802-11 (Cover Plated V-Seal Deck Joint) ³	Cover-plated V-seal (178 mm V-seal)	$150 - 60 = 90$ mm	30 mm ⁽²⁾

1. *The design shear movement from joint installation to the maximum design gap shall not exceed:*
 - a. *13 mm for multi-cell strip seals*
 - b. *20 percent of the maximum allowable joint gap for V-seals.*
2. *The maximum permissible shear movement for the V-seal might not apply concurrently with the maximum normal movement. The maximum permissible shear movement for any specific joint shall be the lesser of:*
 - a. *the movement given in the above table; and*
 - b. *the maximum movement, authorized by the V-seal supplier, that can be used concurrently with the design maximum normal gap.*
3. *Not to be used for roadway design speed > 80 km/h. Cover plate details to be used for curbs, barriers, sidewalks and median slabs regardless of design speed.*

Only approved strip seals listed on the Department’s deck joint Standard Drawings shall be used. Multi-cell strip seal deck joints are the Department’s preferred deck joint system when their use is not limited by the movement capacity of the seal perpendicular and parallel to the joint.

(c) Deck joints shall incorporate stop movement bars to maintain a minimum joint gap of 60 mm to facilitate seal replacement. Design Engineers should note that this is often larger than the minimum gap indicated on manufacturer’s brochures, which provide gap widths suitable for first installation only.

(d) For multi-cell strip seal type deck joints with skew angles within the range of 20° to 45°,

snow plow guard plates shall be installed in accordance with Standard Drawings S-1810-12 to S-1812-12 (Type I Strip Seal Deck Joint - Sheets 1 to 3) to prevent snow plow blades from catching the edge of the joint extrusion. Welded snow plow guard plates shall not be located directly under wheel paths.

- (e) Finger plates shall be fixed to the deck side to allow jacking and raising of the superstructure.
- (f) Modular seal deck joint systems are not permitted.
- (g) The free ends of any cover plates at deck joints shall be pointed towards the bridge abutments to allow jacking and raising of the superstructure.
- (h) Deck joints on steel girder superstructures shall be erected by bolting to the girders (welding is not permitted). The bolted connections shall utilize slotted holes to provide for adjustment in the vertical, lateral and longitudinal directions. Deck joints on concrete girder superstructures or abutments shall be erected on adjustable supports by projecting dowels with threaded couplers for elevation adjustment.
- (i) Deck joints shall run continuously across the full width of the deck, taking into account, skew, cross fall and crown of roadway. Exterior bridge barriers and curbs shall have full cover plates on the inside face and across the top. Interior traffic separation barriers shall have full cover plates on both sides and across the top. Raised concrete medians shall have deck joints follow the top surface or run across the median at the deck level complete with cover plates across the median. Deck joints across the width of sidewalks or pathways shall have non-slip cover plates and be detailed to avoid tripping hazards.
- (j) Only neoprene V-seal and multi-cell strip seals shall be permitted. No other seal materials shall be used.

300.5.2.19 Barriers

The Contractor shall use Department standard barriers, handrails and approach end transitions in accordance with this Section 300.5.2.19 (Barriers).

The bridge barrier exposure index for the Project shall be calculated in accordance with the Bridge Design Code. Once the barrier exposure index has been calculated, the appropriate barrier performance level can be determined from tables provided in the Bridge Design Code. Department standard bridge barrier and approach end transitions shall be selected based on the required test level but shall not be less than the barrier test level requirements stated in Section 200.2.2 (Geometric Design).

300.5.2.19.1 Traffic Barriers and Transitions

1) TL-4 Barriers and TL-4 Transitions

The Department has three standard designs for TL-4 bridge barriers for different applications on the Project, as follows:

- a) Standard 850 mm TL-4 Single Slope Concrete Bridge Barrier (in accordance with

Standard Drawings S-1650-15, S-1651-00, S-1681-07 and S-1701-06)

This single slope concrete barrier shall be used in urban areas for its aesthetic appeal. The barrier has a top ledge originally developed as an architectural feature and for shielding the lower face of the barrier from wetting by rain. This feature has been adopted as a standard as it also provides extra strength in case of collision from a heavy vehicle. Standard Drawing S-1650-15 presents the bridge barrier details and Standard Drawing S-1651-00 presents the thrie beam approach rail transition details that shall be used in conjunction with a steel flexible guardrail. It should be noted that towards the end of the bridge barrier, the single sloped face is transitioned to a vertical face to facilitate the connection to the vertical orientation of a thrie beam. However, if the approach roadside barrier is a matching single slope concrete barrier and not a w-beam, the sloped bridge barrier face should be continued to the end. The interface between the bridge end and a concrete approach barrier is shown on the Standard Drawings S-1701-06 and RDG-B6.14 from the Roadside Design Guide.

For bridges with sidewalks, a traffic separation barrier is required between the traffic and the sidewalk. The Bridge Design Code clause 12.4.3.3 requires traffic separation barriers to have a smooth surface with no snag points and a minimum height of 0.60 m measured from the surface of the sidewalk. A height less than 0.6 m is considered less obvious and could become a tripping hazard. The separation barrier shall be as represented by Standard Drawing S-1650-15 except that the top ledge shall be omitted to create a flat vertical face on the pedestrian side. Note that this is a traffic barrier to prevent vehicle encroachment onto the sidewalk and is not provided as a pedestrian barrier. The approach transition details shall be as presented on Standard Drawings S-1651-00 or S-1681-07, as applicable. Additional to the requirements shown on these Standard Drawings, over the length of the thrie beam transition connecting to the end of the traffic separation barrier and if necessary carrying on to the roadway guardrail section, a HSS 50H x 100V rail, bolted to the sidewalk side of the thrie beam and guardrail posts, to protect pedestrians/cyclists from snagging the sharp corners at the top of the posts, shall be provided. The HSS 50x100 can be terminated when the sidewalk has moved away from the edge of the roadway and has achieved a minimum separation of 600 mm from the back of the thrie beam transition and guardrail posts.

- b) Standard 1420 mm TL-4 Single Slope Combination Barrier (in accordance with Standard Drawings S-1700-06, S-1701-06, S-1651-00 and S-1681-07)

For bridges where the outside lane on the bridge is widened (typically widened to 4.2 m or 4.3 m) to accommodate cyclists, a combination barrier shall be provided. This commonly happens on urban road bridges crossing over the Mainline where a design speed ≤ 70 km/hr would only demand a TL-2 barrier. Standard Drawing S-1700-06 presents the general barrier details and Standard Drawing S-1701-06 presents the details at the bridge barrier end. A connection to a rigid single slope concrete approach roadway barrier is shown here to reflect the common urban situation. However, in situations where the approach roadway barrier is a flexible barrier system, the transition details on Standard Drawings S-1651-00 or S-1681-07 should be used and the end of the bridge barrier should be transitioned from a sloped face to a vertical face.

- c) Standard 850 mm TL-4 Single Slope Concrete or Double Tube Barriers Along Top of MSE Wall (in accordance with Standard Drawing S-1798-09, S-1651-00 and S-1681-07)

This Standard Drawing was developed for traffic barriers located directly on top of MSE retaining walls, and can also be used where there is a need to extend barriers on grade beyond the end of the bridge for drainage control or other reasons. Standard Drawing S-1798-09 presents both the option to use the double tube rail on concrete curb barrier and the single slope concrete barrier. For this Project, only the single slope concrete barrier shall be used. The barrier design is based on guidelines presented in NCHRP Report 663. The approach barrier transition details shall be provided in accordance with Standard Drawings S-1651-00 or S-1681-07, as applicable.

2) TL-5 Barriers, TL-5 Transitions and TL-4 Transitions

The Department has one standard design for TL-5 bridge barriers on the Project which is the 1270 mm high double tube type bridgerail on high concrete curb (in accordance with Standard Drawings S-1702-06, S-1703-06, S-1704-06 and S-1705-06) and shall be used on all bridges requiring TL-5 bridge barriers unless specifically indicated otherwise. Standard Drawings S-1702-06, S-1703-06 and S-1704-06 present the general TL-5 bridge barrier details. This bridge barrier is an FHWA approved design meeting TL-5 barrier requirements. Standard Drawing S-1705-06 presents the standard thrie beam transition details meeting TL-4 requirements (TL-4 is the highest level achieved with a thrie beam both in the transition and roadside barrier application). Where the roadway design requires the use of a TL-4 or a TL-5 concrete roadside barrier, a site specific transition connection design is required with proper modifications to the bridge end.

When TL-5 barriers are required along the top of MSE walls, a site specific design is required. The design shall consist of a footing supported barrier (similar to that used for the TL-4 barrier shown on Standard Drawing S-1798-09) and shall incorporate the proportions, features and details of the TL-5 barrier shown on Standard Drawings S-1702-06, S-1703-06 and S-1704-06 for the extent of barrier situated above the top of the finished roadway, unless Department approval for an alternate arrangement is granted.

When lamp poles or pier shafts are placed behind a TL-5 bridge barrier, the height of the barrier shall be increased to 1370 mm by increasing the height of the lower concrete portion.

3) Miscellaneous Details

- a) Modified Thrie Beam Transition at Abutment Drain Trough Terminal, refer to drawings SK-14 and SK-15 in Appendix B.

Drawings SK-14 and SK-15 in Appendix B present bridge end details around abutment concrete trough drain terminals where the transition posts are tightly spaced.

- b) Curbs and Curb/Guardrail Interaction (Roadside Design Guide Table H4.1, Standard Drawing RDG-B1.10)

The interaction between guardrail and curb is reported in NCHRP Report 537. The recommendations in the report are incorporated in the Roadside Design Guide section H4.3: Curbs and Roadside Design Guide Table H4.1. Placement of guardrail posts and curbs is detailed in Standard Drawings RDG-B1.10 and RDG-B1.11.

When there is a barrier curb that runs up to the end of a bridge barrier, it is important to build the end of the bridge barrier straight out to be continuous with the curb face, and not incorporate the large chamfer under the thrie beam terminal connector as shown on the “Bridge Barrier Isometric View” on Standard Drawings S-1650-15 and S-1703-06.

300.5.2.19.2 Pedestrian / Cyclist Railing

The standard 1150 mm Vertical Bar Type Handrail as shown on Standard Drawing S-1845-16 (Standard Pedestrian Handrail) is designed for use at the outside of sidewalks with a traffic separation barrier on the road side. The handrail shall be mounted on a concrete curb projecting 100 mm above the sidewalk. For the Project, the standard 1150 mm high handrail design shall be modified to 1300 mm for a total rail height of 1400 mm above the sidewalk. This shall be achieved by extending the height of the vertical bar panels and the posts.

For situations where there is an intersection close to the end of the bridge and enhanced vehicle visibility is required, orientation of the staggered bars must be described on the site specific Detailed Designs to suit the site situation.

For combined pedestrian/cyclist use pathways 3.0 m or wider, provide a 50 diameter steel ‘rub rail’ at a height of 1070 mm from the top of the pathway to reduce the snagging hazard of bicycle handlebars on the vertical handrail bars.

At the bridge ends, cantilever the railing out past the last handrail post 1.2 m beyond the end of the wingwalls, following an alignment which uniformly deflects the railing outwards away from the pathway to a maximum of 400 mm at the tip of the cantilever.

300.5.2.19.3 Lamp Poles, Sign Structures and Pier Columns Behind Bridge Barriers

The presence of obstacles, such as signs, lamp posts, sign structure support columns, piers of adjacent bridges, etc., on top of or close behind bridge barriers can potentially cause snagging of errant vehicles or cause debris to fall on the roadway below. The mounting of such hazards are to be avoided whenever practical. However, when it becomes unavoidable, the following set-back requirements or protective measures shall apply. It should be noted that roadside barrier standards on the approaching roadways are determined independently from bridge barriers in accordance with the Technical Requirements:

- 1) When applicable roadside barrier standard is TL-2:
 - Provide minimum 305 mm set-back from traffic face at top of barrier.
- 2) When applicable roadside barrier standard is TL-3:
 - Provide minimum 610 mm set-back from traffic face at top of barrier.
- 3) When applicable roadside barrier standard is TL-4:

- When TL-4 bridge barriers are required:
 - Provide TL-4 combination barrier (S-1700-06 & S-1701-06) with a height of 1420 mm; and
 - Provide minimum 610 mm set-back from traffic face of top steel rail.
 - When TL-5 barriers are required:
 - Provide TL-5 barrier (S-1702-06 to S-1705-06) with the overall height increased to 1370 mm by increasing the height of the concrete base; and
 - Provide minimum 610 mm set-back from traffic face of top steel rail.
- 4) When piers of adjacent bridges are behind bridge barriers, a 3,000 mm minimum set-back is required between the adjacent pier and the traffic face at top of barrier.

Attachments behind barriers (such as street light posts etc.) shall be mounted on top of curb or concrete barrier at locations close to the centreline of piers, whenever practical, to avoid excessive vibration from traffic.

300.5.2.19.4 Standard Barrier Detailing

- 1) Bridgerail shall be detailed as follows:
- All dimensions for bridgerail layouts are to be given on centreline of bridgerail anchor rods.
 - Bridgerail expansion joints shall be provided at all deck joint locations. For long bridges, additional bridgerail expansion joints shall be provided at a maximum spacing of 45 m.
 - The Standard Drawings show a standard bridgerail expansion joint with a gap of 100 mm, and a large expansion joint with a gap of 200 mm. Considering that many bridge abutments have been observed to move in towards the superstructure over the life of the bridge, a large expansion joint should be selected when there is potential for the bridgerail joint to jam up before the deck joint closes.
 - Steel railing for bridges with curve radius > 600 m can be chorded between field splices. Steel railing for bridges with curve radius ≤ 600 m shall be manufactured in a curved alignment. In the latter case, the Design Engineer shall clearly indicate such requirement on the site specific Detailed Designs. Tube sleeves for splices and expansion joints shall be detailed accordingly.
- 2) For attachments mounted behind bridge barriers (such as street light posts etc.), base plates and anchors shall be grouted and sealed with a penetrating sealer. A minimum 40 mm nominal thickness grout pad shall be provided under base plates. The grout shall sit in a grout pocket recessed 20 mm into the surface of the structure. The grout pocket shall extend be 40 mm larger than the base plate around the base plate perimeter.

300.5.2.20 Bridge Drainage

- (a) Concrete drain trough collectors shall be used to channel water off of the bridge and into concrete drain troughs. Typical drain trough details are shown on drawings SK-14 and SK-15 in Appendix B. Drain troughs are required at the low corners of bridges and may also be required at the high corners of the bridges if the approach roadway has significant grade and

the roadway runoff could result in erosion near the bridge wingwalls. Drain troughs may also be required at the ends of retaining walls where a roadway runs adjacent to the top of a retaining wall. Drain troughs shall drain directly down the slope (not across the slope), and shall extend to the bottom of the roadway approach fills with scour protection placed at the ends of the drain troughs. The drain troughs shall be designed to function as intended for the drainage volume and velocity while accommodating differential settlements and other movements between the bridge and the roadway approach fills. Drain troughs may be eliminated if the roadway drainage at the bridge barrier transitions is controlled by curbs/concrete barriers and catch basins.

- (b) Additional drains required to accommodate deck drainage or drainage through deck joints shall be hidden from view where practical and shall be positioned so that the drainage does not come into contact with any components of the bridge structure (not including concrete slope protection). Drains, including mounting brackets that cannot be hidden from view, shall receive a finish that is acceptable to the Department and that causes them to blend into the surrounding structure.
- (c) Deck drainage adjacent to barriers, curbs or medians shall not encroach into the adjacent traffic lane. Bridge runoff shall be evaluated using the Rational Method with runoff coefficient = 0.9, and rainfall intensity = 75 mm/hr. Flow width shall be calculated using the Manning equation with a roughness coefficient = 0.016. Discharge through deck drains shall be assessed based on the FHWA document “Design of Bridge Deck Drainage. Hydraulic Engineering Circular 21.” (1993). For further clarification, refer to Department publication “Best Practice Guideline 12 *Bridge Deck Drainage*”.

300.5.2.21 Engineering Drafting Requirements

(a) General

Drafting standards and standard details shall be in accordance with section 2 – Guidelines for Bridge Projects of the “Engineering Drafting guidelines for Highway and Bridge Projects”, *Design Bulletin #34 Grid-to-Ground Survey Application*, and the following supplementary guidelines. Note that whenever reference is made to the *Engineering Drafting Guidelines for Highway and Bridge Projects* throughout the Technical Requirements, it shall be deemed to include these supplementary requirements.

1. Do not use screened-back lines or screened-back patterns. Greyscales are not acceptable.
2. Do not use the utility symbols provided in section 2 of the *Engineering Drafting Guidelines for Highway and Bridge Projects*. Instead use the utility symbols provided in section 3 for both road and bridge drawings.
3. Provide bench mark locations on drawings in coordinates and not as stations and offsets.
4. All lettering is to be done in capitals except metric SI unit symbols which are to follow SI practice (e.g. mm, m, km, kN, MPa). Minimum text size shall be 3 mm on a 22 x 34 plot.
5. When associated with a number, symbols shall always be used (e.g. 16 m, not 16 metre). However, in text the unit shall be spelled out in full.
6. When a decimal fraction is used, place a leading zero in front of the decimal point.
7. Do not abbreviate unless required to save space. Do not abbreviate in notes.

8. When abbreviating, use only the standard abbreviations provided, and use without periods.
9. Place annotations as close as possible to the relevant item to eliminate or reduce the length of leaders.
10. Where possible annotations shall be in full and positioned to be readable from the bottom of the plan.
11. Use standard Department symbols when available.
12. River and stream names shall follow the shape of the feature.
13. Use a space between numbers and units (e.g. 100 mm).
14. Cross references to other drawings in notes shall refer to the other drawing number (e.g. “for details see dwg 12756”).
15. Electronic CAD files shall be submitted in Microstation V8 format, and shall be submitted as “flat” files without entire models attached to each sheet or referenced details.
16. All Microstation files shall be configured so that when plotted on the Department’s plotters the plots replicate the signed Mylar originals. The Department will supply the pen tables and font libraries for their HP6100 series plotters on request.
17. Drawings submitted on Mylar shall be wet plotted on 3 mil double matte finish Mylar film. Electrostatic plots are not acceptable.
18. Professional stamps shall be signed in permanent black ink. Smear signatures will not be accepted.
19. All dimensions shall be ground dimensions. Stations may be given in either grid or ground coordinates. Chosen system to be specified in the general notes and used uniformly across all drawings sets.
20. Skew angles to be given to the nearest minute.
21. All drawing sets shall have consistent presentation, and shall be modelled on Department practice. Design teams shall be coordinated so that all like drawings are presented in a uniform manner.
22. Design drawings shall illustrate what is to be constructed, and shall not show multiple options.
23. The general principle to be used is that General Arrangement drawings show everything that will exist at the end of construction. Because of this, future girder and substructure layouts are not to be shown on the General Layout drawing. Instead this information must be included on one of the information sheets.

(b) Design Data Drawings (DD Drawings)

DD drawings are planning drawings, and shall show both Stage 1 and Ultimate Stage functional requirements. They do not contain any information on any specific bridge structure apart from the assumed dimensions used to demonstrate that vertical and horizontal clearance requirements can be met. They form their own set of drawings, and will be used after construction by the

Department when future planning issues are under consideration. Sample DD drawings can be obtained from the Department on request.

Site specific DD drawings shall be submitted for review prior to submission of the site specific Design Drawings. Where applicable, the hydrotechnical report shall be submitted at the same time. DD drawings are not required for bridge size culverts less than 4.5 m in diameter or for sign structures.

DD drawings shall, at a minimum, include the following items. Note that in the following requirements for DD drawings the term “stream” is used also to designate a road or railway track in the case of a grade separation or railway crossing.

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- Location and alignment of the proposed bridge crossing relative to the “stream”, together with direction of flow and “stream” name, with stationing on both the road alignment and the “stream”. For a divided road, the direction of flow would correspond to the direction of travel, e.g. EB or NB. A north arrow.
- Centrelines and edges of existing roads as well as lane and shoulder markings where applicable.
- Any benchmarks within the immediate area.
- Existing bridge data (where applicable) giving type of structure/substructure, clear roadway, year of construction and foundation details where these might be in conflict with new construction.
- All utilities and appurtenances, existing and required right-of-way and any existing development, including fences, buildings, access roads, drainage culverts, etc.
- Location of all test holes.
- A detour alignment that meets minimum standards.
- All existing and proposed river training and/or bank protection works where applicable.

Elevation

- Existing bridge, including abutments, piers and foundations.
- Bridge headslopes (existing and proposed).
- Gradeline with stations, elevations and grades at intersection of tops of fills with gradeline.
- Assumed depth of structure and minimum deck elevation.
- Geotechnical information including test holes.
- For grade separations - lane arrangements, vertical clearances and clear zone distances.
- For railway crossings - track locations and clearance box requirements.
- For water crossings:
 - Design bed width and elevation;
 - Existing and proposed bank protection works;

- Design hydraulic conditions including, design high water elevation, high water elevation at time of survey with date of measurement, minimum freeboard, design ice conditions, and anticipated scour.

Bridge Cross-Sections

- Cross-sections showing the minimum proposed clear deck width, lane configurations and crown or superelevation, and approach fills at bridge ends.

Site Map

- Generally 1:250,000 scale, showing bridge location with bridge site circled and identified with file number, with north arrow in the top half of the map.

Drawing Index

- On bottom right of front sheet with the names and numbers of all the sheets in the set, including any standard drawings being used for the Project, and including reference drawings where applicable.

General Notes

- Survey Information:
 - Name of surveyor, date of survey.
 - List of geodetic bench marks (ASCM), with location and elevation.
 - Bench marks set up for specific site. e.g. “BENCH MARK 1, 25 mm x 52 mm WOODEN STAKE, STA 3+650, 15.3 m RT CENTRELINE, EL 931.5, N - 5570551.486, E -30000.0”.
- Hydrotechnical Summary (for water crossing):
 - Drainage area.
 - Design discharge and return frequency.
 - Historical high flood.
 - Mean low velocity for design discharge through the proposed bridge opening.
 - Flowing ice condition with situation & elevation.
 - Streambed slope.
 - Anticipated backwater due to proposed bridge.
- General Notes:
 - Dimensions in metres unless noted otherwise.
 - Highway geometric design standard that is being used for the bridge and underlying roadway where applicable.
 - Reference to any applicable approach fill drawing.
 - Type, specification and quantities of any bridge and/or bank protection material including concrete slope protection or Filter Fabric and Heavy Rock Riprap.

MOSAIC PROFILE SHEET

Site Mosaic (Typically 1:5000)

- Proposed bridge and extent of fills.
- Location of stream and direction of flow, with river training works and/or bank protection works.
- Existing roadway system including horizontal alignment curve data, showing tie-in to proposed bridge.
- Legal land lines, right of way lines and land ownership.
- Aerial photo number and date of photography.

Highway Profiles (Typically 1:5000H, 1:100V or 1:200V)

- Proposed headslopes.
- Sodlines for approximately 250 m either side of the bridge (usually 20.0 m left and right of proposed centreline).
- Existing and proposed gradelines, with stations and elevations for tops of fills, BVC, EVC and PIs and associated K values.
- For roadway crossings, roadway elevations or roadway profile of underlying roadway for approx 750 m each side of the crossing.
- For railway crossings, top of track elevations or track profile of underlying track for approx 750 m each side of the crossing.
- For water crossings, minimum bottom flange elevation, design high water & design high ice elevations, high water elevation with date, if available, water level elevation at time of survey with date.

Streambed and Water/Ice Profiles (for water crossing)

- Streambed profile along the thalweg for a distance of 700 m upstream and 700 m downstream of the proposed crossing, with any beaver dams and irregularities in the streambed identified.
- Top of water/ice elevations at 50 m intervals over the length of the surveyed streambed.

(c) P Drawings

Site specific design drawings are designated as P drawings or as P series drawings. The P drawings reflect the drawing status at the end of the review period. The designation “P” is used, together with Department supplied drawing numbers, in the Department’s bridge drawing record system for all bridge design drawings relating to site specific projects (e.g. 16523-P).

(d) C Drawings

Record Drawings are designated as C drawings or as C series. The “P” designation of the site specific design drawings is changed to a “C” designation for the as-built drawing set (e.g. 16523-C), and therefore have the same format as the design drawings. The Record Drawings shall show all relevant as-built details of the New Infrastructure including, but not limited to, bridge structures, horizontal alignment, vertical alignment, cross-section elements, intersection layouts, interchanges, etc. Details of signing and pavement markings shall be described through reference to standard plans where possible. A detailed description and location of all underground utilities

and conduits, showing horizontal locations, elevations, size and type of utility, etc., shall be shown on Record Drawings. All revisions shall be flagged with a single revision symbol.

For bridges, the Record Drawings shall be an accurate representation of the as-built condition, both dimensionally and visually. All elevations shall be updated to represent the as-built condition. Pile tip elevations shall be updated with average installed pile depths, and drawings shall be revised to show the average installed pile depths to scale. Surveyed benchmark tablet elevations shall be recorded on the drawings. Locations of electrical ground connections for CSE testing, installed in accordance with Section 300.5.2.15(m) (Deck, Curbs, Medians, Concrete Barriers, Sidewalks), shall be recorded on the drawings.

For sign structures, the General Layout drawings shall be updated to match the actual sign structures as fabricated.

(e) The preferred drawing order for bridge type structures is as follows:

- General Layout.
- Information Sheet/Sheets.
- Abutments.
- Pier/Piers.
- Bearings.
- Girders.
- Deck.
- Deck Joints.
- Other (if required).
- Standard Drawings.
- Proprietary Shop Drawings.

Concrete strength, concrete cover and grade of reinforcing steel shall be noted on the leading drawing sheet for each bridge component.

(f) Other types of structures (culverts, etc.) should follow the same basic order with drawings added and/or deleted as necessary.

(g) Clear zone requirements, calculated critical vertical clearances with their critical locations for Stage 1 construction as well as the Ultimate Stage construction shall be shown on the General Layout for all grade separation structures. Design high water elevation, high ice elevation, low water elevation (with date of survey), design general and local scour elevations shall be shown on the General Layout of all river structures.

(h) Design drawings shall show above grade geometry of all MSE walls, earth slopes in front of and behind the wall, wall loading, site drainage including drainage details for roadway run-off, location and type of fences and traffic barriers where applicable, interface details between the bridge structure and the MSE wall where applicable, (e.g. piles, abutment seat, wingwalls, backwalls, diaphragms, and approach slabs), the location and size of any obstructions within the mechanically stabilized earth mass, and the location of all utilities that may affect the design of the MSE wall. The MSE wall drawing in the bridge drawing package shall contain all information needed by the MSE wall designer including dimensions, details of any soil improvement to be undertaken below the wall, and a diagram showing all forces imposed by the bridge on the wall. Design drawings shall also include

design requirements for the precast concrete fascia panels including concrete compressive strength, reinforcing steel type and grade, concrete cover and panel finish requirements, and guidelines for aesthetic treatment. On the “C” drawing set, shop drawings shall be cross referenced by shop drawing number.

- (i) An index listing of all drawings included in the drawing set shall be shown on the first sheet of the set. The index shall be orientated from the bottom up; i.e., sheet No. 1 shown at the bottom and successive sheets listed upward from there.
- (j) Control line designations shall be selected from the following list of examples, and shall be used consistently throughout the same set of drawings: Centreline NBL Hwy XX, Centreline N-W RAMP, Centreline RDWY, Centreline CROWN, Centreline BRG ABUT #X, Centreline ABUT #X (for integral abutments), Centreline PIER #X, Centreline median Hwy XX. Where the centreline is also the control line, the words control line shall be added after the first designation.

“Top of Centreline Finished Crown” stations and elevations are to be shown for each end of the structure. Top of Centreline Finished Crown is defined as the point where the headslope line intersects the finished centreline roadway profile. Station is given to the nearest decimetre and elevation to the nearest centimetre. These points are to be shown on all DD drawings and on most design drawings. However, in cases where abutments are located behind retaining walls, these theoretical points have no relevance and should be left off the design drawings. Where there is a portion of headslope above the wall, the station and elevation of the intersection of this headslope and the top of finished crown on the control line should be included and denoted as top of headslope.

- (k) Substructure elements are to be numbered in the direction of increasing stationing, i.e. Abutment 1 or Pier 1 occurs at the lower station location and numbering increases from there.

(l) Reinforcing Steel Details

The Department’s *Engineering Drafting Guidelines for Highway and Bridge Projects* shall be followed. The following specific requirements shall also apply:

- Bar marks shall not be duplicated on any bridge unless the bars are identical;
- Incremented bars should each have their own bar mark;
- Bar mark suffixes on bar lists for bars other than carbon steel reinforcing bars shall be as follows:
 - C Epoxy coated bars
 - MX Low carbon/chromium steel bars (ASTM 1035)
 - SS Solid stainless steel bars (UNS S31653, S31603, S31803, S30400, S32304 or S32101);
- The type of stainless steel bars shall be updated to actual bar type used for construction on the C-drawings;
- In the quantity summary on the Information Sheet drawing, totals for each bar type shall be shown separately for substructure and superstructure; and

- The minimum size of reinforcing bars shall be 15M with the following exceptions:
 - Welded wire mesh in headslope protection;
 - Reinforcing bars in precast concrete girders;
 - Reinforcing bars in precast deck panels;
 - Reinforcing bars in drain troughs.

(m) Substructure / Foundations

The following design pile load information for abutment and/or pier piles shall be shown in the General Notes on the Information Sheet:

- SLS permanent loads only
- SLS extreme loads (combination #)
- ULS permanent loads only
- ULS extreme loads (combination #)

Outlines of the foundations and estimated pile tip elevations shall be shown relative to test holes on the geotechnical information sheet.

All welded pile splices whose tensile or flexural capacity is critical to the structural integrity of the bridge (for example with integral bridges), shall be identified on the Detailed Designs. The following note is an example:

“ALL OF THE PILE SPLICE WELDS THAT ARE REQUIRED WITHIN THE TOP “X” METRES OF THE PILE ARE TENSION SPLICE WELDS”

The long-term longitudinal and lateral movements for which deck joints, bearings and tops of piles at integral abutments have been designed shall be recorded in the general notes on the information sheet.

(n) Girders

Span lengths established from preliminary engineering requirements shall be rounded up to the nearest whole metre.

Girder camber variations shall be accommodated by adjusting the deck formwork elevation and thickness of the deck haunch on the girders. The following standard note shall be shown on the deck drawing and shall apply to the nominal girder haunch and the outside of curb/fascia dimensions:

“THESE DIMENSIONS WILL VARY DUE TO VARIATIONS IN GIRDER CAMBER. THE CONTRACTOR SHALL DETERMINE THE ADJUSTMENTS AND MAKE THE APPROPRIATE CORRECTIONS.”

i. Steel Girder Superstructures:

The span lengths shown on the general layout drawings shall be measured at a fabrication temperature of 20 degrees Celsius, from centreline bearing to centreline bearing along the bottom flange for uniform depth girders, and along the top flange for tapered or haunched girders. Expansion bearings are to be centred on centreline bearing at -5 degrees Celsius.

Ground stationing for locating the centreline bearing of sub-structure elements shall be adjusted to account for the following:

- length difference between gradeline profile and horizontal surveyed distances,
- length difference due to thermal change between 20 degrees Celsius and -5 degrees Celsius,
- longitudinal shift due to off-plumb tilting of bearing stiffeners or control sections set perpendicular to the top flange, when span lengths are measured along the top flange,
- differences between ground distances and other surveying systems.

For expansion bearings, a bearing temperature setting chart shall be provided for positioning bearing components according to the girder temperature at the time of bearing setting.

For fixed bearings for continuous steel girder bridges, bearings shall be centred on girder bearing stiffeners. The size of voids for grouting anchor rods shall have sufficient room to accommodate girder length changes at erection temperatures other than -5 degrees Celsius, in addition to normal construction tolerances. Supporting piers shall be designed for any eccentricities that may arise.

The following standard note shall be incorporated on the general layout drawing:

“GIRDER LENGTHS SHOWN ARE MEASURED ALONG BOTTOM FLANGE (along TOP side of bottom flange adjacent to web) AND ARE CORRECT AT +20 DEGREES CELSIUS. ABUTMENT AND PIER STATIONINGS ARE LOCATED SUCH THAT BEARINGS ARE CENTRED AT -5 DEGREES CELSIUS”.

Welded steel girders shall be cambered for 100% of the dead load deflection and roadway gradeline profile. Camber data shall be shown on a camber diagram, at 10th span points, centreline of supports, and centreline of field splices, along with net camber values for individual girder segments between splices. For spans longer than 50 m, data shall be presented at 20th span points. Data shall include girder DL, deck DL, Super-imposed DL (including curb/barrier/median/sidewalk + wearing surface), and vertical grade. Notwithstanding the Bridge Design Code clause 10.7.4.1, welded steel girders spanning less than 25 m shall be cambered to compensate for dead load deflection and highway grade profile.

Structural steel mass for steel girder superstructures shall be calculated and the mass, in tonnes, shall be shown in the ‘General Notes’ area on the steel girder drawings. Mass shall include girders, diaphragms, stiffeners, and splice plates but does not include deck joints, bearings, and bolts.

ii. Precast Concrete Girder Superstructures:

Lengths of precast concrete girders are to be shown on the general layout drawings together with pier diaphragm thicknesses between girder ends, and distance from abutment girder end to centreline abutment bearing. Precast girder lengths shall be set to meet geometric and clearance requirements and shall be measured along the bottom flange at a fabrication temperature of 20 degrees Celsius. Allowance shall be made for prestress shortening, shrinkage and creep up to the time of girder erection. Expansion bridge bearings shall be centred on centreline bearing at -5 degrees Celsius.

Ground stationing for locating the centreline bearing of sub-structure elements shall be adjusted to account for the following:

- length difference between gradeline profile and horizontal surveyed distances,
- length difference due to thermal change between 20 degrees Celsius and -5 degrees Celsius,
- differences between ground distances and other surveying systems.

For expansion bearings, a bearing temperature setting chart shall be provided for positioning bearing components according to the girder temperature at the time of setting the bearing. The bearing design and setting chart shall make allowances for girder shortening due to post-tensioning and long term shrinkage and creep.

The following standard note shall be incorporated on the general layout drawing:

“GIRDER LENGTHS SHOWN ARE MEASURED ALONG BOTTOM FLANGE AND ARE CORRECT AT +20 DEGREES CELSIUS. ABUTMENT AND PIER STATIONINGS ARE LOCATED SUCH THAT BEARINGS ARE CENTRED AT -5 DEGREES CELSIUS. PRECAST SUPPLIERS SHALL MAKE APPROPRIATE ALLOWANCE FOR PRESTRESS SHORTENING, SHRINKAGE AND CREEP UP TO THE TIME OF GIRDER ERECTION”.

Theoretical calculated cambers based on best estimates shall be shown on the Detailed Designs. Camber data shall be provided at various construction stages, such as at transfer, erection, deck pour, post-tensioning, Super-imposed DL, gradeline profile, etc.

iii. Cast-In-Place or Segmental Concrete Superstructures:

Data shall be presented on the drawings to allow setting of form elevations. The deflection data used in the determination of the form elevations shall be presented.

The span length shown on the general layout drawing shall be the ground distance on the control line between centreline bearings. The following standard note shall be incorporated on the general layout drawing:

“SPAN LENGTH SHOWN IS THE GROUND DISTANCE ON CONTROL LINE BETWEEN CENTRELINE OF BEARINGS”

iv. Curved and flared Superstructures:

For curved structures with equal girder lengths (parallel chords) within each span, measure span length along girder lines as defined above for steel and precast concrete girders.

For curved or flared bridges with variable girder lengths (either curved or chords) within a span, measure span length along a selected girder line on the general layout drawing, with a cross reference to a detailed girder layout drawing showing complete geometry of all girders.

Actual girder lengths for all girders, measured along centreline of each girder as defined above for steel and precast concrete girders, shall be detailed elsewhere in the drawing set, with the following note:

“GIRDER LENGTHS SHOWN ARE MEASURED ALONG BOTTOM FLANGE (along TOP side of bottom flange adjacent to web) AND ARE CORRECT AT +20

DEGREES CELSIUS. ABUTMENT AND PIER STATIONINGS ARE LOCATED SUCH THAT BEARINGS ARE CENTRED AT -5 DEGREES CELSIUS”.

For precast girders, the following note shall be added:

“PRECAST SUPPLIERS SHALL MAKE APPROPRIATE ALLOWANCE FOR PRESTRESS SHORTENING, SHRINKAGE AND CREEP UP TO THE TIME OF GIRDER ERECTION”

(o) Bridgerail

All dimensions for bridgerail layouts are to be given on centreline of bridgerail anchor rods in both directions.

(p) Benchmark Tablets

Benchmark tablet numbers can be obtained from the Department through the Survey and Imagery Coordinator at (780) 644-1706. Once the benchmarks have been installed and surveyed, report the elevations of the benchmarks back to the Survey and Imagery Coordinator.

300.5.2.22 Mechanically Stabilized Earth (MSE) Walls

300.5.2.22.1 Design Standards

Drawings SK-16 to SK-19 in Appendix B clarify a number of the requirements set out in the text of this Section 300.5.2.22.

MSE walls shall also meet all requirements of Section 300.5.2.10 (Substructure/Foundations) and Section 300.5.2.11 (Retaining Walls). If a conflict results between the three Sections the most stringent requirements shall apply.

The Detailed Designs shall include location, layout, geometry control, global stability, allowable rate of fill placement and allowable foundation bearing capacity, internal and external stability (sliding and overturning), tensile resistance, pullout resistances, and all elements for a complete MSE wall system. Global stability design shall be confirmed using actual soil properties upon confirmation of the source of backfill.

Bridge abutments shall be independently supported on piled foundations.

Two Stage MSE Walls are not permitted. “**Two Stage MSE Wall**” means an MSE wall where the first stage consists of a wire-faced or geosynthetic-faced or basket faced MSE wall or otherwise faced wall and the second stage consists of attaching precast concrete fascia panels with or without additional fill in front of the first stage MSE wall.

The most stringent requirements of the following standards shall be met:

- Canadian Highway Bridge Design Code (CSA Standard CAN/CSA-S6);
- AASHTO LRFD *Bridge Design Specifications*; and
- Alberta Transportation’s *Roadside Design Guide*.

The following publication is a recommended reference:

- Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volumes 1 and 2 FHWA-NHI-10_024 and FHWA-NHI-10_025.

Maximum reinforcement loads shall be calculated using the “Simplified Method” as presented in the AASHTO LRFD Bridge Design Specifications.

MSE wall embedment depths shall not be less than provided in Table C11.10.2.2.1 “Guide for Minimum Front Face Embedment Depth” in the AASHTO LRFD Bridge Design Specifications Commentary, and in addition shall not be less than 1 m.

The design life for all MSE wall system components shall be as defined in Section 300.5.2.7 (Durability).

300.5.2.22.2 Waterways, Water Carrying Appurtenances and Utilities

MSE walls shall not be used adjacent to waterways.

Mechanically stabilized earth mass shall not be placed over or in the vicinity of any utilities or water carrying appurtenances, unless such utilities or water carrying appurtenances can be removed and repaired without disturbing the mechanically stabilized earth mass, excavation of such utilities or water carrying appurtenances can be executed without impact on wall stability, and agreement is obtained from the utility owners. Water carrying appurtenances shall include catch basins, drainage inlets/outlets, and culverts. As illustrated in section A on SK-16 and SK-18, utilities or water carrying appurtenances carrying potentially eroding materials shall not be permitted within 10 m of any wall backfill unless the utilities or water carrying appurtenances are sufficiently enclosed within a containment structure that is designed to prevent exposure of any leakage from the utilities or water carrying appurtenances into or onto the MSE wall system, and the extent and design of the containment structure shall be sufficient to protect the MSE wall system against any discharges from this containment structure. No change of direction of utility lines, and no valves, valve chambers or any other discontinuity shall be permitted within the mechanically stabilized earth mass.

300.5.2.22.3 Facing

All MSE walls shall be faced with precast concrete fascia panels. The non-exposed side of MSE wall precast concrete fascia panels shall be in full contact with compacted backfill.

In locations where traffic is running adjacent to the bottom of, and nominally parallel to a MSE wall, and where thrie beam approach rail transitions are anchored to one or both ends of the MSE wall, anchor blocks with sufficient strength shall be provided for anchoring of the thrie beam transitions where they connect to the ends of the MSE wall.

300.5.2.22.4 Coping Cap

A cast-in-place concrete coping cap shall be placed on the top of all MSE walls, unless the section of MSE wall requires a cast-in-place concrete barrier slab detail in accordance with the Technical Requirements. The top of the cast-in-place concrete coping cap shall be smooth, have no steps or abrupt changes in height and shall have a 3% wash slope towards the back of the wall.

Copings shall have control joints and shall have drip grooves in the soffit. Control joints and drip grooves shall be detailed in accordance with Standard Drawing S-1680-07 (Standard Curb Details). Control joints shall be located to line up with the precast concrete fascia panel joints, shall be perpendicular to the wall alignment, and shall in no case exceed 4m spacing. At control

joints, all longitudinal reinforcing in the coping cap shall be discontinuous and shall have 50 mm cover measured from the centre of the control joint.

300.5.2.22.5 Vertical Slip Joints

In instances where a continuous length of MSE wall cannot be built all at the same time as a result of an existing obstruction (e.g. existing bridge, or existing roadway, etc.), the continuous length of MSE wall may be divided into multiple sections and some or all of the sections constructed at different times. In such instances, if large differential settlement is expected between any of the various sections of the MSE wall, appropriately designed full height vertical slip joints shall be provided between adjacent MSE wall sections. This manner of staging MSE wall construction shall not be confused with Two Stage MSE Wall (as defined in Section 300.5.2.22.1 (Design Standards)) construction, which is not permitted as set out in Section 300.5.2.22.1 (Design Standards).

The cast-in-place coping cap shall be designed with vertical joints in line with precast concrete fascia panel joints, and with horizontal reinforcement in the cap made discontinuous at these joints.

300.5.2.22.6 Geometric Requirements

All MSE walls shall be designed so that in the final position, they will be battered back against the retained soil from a vertical plumb line by a ratio of 50 vertical units to 1 horizontal unit.

MSE wall backfill shall extend a minimum of 0.5 m beyond the end of the soil reinforcement.

For stepped levelling pads, the maximum elevation difference between adjacent steps shall not exceed 1250 mm. The minimum length of each stepped section shall be 2500 mm.

For MSE walls utilizing geosynthetic reinforcing materials, soil reinforcing details shall be designed to accommodate the requirements in Section 300.5.11.4.5 (Backfill) for overlapping reinforcing.

Acute corners less than 70° (measured between backfill sides of precast concrete fascia panels) shall not be allowed.

300.5.2.22.7 Surface Drainage

Drawings SK-16 to SK-19 in Appendix B clarify a number of the requirements set out in the text of this Surface Drainage part of Section 300.5.2.22.7.

Highway and bridge surface drainage shall be controlled and channelled away from the back of the MSE walls and the mechanically stabilized earth mass.

Water carrying appurtenances, such as catch basins, drainage inlets/outlets, culverts etc., shall be placed away from, or beyond the ends of the soil reinforcement zone, and provisions shall be made to mitigate the detrimental effects of potential leakage. No trough drain or wick drain carrying roadway drainage shall be located over the steel soil reinforcement, and no drain pipe carrying roadway runoff shall be located within the MSE wall soil reinforcement.

All galvanized steel soil reinforcement shall be protected from exposure to roadway de-icing salt by an impermeable geomembrane placed above the top layer of soil reinforcement. This shall include soil reinforcement directly below a roadway, as well as immediately adjacent to the roadway for a minimum width of 5 m parallel to the outer edge of roadway shoulder. In addition,

for MSE walls that run parallel to the roadway, impermeable membrane shall be provided to intercept any drainage from the roadway base layer and direct it away from all MSE walls. The membrane shall be sealed to prevent leakage, sloped at a minimum 5% to drain away from the bridge and wall and be connected to an outlet beyond the MSE soil mass. A non-woven geotextile filter fabric layer shall be placed below and above the membrane to prevent puncture. In all cases the geomembrane material shall be made continuous and water-tight, and shall extend a minimum of 500 mm beyond the extent of the steel soil reinforcement. Any necessary joints shall be shingled in the direction of drainage and welded or bonded to prevent leakage.

Downspouts shall be provided for deck joint and deck wick drain drainage. Downspouts shall be rigid PVC type DB2 conduit meeting the requirements of CSA C22.2 No. 211.1. Couplers shall be solvent bell ends (“SBE”). Downspouts shall have a vertical slip joint with a dished top drain inlet cast into the wall coping. Downspouts shall not be directed through the mechanically stabilized earth mass. Down spouts shall be recessed full height in a chase formed into the front of precast concrete fascia panels or by using special precast concrete fascia panels and covered with a 10 gauge or 2.6 mm thick steel plate. The plate shall be shop painted with a system selected from the SS1 or SS2 category of the Department’s list of approved coating systems. Surface preparation shall be in accordance with the selected coating systems published product data sheet.

The geometry of MSE walls, including associated headslopes and embankments, shall be sloped so that all drainage is directed away from bridge abutments. Where MSE walls are placed close to the bridge abutment, a concrete walkway shall be provided in front of the abutment (for inspection purposes) within the footprint of the bridge deck. Where a headslope is provided between the MSE wall and the bridge abutment, a concrete swale shall be provided within the footprint of the bridge deck and the headslope shall be protected with concrete slope protection. Closed cell foam of adequate thickness to accommodate thermal movements shall be provided between the concrete walkway and integral concrete bridge abutments. A 10 mm thick asphalt impregnated fibre board shall be placed between the concrete walkway and semi-integral or conventional concrete bridge abutments. Beyond the footprint of the bridge deck, grassed swales with a non-degradable erosion control mat shall be provided behind the top of MSE cast-in-place concrete wall coping. All swales shall be designed for the 1:100 year storm event without overtopping, but shall have a minimum width of 600 mm, a minimum depth of 150 mm and a minimum longitudinal (parallel to the face of the wall) slope of 0.5%. Swales shall have a bottom liner of impermeable geomembrane that has positive drainage to the ends of the walls. Swales and top of walls shall slope away from bridge abutments. Mitigating measures shall be designed to direct flow away from toes and ends of walls, and to prevent erosion at these locations and at drainage swale discharge points.

300.5.2.22.8 Sub-Surface Drainage

Continuous weeping drains consisting of perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corners of the mechanically stabilized earth mass. The weeping drains shall be day lighted into drainage ditches or connected to drainage collection lines for positive drainage and disposal in accordance with jurisdictional requirements. The high end of the drains shall be capped and sealed to prevent the ingress of native or backfill materials. The water level within the mechanically stabilized earth mass shall be assumed to be at the invert level of the weeping drains or, at the discretion of the Design Engineer, at a higher elevation should the design warrant it.

300.5.2.22.9 Barriers/Railings

Barriers and railings on top of MSE walls shall be provided in accordance with Section 300.5.2.11 (Retaining Walls). The MSE wall shall be designed to fully resist the loads applied to the barrier and railings, and loads from any attachments such as sign supports and lamp posts. Rigid bridge barriers shall be located on top of the MSE wall and shall be supported on moment slabs to resist sliding and overturning. TL-4 bridge barriers on top of MSE walls shall be detailed to Standard Drawing S-1798-09 (TL-4 Single Slope Concrete and Double Tube Type Barriers along Top of MSE Wall).

300.5.2.22.10 Obstructions within the Backfill

Obstructions within the mechanically stabilized earth mass, such as foundation piles and associated casings, casings for future pile installations, or other obstructions, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. For those MSE wall systems that lend themselves to splaying of the soil reinforcement, the splay angle shall not exceed 20° from the perpendicular of the precast concrete fascia panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each wall location within the Project Limits.

300.5.2.22.11 Precast Concrete Fascia Panels

Precast concrete fascia panels shall have a minimum thickness of 140 mm, excluding any additional thickness required for aesthetic surface treatments. The minimum cover to reinforcing steel shall be 50 mm from all faces, and steel reinforcing bars shall be electrically isolated from soil reinforcement attachment hardware.

Joints between precast concrete fascia panels shall have a lip and recess (ship lap) configuration. Butt joints may be used if a precast HPC concrete backing block with filter fabric is designed and installed along the joint to prevent soil infiltration. Backing blocks shall overlap adjacent precast concrete fascia panels a minimum of 200 mm and have a minimum thickness of 140 mm.

The precast concrete fascia panel precast concrete panel system shall be designed to accommodate a differential settlement of 100 mm in 10 metres of length along the wall. The gap spacing between adjacent precast concrete fascia panels shall be designed to be 20 mm nominal.

To facilitate construction of the cast-in-place concrete coping cap, pre-formed holes in the precast concrete fascia panels are permitted provided the holes are located a minimum of 100 mm above the coping cap soffit.

A minimum 300 mm wide strip of filter fabric shall be installed behind all precast concrete fascia panel joints. An adhesive shall be used to hold the fabric securely against the precast concrete fascia panel with the fabric centered on all vertical and horizontal joints. At MSE wall corners, the fabric shall be installed in one piece crossing the corner joint.

300.5.2.22.12 Inspection Components

Galvanized steel inspection wires shall be provided in all MSE wall systems in addition to the soil reinforcement design requirements. One inspection wire shall be provided for each 25 m² of wall area. Inspection wires shall be placed in vertically distributed sets of two or three depending on the wall height. Two locations shall be provided where the wall height is less than 6 m and three locations provided where the wall height is greater than 6 m. Vertical distribution shall be such that a single inspection wire is placed within the center of the bottom wall precast concrete

fascia panel, center of the top wall precast concrete fascia panel, and in the center wall precast concrete fascia panel when three locations are required. Sets of inspection wires shall be evenly distributed along the length of the wall.

Inspection access ports, wire removal and centering devices shall be detailed in accordance with the California Department of Transportation standard bridge detail sheet XS13-020-3. Inspection access ports shall be cast as voids in the precast concrete fascia panels at the precast concrete fascia panel manufacturing facility and the remaining cavity placed and filled with a type OH-V Approved Product patching product in accordance with the manufacturer's recommendations. All inspection access ports shall be marked with a 25 mm diameter galvanized survey target anchored into the patching material and flush with the wall surface. Survey targets shall not receive pigmented sealer when it is specified on the precast concrete fascia panels.

300.5.2.23 Deck Systems Using Precast Concrete Partial Depth Deck Panels

300.5.2.23.1 General

This Section 300.5.2.23 is for the design of deck systems using precast concrete partial depth deck panels.

Unless otherwise noted in this Section 300.5.2.23, all other requirements of Section 300.5.2 (Design Criteria) shall apply to the design of deck systems using precast concrete partial depth deck panels.

300.5.2.23.2 Design

Deck slabs using precast concrete partial depth deck panels shall be permitted with the following design requirements:

- (a) Deck slabs using precast concrete partial depth deck panels shall consist of a cast-in-place concrete deck slab on precast concrete partial depth deck panels;
- (b) The cast-in-place concrete deck slab shall be designed to be fully composite with the precast concrete partial depth deck panels;
- (c) The minimum composite deck slab system (precast concrete partial depth deck panels and cast-in-place deck together) thickness shall be the greater of the girder spacing divided by 15.0, or 225 mm (i.e. the minimum allowable combined thickness of the precast concrete partial depth deck panel and the cast-in-place deck is 225 mm). In addition, the following shall be satisfied:
 - i) The precast concrete partial depth deck panel shall have a minimum thickness of 90 mm;
 - ii) The cast-in-place concrete portion of the composite deck slab system shall have a minimum thickness of 115 mm; and
 - iii) The cast-in-place portion of the composite slab system shall have sufficient thickness to satisfy all reinforcement cover requirements and maintain adequate spacing between reinforcement bars.

- (d) The precast concrete partial depth deck panels shall be fully pretensioned and the stresses in the precast concrete partial depth deck panels shall not exceed the following:
- i) From transfer until the 28 day strength is attained:
 - Compression: $0.6 f'_{ci}$;
 - Tension: $0.5 f_{cri}$;
 - ii) After the 28 day strength is attained and at serviceability limit states:
 - Tension: f_{cr} ;
 - iii) The average compressive stress in the precast concrete partial depth deck panels at pretension strand release shall be ≤ 7.0 MPa;
- (e) The empirical method in accordance with clause 8.18.4 of the Bridge Design Code shall not be permitted for design of the composite deck slab system using partial depth precast deck panels;
- (f) The composite deck slab system shall be designed using flexural design methods based on elastic moments:
- i) For 'square' (i.e. deck span is perpendicular to girder axes, not skew) deck slabs continuous over three or more girder lines, the maximum positive and negative transverse moments shall be determined using the simplified elastic method in accordance with clause 5.7.1.2 of the Bridge Design Code, with P adjusted to 112 kN to correspond with the CL-800 Design Truck. These moments shall be used to design the maximum transverse positive moment reinforcing requirements in the precast concrete partial depth deck panels and the composite cast-in-place concrete slab as well as the transverse maximum negative moment reinforcing requirements in the cast-in-place concrete portion of the deck slab. In addition, reinforcement development and cut-off locations shall be determined using moment envelopes based on elastic analysis;
 - ii) For curved or skewed bridges, all moments shall be determined by elastic analysis;
 - iii) For all bridges the following minimum transverse positive moment reinforcing shall be provided over supporting girder lines:
 - In addition to the required pretensioning strands, transverse stainless steel reinforcing bars, with a minimum reinforcement ratio, ρ , of 0.003, shall be provided throughout the precast concrete partial depth deck panels and shall project over the girder lines and into the cast-in-place concrete portion of the composite deck slab system. The reinforcement ratio, ρ , shall be calculated for d equal to the effective depth of the composite deck slab system. The spacing of the transverse stainless steel reinforcing bars shall not exceed 300 mm;

- At interior girder lines, the transverse stainless steel reinforcing bars shall project out of the precast concrete partial depth deck panel edges and over the girder flanges as required to provide a full lap splice with the bars projecting from opposing precast concrete partial depth deck panels supported on the same girder, a splice length adequate to develop the bar yield capacity. At exterior girder lines, the transverse stainless steel reinforcing bars shall be extended at least one full development length beyond the exterior girder centreline;
- (g) The minimum design compressive strength for the precast concrete partial depth deck panels shall be as specified in Section 300.5.2.7 (Durability);
- (h) The composite deck slab system shall conform to the following:
- i) The precast concrete partial depth deck panels shall have a minimum age of 45 days when the cast-in-place portion of the deck is cast;
 - ii) The cast-in-place concrete portion shall have 15M continuous bottom longitudinal reinforcing bars (parallel to girders lines) spaced at a maximum of 300 mm on centre placed directly on top of the precast concrete partial depth deck panels;
- (i) Pretensioning strands shall be 9.5 mm diameter;
- (j) Pretensioning strands shall not project beyond the edges of the precast concrete partial depth deck panels;
- (k) Pretensioning strand cast into the precast concrete partial depth deck panels shall be uncoated steel;
- (l) With a steel girder superstructure, the following additional provisions shall apply:
- i) The precast concrete partial depth deck panel length shall be set to provide a minimum 75 mm long bearing zone (as measured perpendicular to the girder line) on the haunch concrete. A minimum 50 mm thick haunch shall be provided beneath the underside of the precast concrete partial depth deck panels;
 - ii) The girder top flange shall have a minimum width of 450 mm;
 - iii) Shear studs attached to the girder top flange shall project above the top surface of the precast concrete partial depth deck panels and provide at least 25 mm clearance between the underside of the shear studs and the top of the precast concrete partial depth deck panels;
- (m) With precast concrete girder superstructures, the following additional provisions shall apply:
- i) For NU girders or any other girder shape where the top flange is less than 150 mm thick at the flange edges, the precast concrete partial depth deck panel length shall

be set to provide a minimum 200 mm long bearing zone (as measured perpendicular to the girder line) on the haunch concrete. For all other girders, the precast concrete partial depth deck panel length shall be set to provide a minimum 75 mm bearing zone (as measured perpendicular to the girder line) on the haunch concrete. A minimum 50 mm thick haunch shall be provided beneath the underside of the precast concrete partial depth deck panels;

- ii) Stirrups projecting from the top girder flange shall project above the top surface of the precast concrete partial depth deck panels and provide at least 25 mm clearance between the underside of the stirrup tops and the top of the precast concrete partial depth deck panels;
- (n) Vertical bleed holes shall be provided through the precast concrete partial depth deck panels and evenly distributed along the two supported panel edges. The holes shall be not less than 25 mm diameter, and shall be located adjacent to the formed edge of the haunch to facilitate the escape of entrapped air;
- (o) When a bridge includes a traffic separation barrier between a sidewalk and the traffic, any reinforcement required to anchor the separation barrier to the deck shall be cast into the precast concrete partial depth deck panels and project into the barrier; and
- (p) No portion of any hardware associated with deck formwork, including deck overhang formwork, shall be visible after removal of all formwork.

300.5.3 DESIGN REPORT REQUIREMENTS

300.5.3.1 Site Specific Design Package

Prior to initiating construction of a bridge structure, the Contractor shall submit to the Department a comprehensive design package for the bridge structure, including as applicable *Canada Transportation Act* applications, approvals and agreements, *Navigable Waters Protection Act* drawings, permit applications, approvals, and proof of advertising, Department of Fisheries and Oceans applications, approvals and orders, geotechnical reports, design drawings, and construction and material specifications not included in the Technical Requirements. The geotechnical reports shall be in accordance with the Bridge Design Code clause 6.7, and shall address the global stability of bridge headslopes and retaining walls.

The comprehensive design packages may be submitted in a manner suiting the Contractor's proposed design and construction schedule, and may be submitted in logical components. However, no construction shall commence on any portion of the bridge for which the design drawings have not been submitted for review by the Department.

No construction shall commence on any foundation element until the geotechnical report has been submitted for review by the Department, nor on any element requiring construction and material specifications not included in the Technical Requirements until such construction and material specifications have been reviewed and accepted by the Department.

300.5.4 FINAL DESIGN REPORT REQUIREMENTS

300.5.4.1 General

Following final completion of the detailed design of a bridge structure, the Contractor shall submit copies of the following documents for the bridge structure, if applicable, to the Department for its bridge structure records system.

- Location/Key map (first page);
- Design notes;
- Design check notes;
- Geotechnical report;
- Hydrotechnical report;
- Corrosion survey report;
- *Canada Transportation Act* applications, approvals and agreements;
- *Navigable Waters Protection Act* drawings, permit applications, approvals, and proof of advertising;
- Department of Fisheries and Oceans applications, approvals and orders;
- Railway grade separation agreements;
- Utility agreements;
- Site-specific (P) drawings, hardcopy and electronic Microstation.dgn format;
- PDF's at 22 x34 size, one set locked and one set un-locked; and
- Construction and material specifications not contained in Section 300 (Design and Construction - New Infrastructure).

300.5.4.2 Design Drawing Submission Specifics

The Contractor shall supply the following for the Department's record purposes:

- One full-size stamped and signed set of P series drawings on 3 mil matte polyester film;
- One set of the electronic version of the stamped and signed P series drawings in Microstation.dgn format;
- One set of the electronic version of the stamped and signed P series drawings in .pdf format, one per each bridge file number at 22 x34 size (one set locked and one set unlocked); and
- For each sign structure a single drawing is to be included that shows the entire length of the New Infrastructure showing all sign structures and their identifications, drawing is to be both in Microstation .dgn format and pdf format.

The "P" drawing submission of design drawings shall include Department drawing numbers, which will be provided by the Department on request. Each structure shall have its own complete stand-alone set of "P" drawings, and any drawings that are common to a number of structures shall be included in each set and allocated a different Department number in each set. Electrical drawings pertaining to each structure shall be included in each drawing set.

Department drawing numbers shall be kept as one sequential set through each bridge "P" drawing package. Include the electrical drawings in the sequential drawing number allocation.

Drawing numbers in the drawing index shall be in sequential order with no gaps in the numbering, and shall also list all Standard Drawings used with the Standard Drawing numbers.

Any Contractor assigned drawing numbers shall remain on the drawings, and be located immediately above the “P” drawing numbers.

All sign structures shall have their own General Layout drawing, as illustrated on Standard Drawing S-1721-07 (Sign Structure Sample General Layout).

Sign structure drawings are considered to be bridge drawings, so unless indicated otherwise the same guidelines shall be followed for sign structures as outlined for bridge structures.

300.5.5 CONSTRUCTION REQUIREMENTS

300.5.5.1 General

300.5.5.1.1 Materials

All materials incorporated into the bridge structures for the Project shall be new. Timber materials shall only be used for approach guardrail posts and blocking.

300.5.5.1.2 Existing Reference Documents

The Contractor is advised that the Department has an existing *Standard Specifications for Bridge Construction* document that outlines the requirements for the construction of bridge structures. While the provisions of the document are not directly binding for the Project, unless noted otherwise, it is based on the Department’s past experience and best practices and may provide guidance and assistance for the construction of the bridge structures.

300.5.5.1.3 Site Office for Bridge Construction

The Contractor shall provide and maintain, in a clean and safe condition, an office trailer at the site for the sole use of the Department. The site office trailer shall be located within the Contractor’s working area, at a separate location from the Contractor’s office or any other structure, and shall meet the following requirements:

- Minimum floor area 60 m², with two lockable offices and a common room, with minimum headroom of 2.4 m;
- Windproof, weatherproof and insulated;
- Lockable exterior door at each entrance;
- Air conditioned and thermostatically controlled heating capable of maintaining a temperature of approximately 20 degrees Celsius in both summer and winter conditions;
- Windows that open on all sides, with screens and shades;
- Minimum two electrical receptacles in each office and a minimum of two receptacles in the common room;
- Resilient flooring material;
- Interior electric lighting to the standard of an office environment plus an exterior light at each entrance;
- Desks and office chairs for each office;
- Table and chairs suitable for 10 people for common room;

- A lockable four-drawer filing cabinet for each office;
- Laser printer/scanner suitable for 11 x 17 paper format or smaller; and
- Telephone, fax and hard-wired high speed internet services available 24 hours a day, 365 days a year so long as the office trailer is provided on site.

Details of the site office trailer, its contents and its proposed location shall be submitted in advance to the Department for approval.

The Contractor shall provide the site office trailer prior to the commencement of any field work and ensure that it is continuously available until Traffic Availability has been achieved.

The location of the site office trailer will be determined by the Department and will consider the work sequence undertaken by the Contractor. The Contractor may be required to move the site office trailer occasionally, as may be reasonably requested by the Department from time to time, to locate it suitably with respect to the work.

The Contractor shall provide and maintain a firmly compacted free draining all-weather access and parking surface direct from a public roadway to the site office trailer. Site office parking area shall accommodate a minimum of 10 vehicles that is independent from any construction access points (no through traffic) or construction/contractor parking.

A minimum of one restroom/toilet unit shall be provided adjacent to the site office for the sole use of the Department representatives. The Contractor shall empty and clean the toilet at least once every week or more often if warranted.

If the site office trailer has not been provided to the Department prior to the commencement of any field work or becomes unavailable for the Department's use, Payment Adjustments of \$2,000/week or portion thereof for the first four (4) weeks and \$5,000/week or portion thereof thereafter shall apply.

300.5.6 CONSTRUCTION CRITERIA

300.5.6.1 Specifications For Bridge Construction

For bridge structures that form part of the Project the construction specifications shall incorporate the following specification sections:

300.5.6.1.1 Cast-In-Place Concrete

All cast-in-place concrete for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.7 (Cast-In-Place Concrete).

300.5.6.1.2 Structural Steel

All structural steel for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.8 (Structural Steel).

300.5.6.1.3 Precast Concrete Units

All precast concrete units for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.9 (Precast Concrete Units and Post-Tensioning).

300.5.6.1.4 CSP and SPCSP Structures

All CSP and SPCSP bridge sized culverts that form part of the New Infrastructure shall be in accordance with Section 300.5.10 (Construction of CSP and SPCSP Structures).

300.5.6.1.5 Post-Tensioning

All concrete post tensioning for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.9 (Precast Concrete Units and Post-Tensioning).

300.5.6.1.6 Mechanically Stabilized Earth Walls

All MSE walls that form part of the New Infrastructure shall be in accordance with Section 300.5.11 (Mechanically Stabilized Earth Walls).

300.5.6.1.7 Sign Structures

All overhead and cantilevered sign structures that form part of the New Infrastructure shall be in accordance with Section 300.5.12 (Sign Structures).

300.5.6.1.8 Piling

All piling for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.13 (Piling).

300.5.6.1.9 Reinforcing Steel

All reinforcing steel for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.14 (Reinforcing Steel).

300.5.6.1.10 Bridge Deck Waterproofing and Asphalt Concrete Pavement

All deck waterproofing membrane for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.15 (Bridge Deck Waterproofing and Asphalt Concrete Pavement).

300.5.6.1.11 Deck Systems Using Precast Concrete Partial Depth Deck Panels

All deck systems using precast concrete partial depth deck panels that form part of the New Infrastructure shall be in accordance with Section 300.5.16 (Deck Systems Using Precast Concrete Partial Depth Deck Panels).

300.5.6.1.12 Heavy Rock Riprap

All heavy rock riprap for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.17 (Heavy Rock Riprap).

300.5.6.1.13 Bridge Bearings

All elastomeric and pot bearings for bridge structures that form part of the New Infrastructure shall be in accordance with Section 300.5.18 (Bridge Bearings).

300.5.6.1.14 Supplemental Specifications

For any particular design element or construction approach for which the Contractor believes

may not be fully addressed by the Technical Requirements, the Contractor shall advise the Department in writing and if so required by the Department, the Contractor shall submit to the Department proposed supplemental specifications that cover such design element or construction approach, for review and written acceptance by the Department, acting reasonably. The proposed supplemental specifications shall be consistent with relevant codes and recognized then current engineering practices.

An initial review by the Department of the proposed supplemental specifications may be conducted and a ruling of acceptance, conditional acceptance or rejection provided. If conditional acceptance is granted by the Department, a subsequent submission of requested information to address the conditional acceptance shall be provided to the Department for further review and acceptance, conditional acceptance or rejection. The Department's decision on acceptance or rejection of a proposed supplemental specification shall be binding.

No construction shall commence on an aspect of the Project for which supplemental specifications may be required under this Section 300.5.6.1.14 until the supplemental specifications have been reviewed and accepted in writing by the Department.

300.5.7 CAST-IN-PLACE CONCRETE

300.5.7.1 General

This Section 300.5.7 (Cast-In-Place Concrete) is for the production, handling, sampling and testing, transporting, placing, curing, finishing and quality of cast-in-place concrete.

Metric versions of references are inferred, when available and relevant.

300.5.7.2 Submissions

The Contractor shall submit concrete aggregate test results and concrete mix designs to the Department for class C, HPC, Pile and any other class or type proposed for use. Submittals shall be in accordance with Section 300.5.7.5.4 (Concrete Mix Design and Aggregate Testing), and received a minimum of seven days prior to proposed use. Trial batch results shall be included with aggregate test results and concrete mix designs.

The Contractor shall provide notice prior to concrete placing as detailed in Section 100.2.1.2 (Construction).

In the event that the Department requests any of the following information, it shall be submitted within the times noted below:

Two days prior to sandblasting/shotblasting:

- Concrete crack measurements for Class HPC and Class HPC with steel fibres concrete;

Within seven days of request by the Department:

- Plastic concrete test results;
- Concrete cylinder strength test results;
- Concrete core strength results; and
- Concrete repair procedures.

300.5.7.3 Reference Drawings

- Drawing S-1409-16 (Standard Concrete Slope Protection for Grade Separations);
- Drawing S-1411-87 (Standard Concrete Joints);
- Drawing S-1412-99 (Standard Construction Joints); and
- Drawings S-1838-15 and S-1839-15 (Deck Water Proofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement (Sheets 1 and 2)).

300.5.7.4 Materials

Concrete shall consist of hydraulic cement, aggregates, water and admixtures or additives that conform to the requirements as specified.

Hydraulic Cement - Hydraulic cement shall conform to the requirements of CSA Standard A3001. General use (Normal), Type GU, or High Sulphate Resistant, Type HS or HSb, shall be supplied unless otherwise specified.

As an alternative to Type HSb cement, concrete intended for placement in sulphate environments may be produced with combinations of Type GU cement and supplementary cementing materials provided current CSA A3004-C8 test data demonstrating compliance with CSA A3001 requirements for high sulphate resistance.

Silica Fume - Condensed silica fume shall conform to the requirements of CSA Standard A3001 for a Type SF supplementary cementing material, with a SiO₂ content of at least 85%, a maximum loss on ignition of 10%, and a SO₃ content not more than 1%.

Fly Ash - Fly ash shall conform to the requirements of CSA Standard A3001 for Type “F” fly ash with a maximum calcium oxide (CO) content of 12%.

Water - Water to be used for mixing of concrete, or approved concrete patching materials, or concrete finishing materials, shall conform to the requirements of CSA Standard A23.1 Clause 4.2.2 and shall be free from harmful amounts of alkali, organic materials or deleterious substances. The Contractor shall not use slurry water, treated wash water or water from shallow, stagnant or marshy sources.

Aggregates - Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1 and shall be stockpiled separately.

Admixtures - Admixtures shall be compatible with all mix constituents. Water reducing agents and superplasticizers shall conform to ASTM C494. The addition of calcium chloride, air reducing agents or accelerators will not be permitted. Air entraining agents shall conform to ASTM C260.

Hydration stabilizing admixtures shall conform to ASTM C494 Type D water reducing and retarding admixtures. The use of hydration stabilizing admixtures requires prior written acceptance of the Department and their usage shall be limited to elements requiring hydration stabilization due to mass concrete placement considerations.

Anti-washout admixtures shall conform to the US Army Corps of Engineers CRD-C 661.

Steel Fibres - When specified, steel fibres shall be Novocon XR, Wiremix W50 or an equivalent accepted in writing and in advance by the Department. The fibres shall conform to ASTM A820/A820M-04, Type 1 or 5 and be 50 mm in length with the aluminum content no more than

0.020% by mass when tested in accordance with test method Environmental Protection Agency (EPA) 3050B.

300.5.7.4.1 Storage of Materials

Hydraulic cement, silica fume, fly ash and steel fibres shall be stored in suitable weather tight buildings to protect such materials from moisture. Cement, silica fume and fly ash shall be free from lumps at all times during their use in the work. Steel fibres shall be free from balls and clumps at all times during their use in the work.

All aggregates shall be handled in a manner that prevents segregation and maintains uniformity of materials. The separated aggregates, and aggregates secured from different sources, shall be piled in separate stockpiles. The site of the stockpiles shall be clear of all foreign materials and shall be reasonably level and firm. If aggregates are placed directly on the ground, material shall not be removed from the stockpile within 150 mm of the ground level. This material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

300.5.7.5 Class and Composition of Concrete

300.5.7.5.1 Class of Concrete

Class of Concrete	Minimum Specified Compressive Strength at 28 Days (MPa)	Nominal Maximum Aggregate Size (mm)	Range of Slump ⁽⁵⁾ (mm)	Total Air Content ⁽⁴⁾ (%)	Max. Water/Cementing Materials Ratio
C	35	20 to 5 ⁽¹⁾	100 ± 30	5 - 8	0.40
HPC ^(2,3,7)	45	20 to 5 ⁽⁶⁾	120 ± 30	5 - 8	0.38
D	30	14 to 5	100 ± 30	5 - 8	0.42
S	20	28 to 5	100 ± 30	4 - 7	0.50
Pile	30	28 to 5	130 ± 30	4 - 7	0.42

Notes

1. 28 to 5 mm nominal maximum coarse aggregate size may be utilized for Class C concrete and shall be considered in mass concreting operations.
2. Additional requirements for class HPC are listed in Section 300.5.7.5.2 (Class HPC and Class HPC with Steel Fibres). The requirements for Class HPC concrete with steel fibres are the same as for Class HPC concrete.
3. The fly ash shall not exceed 30% by mass of cementing materials. For Class HPC fly ash contents shall be in accordance with Section 300.5.7.5.2 (Class HPC and Class HPC with Steel Fibres). Fly ash may be used in concrete mixes where the aggregate is assessed to be potentially alkali-silica reactive.
4. Range in air content to be in compliance with actual maximum aggregate size as per CSA A23.1 Table 4.
5. Slump ranges proposed by the Contractor that are outside those specified require acceptance in writing from the Department.
6. For MSE precast concrete fascia panels smaller nominal maximum coarse aggregate size may be required to suit panel design.

7. For partial depth precast deck panels f'_{ci} at release shall not be less than 30 MPa.

300.5.7.5.2 Class HPC and Class HPC with Steel Fibres

- (a) Mix shall include silica fume and fly ash as supplementary cementing materials in combination with compatible air entraining, water reducing and/or superplasticizing admixtures, as required.
- (b) The gradation limits for the fine aggregate shall conform to CSA Standard A23.1, except that the amount of material finer than 160 μm shall not exceed 5%.
- (c) Coarse aggregate shall conform to CSA Standard A23.1 and the maximum combination of flat and elongated particles (4:1 ratio), as determined by CSA Standard A23.2-13A (Procedure A), shall not exceed 10% of the mass of coarse aggregate.
- (d) Minimum type GU cement content (excluding supplementary cementing materials) shall be 335 kg/m^3 . Type HS cement shall not be used.
- (e) Sum of silica fume and fly ash by mass of cementing materials shall be 17% to 20%.
- (f) Silica fume by mass of cementing materials shall be from 6% to 8%.
- (g) Fly ash by mass of cementing materials shall be 11% to 15%.
- (h) Resistance to rapid chloride ion penetration shall be determined in accordance with ASTM C1202 on duplicate laboratory moist cured samples at 28 days. The average of all tests shall not exceed 1000 coulombs, with no single test greater than 1250 coulombs. When only two test values are used to calculate the average coulomb rating, no test shall exceed 1000 coulombs. For HPC with steel fibres, rapid chloride ion penetration testing shall be done without the presence of the steel fibres.
- (i) An air-void spacing factor shall be determined in accordance with ASTM C457 modified point-count method at 100 times magnification. The average of all tests shall not exceed 230 μm with no single test greater than 260 μm . When only two test values are used to calculate the average air-void spacing factor, no test shall exceed 230 μm .
- (j) When Class HPC with steel fibres is specified, it shall contain 60 kg of 50 mm long steel fibres, per cubic metre. The Contractor shall review test results of the aluminum content in the steel fibres prior to placing concrete at the site. When alternative steel fibres are proposed, their equivalency and dosage rate shall be determined in accordance with ASTM C1609. The toughness (T^D_{600}) shall be greater than or equal to that determined for the specified fibre type and dosage rate.
- (k) The shrinkage after 28 days of drying, concrete age of 35 days, shall not be greater than 0.060% if prisms with a cross-section of 75 x 75 mm are used or 0.055% if prisms with a cross-section of 100 x 100 mm are used.

300.5.7.5.3 Intentionally Deleted

300.5.7.5.4 Concrete Mix Design and Aggregate Testing

The Contractor shall prepare a concrete mix design for each proposed class of concrete including all applicable material test reports and product data sheets.

The sampling and testing of aggregates shall be completed by a concrete testing laboratory certified to CSA A283. Concrete mix designs, including the review of all material test reports, shall be signed and sealed by a Professional Engineer employed by a concrete testing laboratory certified to CSA A283. The Professional Engineer shall also provide a professional opinion indicating that the concrete mix is suitable for the intended use and can be expected to meet the Technical Requirements.

Material test reports shall be current and fully represent materials to be used in production. For each mix design submission the source(s) of proposed aggregate(s) and following aggregate analysis shall be provided:

Aggregate Analysis	Standard	Required Frequency of Analysis (maximum days prior to and during production)
Fine and Coarse Aggregate Sieve	(CSA A23.2-2A)	90
Amount of material finer than 80 µm in aggregate	(CSA A23.2-5A)	90
Organic Impurities in Sands for Concrete	(CSA A23.2-7A)	90
Fine aggregate ironstone	(CSA A23.2-15A)	90
Results of deleterious substances and physical properties of aggregates	(Table 12, CSA A23.1; A23.2-3A, A23.2-4A, A23.2-13A {Procedure A}, A23.2-23A, A23.2-24A A23.2-29A)	180
Potential expansivity of aggregates	(CSA A23.2-14A)	24 months
Detection of alkali-silica reactive aggregate by accelerated expansion of mortar bars	(CSA A23.2-25A)	12 months
Petrographic Examination of Coarse Aggregate for Concrete	(CSA A23.2-15A)	180

Additional analyses shall be provided by the Contractor when requested by the Department to confirm that the mix constituents continue to meet the Technical Requirements. A break in production of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides conclusive evidence that the material initially tested is still representative. Conclusive evidence shall consist of a written submission of confirmation from the Contractor which identifies the aggregate source location and the period of production represented by the analysis. The written confirmation shall include supporting information which verifies the aggregate sampling dates, aggregate delivery dates, and that the aggregates delivered will be those used to produce the class of concrete specified for the work intended. The submission, if made separately from the concrete mix design, shall be signed and sealed by a Professional Engineer employed by a concrete testing laboratory certified to CSA A283.

If the fine aggregate consists of a blend from more than one source, the “Fine Aggregate Sieve” analysis shall show the gradation of the blended fine aggregates. Similarly in the case of blended coarse aggregates, the “Coarse Aggregate Sieve” analysis shall indicate the gradation of the blended coarse aggregates.

Fine aggregate, tested in accordance with CSA Test Method A23.2-7A, “Organic Impurities in Sands for Concrete”, shall 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 in the absence of a satisfactory record of performance of a similar class of concrete (minimum 30 tests over the last 12 months); provisions 4.2.3.3.2 (a) & (b) of CSA Standard CAN3 A23.1 14 shall not apply. Iron stone content in fine aggregate (material retained on the 2.5 mm sieve) shall not exceed 1.5% by total dry mass of fine aggregate for all classes of concrete except pile concrete.

The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA Standard A23.2-27A. This assessment shall include the risk level associated with structure size and environment, the level of prevention related to design life requirements and the determination of the appropriate preventative measures, including testing in accordance with CSA A23.2-28A. Current (less than 18 months old) test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA Standard A23.2-14A or CSA Standard A23.2-25A is required. In the absence of current test data and outside of areas of known highly reactive aggregate, the aggregate shall be presumed to be moderately reactive.

Petrographic analysis on the proposed coarse aggregates shall be performed in accordance with CSA A23.2-15A by experienced personnel employed by a laboratory certified to CSA A283. The weighted petrographic number shall not exceed 130, and the ironstone content shall not exceed 0.8%. The Petrographic Analysis report shall be stamped by a Professional Engineer, a professional geologist, or a geological engineer registered in the Province of Alberta.

Concrete mixes that will be placed by concrete pump shall be designed for pumping.

The Contractor shall complete trial batches for Class HPC, Class HPC with Steel Fibres, and/or any class of concrete containing hydration stabilizing admixtures. The Contractor shall produce evidence satisfactory to the Department that the proportions selected will produce concrete of the quality specified. The trial batches shall be performed a minimum of 35 days prior to placement of concrete at site. Each trial batch shall be a minimum of 3 m³ or 50% of the rated mixer capacity (whichever is greater). The Quality Field Staff shall be present for the full duration of all trial batches and shall comprehensively document all results. The Contractor shall provide the Department with at least 24 hours’ notice prior to a scheduled trial batch. All trial batch testing

shall be repeated in conjunction with required aggregate testing and in accordance with the following requirements.

(a) Trial batch requirements for Class HPC and Class HPC with Steel Fibres Slump retention shall be evaluated at 15, 30, 50, and 70 minutes after batching. Slump retention after 45 minutes shall be at least 50% of the slump measured at 15 minutes.

At 70 minutes from the time of batching, samples shall be cast to determine compressive strength at 7 and 28 days, rapid chloride ion penetration, and hardened air void system in accordance with the requirements of Section 300.5.7.5.2 (Class HPC and Class HPC with Steel Fibres).

Shrinkage of the trial batch concrete shall be measured in accordance with CSA A23.2-21C.

The trial batch concrete shall be placed into a 4.5 m x 4.5 m x 0.15 m thick form on grade. The Contractor shall consolidate, screed and finish the concrete such that the Contractor can assess the mix's workability, finishability in accordance with the Technical Requirements.

(b) Trial batch requirements for Hydration Stabilized Concrete Mixes

The design length of hydration stabilization shall be the difference of the projected haul time and the specified allowable haul time (not exceeding 90 minutes) or that required by mass concrete pour considerations. The hydration stabilized mix design, including a detailed concrete batching procedure, shall be submitted and reviewed in accordance with this Section 300.5.7.5.4 (Concrete Mix Design and Aggregate Testing). Hydration stabilized concrete mixes demonstrating significant inconsistencies, as determined by the Department, shall require additional trial batch testing to demonstrate compliance.

The time of initial set, compressive strength at 3, 7, and 28 days and hardened air void system shall be determined. Initial set shall be determined by ASTM C 403/ C 403M and when the penetration resistance reaches 1.0 MPa. Hardened air void systems shall meet the requirements of Section 300.5.7.5.2(i). Slump retention shall be assessed at 15 minutes after batching, quarter points of the design hydration stabilization period and at the design period. Trial batches of Class HPC and Class HPC with steel fibres shall also meet the requirements for rapid chloride permeability and submission of shrinkage test results to the Department within seven days of test completion.

Notwithstanding the Department's review of, or failure to review, the concrete mix designs, aggregate testing, and trial batch results it remains the Contractor's responsibility to meet the Technical Requirements.

300.5.7.5.5 Mix Adjustments

If during the progress of the work the initial mix design is modified or found to be unsatisfactory on the basis of meeting the Technical Requirements, either by the Department or the Contractor, the Contractor shall make the necessary adjustments, and shall provide a revised mix design in accordance with Section 300.5.7.5.4 (Concrete Mix Design and Aggregate Testing) to the Department for review. Notwithstanding the Department's review of, or failure to review, the concrete mix design adjustments, it remains the Contractor's responsibility to meet the Technical Requirements.

300.5.7.5.6 Measurement of Materials

Coarse and fine aggregate materials shall be separated and measured separately by weighing.

The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Each size of aggregate and cementing materials shall be weighed separately. The accuracy of weighing devices shall be such that successive quantities can be measured to within 1% of the desired amount. The mix water shall be measured by volume or by weight. The water measuring devices shall be capable of control accurate to +/- 0.5% of the design quantity. Air entraining agent or other admixtures shall be added to the mix in a water-diluted solution. For mix adjustments at the site, the Contractor shall provide facilities to control the amount of superplasticizer and air entrainment so that the required tolerances can be met.

300.5.7.6 Mixing Concrete

Mobile continuous mixers or other such concrete supply equipment shall not be used.

Concrete shall be mixed thoroughly with all ingredients uniformly distributed. If required by the Department, the Contractor shall demonstrate compliance with CSA 23.1 Clause 5.2.3.5. The “batch” is considered the quantity of concrete inside the mixer, regardless of size of the mixer. The mixing period shall be measured from the time all materials enter the mixing drum.

The Contractor shall in no case load the mixer above its rated capacity. The Contractor shall maintain the mixer in good condition. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades which are bent or worn down so as to affect the mixing efficiency shall be renewed. Any mixer leaking mortar or causing waste of materials through faulty charging shall be taken out of service until repaired. The Contractor shall, at all times, operate the mixer at the speed recommended by the manufacturer and shall, if requested, supply the manufacturer's certification of the mixing capacity of the machine in use.

The mixer shall be fitted with an accurate and dependable means for measuring the water added, which is not affected by variation in pressure in the water supply line. All joints, valves and other parts shall be maintained so that there is no leakage of water into the mixer drum. Mixers that do not have an accurately working and dependable water gauge shall not be used.

Water shall be released first and continue to flow while the solid materials are entering the mixer. The water discharge pipe shall be so arranged and be of such size that the flow into the mixer is completed within the first quarter of the mixing time, and the water is delivered well within the mixer where it will be quickly mixed with the entire batch.

Air entraining agents and admixtures shall be placed in the mixer after the initial water is in the mixer drum but before the remaining materials are added. Superplasticizer shall be added after initial mixing and as per the manufacturer's recommendation.

300.5.7.6.1 Truck Mixing

Truck mixers shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure uniform distribution of materials throughout the batch. All materials for the concrete shall be accurately measured and charged concurrently into the drum at the production plant in accordance with mix design proportioning. Increases in water to cementitious materials ratio will not be permitted.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer. Truck mixing shall commence immediately upon introduction of ingredients into the drum and be continued for not less than 70 revolutions, with the mixing rate being in accordance with the manufacturer's

recommended rate, and shall be such as to thoroughly mix the concrete.

When adjustment to the mix by adding air entraining agent or superplasticizer at the site is made, the mixer shall rotate for a minimum of 70 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wet prior to use.

300.5.7.6.2 Time of Hauling

The maximum time allowed for all classes of concrete other than Class HPC and Class HPC with steel fibres including delivery to the site of the work and discharge shall not exceed 90 minutes after batching. For Class HPC and Class HPC with steel fibres this requirement is reduced to 70 minutes. In hot weather, or under conditions that accelerate the setting characteristics of the concrete, a further reduction in these times may be required. Batching of all classes of concrete is considered to occur when any of the mix ingredients are introduced into the truck mixer drum, regardless of whether or not the drum is revolving.

300.5.7.6.3 Delivery

The concrete supplier shall have sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that cold joints do not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of re-handling, and without damage to the structure or the concrete.

300.5.7.6.4 Discharge Temperature

The temperature of all classes of concrete not containing silica fume shall be between 10 degrees Celsius and 25 degrees Celsius at discharge. Temperature requirements for Class HPC and Class HPC with steel fibres shall be between 10 degrees Celsius and 20 degrees Celsius at discharge.

300.5.7.7 Inspection and Testing

The Contractor shall provide the Department with full access for any inspections that it may carry out relative to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete wherever this may be situated. The access shall be adequate to permit proper sampling of concrete, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant Technical Requirements, including cylinders cast by the Department, is the responsibility of the Contractor and adequate cylinder storage space shall be provided prior to any concrete pour.

The Contractor shall utilize ACI or CSA certified testers with extensive related experience to test at site, the air content, density slump and temperature of each batch. Additional tests shall be completed if the results are borderline or widely variable. In case of an unacceptable result, one check test will be accepted. The certified testers shall cast the test cylinders as specified in Section 300.5.7.7.3 (Test Cylinders). The certification of the testers shall be current and available for ad hoc auditing by the Department. The certified testers shall utilize the “Concrete Testing Summary at Site” forms contained in Appendix B. The completed forms shall accompany the concrete test cylinders to the testing laboratory. In addition to the testing performed as described in this Section the Contractor shall perform periodic independent tests and audits of staff performing concrete sampling, slump tests, air content test, and the casting and handling of test

cylinders. The independent test and audits shall be performed quarterly by a certified ACI or CSA certified agency. The agency shall be a person or legal entity and shall not be carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or the fabricator.

Current summaries of concrete testing results including bridge identification, pour location, cylinder identification, slump, air, and individual and average compressive strengths at seven days and 28 days shall be kept by concrete type for each bridge, and these summaries shall be provided to the Department at the end of every month.

300.5.7.7.1 Strength Tests

A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standards as modified herein. One cylinder shall be tested at seven days. The 28 day test result shall be the average of the strengths of the remaining three specimens, except that if any specimens in a test showing distinct evidence of improper sampling, molding or testing, shall be discarded and the remaining strengths averaged. Additional cylinders may be cast at the discretion of the Contractor.

For Class HPC and Class HPC with steel fibres the Contractor shall take a strength test to represent each approximate 20 m³ portion of the concrete pour, to a minimum of one strength test for every two loads of concrete. For all other concrete, the Contractor shall take a strength test to represent each bridge element or portion of the element (e.g. abutment seat, abutment backwall, pier footing, and pier cap. On larger pours a strength test shall be taken to represent each approximate 30 m³ portion of the concrete pour, to a minimum of one strength test for every three loads of concrete. Such tests shall be taken from representative batches.

300.5.7.7.2 Sampling

Sampling of concrete shall be carried out in accordance with CSA Standard A23.2-1C.

When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose with the exception that when concrete is being placed underwater by tremie methods, sampling may occur at the pump's hopper.

300.5.7.7.3 Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA Standard A23.2-3C, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor's ACI or CSA certified testers in standard CSA approved heavy duty steel or plastic moulds. Plastic moulds shall have a wall thickness of at least 6 mm. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in section 8.3.2.1 of CSA Standard A23.2-3C for a period not less than 24 hours and further protection, from adverse weather and mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a portable building which will be used by Contractor's personnel or the Department during the first 24-hour storage period is not permitted. Storage facilities shall be provided, installed, and accepted in writing and in advance by the Department before any concrete is placed.

Handling and transporting of the cylinders shall be in accordance with CSA Standard 23.2-3C. No extra laboratory curing time shall be allowed for cylinders that are delivered late to the

laboratory. For Class HPC and HPC with steel fibres, the ends of cylinders shall be ground flat prior to testing.

If the test cylinders exhibit frost etchings or were stored at temperatures below 10 degrees Celsius or above 25 degrees Celsius, or are otherwise mishandled resulting in unreliable strength test results, the Contractor shall reject those portions of the work represented by the cylinders unless the strength of the concrete is confirmed by core testing in accordance with section 300.5.7.18.5 (Coring for Compressive Strength Testing).

300.5.7.7.4 Slump

Slump tests shall be conducted in accordance with CSA Standard A23.2-5C.

300.5.7.7.5 Air Content and Density

Air content and density tests shall be made in accordance with CSA Standard A23.2-4C and A23.2-6C respectively.

300.5.7.7.6 Testing Cylinders

Test cylinders shall be tested in compression in accordance with CSA Standard A23.2-9C by an independent CSA certified testing laboratory engaged by the Contractor. The independent testing laboratory and certified personnel shall be a legal entity not carrying out any design or construction for the Project, and that is at arm's length from and completely independent of the Contractor or the fabricator.

300.5.7.7.7 Failure to Meet Slump or Air Content

If any batch of concrete fails to meet slump or air content requirements, attempts at mitigation shall be limited to adjusting the quantities of superplasticizer and air entraining agent at site. The Contractor shall reject any batch in the event of confirmed unacceptability as determined by quality control tests, and shall immediately remove any concrete from this batch which may have already been placed in the structure.

300.5.7.8 Falsework and Formwork

300.5.7.8.1 General

All falsework and formwork drawings shall be prepared and sealed by a Professional Engineer and inspected prior to placing concrete to confirm that it is in conformance with the design and drawings. For the design of falsework and formwork, the density of fresh concrete shall be assumed to be 2400 kg/m³ unless otherwise noted on the Detailed Designs.

All forms shall be of wood, metal or other acceptable materials, and shall be designed and built mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of vibrated concrete and other loads incidental to the construction operation. The forms shall be substantial and unyielding, and shall be designed so that hardened concrete will conform to the design dimensions and alignments. The shape, strength, rigidity, water tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged formwork shall be repaired or replaced before being used. The Contractor shall make every effort to accurately position formwork against hardened concrete so as to avoid form lines and discontinuities at the construction joints. Construction tolerances for formwork misalignments are outlined in Section 300.5.7.11.8 (Surface Defects and Tolerances).

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven and removed in a manner acceptable to the Department.

For formwork constructed of wood, drawings shall specify the type and grade of lumber and show the size and spacing of all members. The formwork drawings shall also show the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing.

For walls, columns, and other elements where the bottom of the form is inaccessible, removable panels shall be provided in the bottom form panel to facilitate cleaning out of extraneous material prior to placing concrete.

All formwork must be removed from the completed structure.

300.5.7.8.2 Standard Details

The Contractor shall use the standard details shown on Standard Drawings S-1409-16 (Standard Concrete Slope Protection for Grade Separations), S-1411-87 (Standard Concrete Joints), S-1412-99 (Standard Construction Joints), and Drawings S-1838-15 and S-1839-15 (Deck Water Proofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement (Sheets 1 and 2)).

300.5.7.8.3 Deck Formwork

The Contractor shall survey all girders at locations corresponding with those detailed on the camber diagram and determine girder haunch dimensions required to achieve design grades. The Design Engineer shall review and accept the survey data. The Field Review Engineer shall perform an additional and independent haunch dimensional check to confirm deck thickness and grades prior to deck reinforcing steel placement. If the design haunch dimensions vary more than allowable girder fabrication tolerances, the Contractor may revise grades when accepted by the Design Engineer and the Department.

Stay in place corrugated metal, timber or other deck soffit formwork types are not permitted. Formwork shall not remain in place as part of the structure. Use of any formwork system or components shall not reduce design dimensions as required by the Technical Requirements or the Detailed Design, in that order.

The Contractor shall design and install support brackets such that no damage to girder flanges and webs will result. Where required, deck formwork design shall include any additional bracing system to those shown on the Detailed Designs. Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. Where brackets bear against girder webs, the Contractor shall protect the contact surface with timber or neoprene softeners. No drilling of additional holes, or any other modifications including field welding, shall be made to the superstructure elements. Formwork for decks, curbs, sidewalks and parapets shall be fabricated so that the lines and grades shown on the drawing are achieved, with adjustments made where necessary to compensate for variances in girder dimensions, positioning, alignment and sweep.

Formwork hangers or ties for exposed surfaces of decks, including underside surfaces, shall be an acceptable break-back type with surface cone, or removable threaded type. No portion of the hardware associated with deck or deck overhang formwork shall be visible after all formwork

has been removed. All cavities resulting from threaded rod removal along the underside of deck overhangs shall be adequately prepared and filled with an approved concrete patching material from the Vertical/Overhead (OH-V) Approved Product category and placed in accordance with the manufacturer's published product data sheet. Deck overhang patches shall be placed level with adjacent surfaces and be similar in colour and texture. For interior bays, all cavities resulting from threaded rod removal shall be filled with Sikaflex 15LM or an equivalent accepted in advance and in writing by the Department. The caulked surface shall be placed level with adjacent surfaces and be similar in colour.

300.5.7.8.4 Forms for Exposed Surfaces

Forms for exposed surfaces which require a Class 1 "Ordinary Surface Finish" shall be made of good quality plywood, or an equivalent acceptable to the Department, of uniform thickness, with or without a form liner. Forms for exposed surfaces requiring a Class 2 "Rubbed Finish" or Class 3 "Bonded Concrete Surface Finish" are designated "coated formply", which shall be all new material consisting of Douglas Fir substrate with resin-impregnated paper overlay and factory treated chemically active release agent. All form material for exposed surfaces shall be full-sized sheets, as practical.

All forms for exposed surfaces shall be mortar-tight, filleted at all sharp corners, and given a bevel or draft in the case of all projections. At the top edges of exposed surfaces, the chamfers are to be formed by chamfer strips.

For all exposed concrete where the pour height is 1.5 m or less, minimum formwork requirements shall be 18 mm plywood supported at 300 mm maximum on centres. Where the pour height is greater than 1.5 m, minimum formwork requirements shall be 18 mm plywood supported at 200 mm maximum on centres. The support spacing specified here assumes the use of new material. Closer spacing may be required in case of re-used material. Strong-backs or walers placed perpendicularly to the supports shall be employed to ensure straightness of the form.

Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 20 mm from the concrete surface. Break-back type form ties shall have all spacing washers removed and the tie shall be broken back a distance of at least 20 mm from the concrete surface. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel hangers and ties will not be permitted. All cavities created from ties or associated hardware removal shall be filled with an approved concrete patching material from the Overhead/Vertical (OH-V) Approved Product category and placed in accordance with the manufacturer's published product data sheet. The surface shall be left sound, smooth, even and uniform in colour.

When plastic sleeves with removable inner rods are used, the plastic sleeves shall be removed for a distance of 100 mm back from the face of the concrete, except for curbs, barriers and medians where the entire plastic sleeve shall be removed. The entire cavity shall be filled with a Type 1 non shrink grout Approved Product to 75 mm from the concrete surface and cured a minimum 24 hours. The remaining 75 mm of the cavity shall then be filled with an approved concrete patching material from the Overhead/Vertical (OH-V) category Approved Product and placed in accordance with the manufacturer's published product data sheet. When fibre reinforced polymer rods are used they shall be removed a distance of 75 mm back from the face of the concrete and filled with an approved concrete patching material from the Overhead/Vertical (OH-V) category Approved

Product and placed in accordance with the manufacturer's published product data sheet.

300.5.7.8.5 Protection of "Weathering" Steel Girders

Where steel girders are fabricated of "weathering" steel, it is essential that the uniformity of rust formation is not adversely affected by the Contractor's work.

The Contractor shall exercise utmost care and provide the necessary protection to prevent marking or staining of the girders. All joints between deck formwork and steel members (including interior girders, and diaphragms) shall be sealed to prevent leakage of cement paste or concrete. Polyurethane sealant or an equivalent accepted in advance and in writing by the Department shall be used to achieve the seal.

If foreign material spills onto the girders despite the protection provided, the Contractor shall clean off, wash, and abrasive blast the contaminated areas.

If the exterior fascia web and flanges of an exterior girder becomes contaminated with foreign material, stained or marked, the Contractor shall clean off, wash and abrasive blast the entire exterior fascia web and flanges and weather the surfaces such that uniformity of girder colour is achieved. Weathering shall be achieved by repeatedly fogging the exterior girder faces with clean water and then allowing to dry. Fogging shall leave girder surfaces wet but not running wet, and be repeated when the girders are completely dry until a finish acceptable to the Department is achieved.

300.5.7.8.6 Protection of Concrete Work and Bridge Elements from Staining

The Contractor shall take precautions to protect all concrete work and bridge elements from staining prior to the deck, curb or barriers being cast and deck joints installed. If staining occurs, it shall be removed. Stained concrete surfaces that have received a Class 3 finish shall have the entire surface face of the element sandblasted and the Class 3 finish reapplied. Stained concrete surfaces that have received a Class 2 finish shall have the entire surface face of the element refinished. There shall be no trace of staining after the specified concrete finishing is completed.

300.5.7.9 Handling and Placing Concrete

300.5.7.9.1 General

The method of concrete placement shall have a consistent minimal impact on the concrete properties. All the necessary equipment for any particular pour shall be on site and proven to be in working condition before the pour commences, with backup equipment on site. The equipment shall be well maintained, suitable for the intended purpose and adequate in capacity for the work.

In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. When depositing concrete by mixer truck chute, concrete pump or crane and

bucket, the free fall of the concrete shall not exceed 1 metre. Concrete placement in elements containing multiple layers reinforcing steel shall be completed such that the concrete is not deposited on upper layers of reinforcing steel.

Concrete for the structure shall be deposited in the forms in the order indicated on the Detailed Designs, and each portion placed between construction joints shall be placed in one continuous operation. Concrete placing operations shall not work off, or transport concrete directly over concrete previously placed.

300.5.7.9.2 Consolidation

Concrete, during and immediately after depositing, shall be thoroughly consolidated. The consolidation shall be done by mechanical vibration, and subject to the following conditions:

- The vibration shall be internal;
- Vibrators shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4500 impulses per minute;
- The intensity of vibration shall be such as to visibly affect a mass of concrete of 25 mm slump over a radius of at least 0.5 m;
- The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms;
- Vibrator operators shall be suitably instructed in the use of vibrators, and the importance of adequate and thorough vibration of the concrete;
- Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Application of vibrators shall be at points uniformly spaced and not farther apart than the radius over which the vibration is visibly effective;
- Vibration shall not be applied directly or through the reinforcement of sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration;
- Vibrators shall not be used to transport concrete within forms or made to flow over distances resulting in segregation; and
- Vibration shall be supplemented by spading as is necessary to ensure smooth and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

Once vibrated, the Contractor shall avoid disturbing concrete, and shall not step into the concrete or add additional concrete after vibration.

300.5.7.9.3 Additional Requirements

When concrete placing is discontinued, for whatever reason, all accumulations of mortar splashed on the reinforcing steel and the form surfaces shall be removed. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break

the concrete-steel bond at and near the surface of the concrete, while cleaning the reinforcing steel.

Concrete shall be placed while fresh and before it has taken its initial set. Partially hardened concrete shall not be re-tempered. Concrete that does not reach its final position in the forms within the time limits specified shall not be used.

After initial set of the concrete, the forms shall not be jarred or any strain placed on the ends of projecting reinforcing bars.

Concrete which would be adversely affected by the presence of freestanding water shall be protected to prevent its occurrence, and the Contractor shall take whatever steps may be necessary to prevent free water build-up in the event of unexpected rainfall or similar occurrences for the first 24 hours.

Water used to keep equipment clean during the pour, or to clean equipment at the end of the pour, shall be discharged clear of the structure and any water channel.

300.5.7.9.4 Pumping

The operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be so arranged that the freshly placed concrete is not damaged by any form of vibration caused by the pump. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

300.5.7.10 Placing Pile Concrete

300.5.7.10.1 General

The Contractor shall make all attempts necessary to obtain a dry hole as per Section 300.5.13.7.3 (Drilling Pile Holes). If in the opinion of the Department all attempts to achieve a dry hole have been taken and proven unsuccessful, placement of pile concrete shall be in accordance with Section 300.5.7.10.3 (Concrete Placed Under Water).

300.5.7.10.2 Concrete Placed in the Dry

Pile concrete shall be placed by means of a hopper equipped with a centre pipe drop tube. The pipe drop tube shall be a minimum of 200 mm in diameter and 2 m long. Concrete may be placed free fall, providing the fall is vertically down the centre of the casing or drilled hole and there are no transverse ties or spacers. Pile concrete shall have a slump range of 130 ± 30 mm at time of discharge. Concrete in the upper 3 m of the piles shall be consolidated by the use of an acceptable concrete vibrator.

300.5.7.10.3 Concrete Placed Under Water

Placement of pile concrete under water shall be in accordance with Section 300.5.7.14 (Depositing Concrete Under Water). In addition, all drilled pile shafts cast under water shall be inspected by Crosshole Sonic Logging (“CSL”) to check structural integrity.

In order to test for voids or other abnormalities in the concrete, all drilled pile shafts cast under water shall be equipped with PVC or steel access tubes to permit inspection by CSL. The Contractor shall submit the proposed method for review two weeks before beginning drilled pile

work. The Contractor shall supply and install four 50 mm inside diameter tubes in each drilled pile with a diameter of 1.5 m or less and six tubes in each pile with a diameter greater than 1.5 m.

Tubes supplied shall be round and have a regular internal diameter that is free from defects, obstructions and joints, and shall be watertight, free from corrosion and have clean internal and external faces to ensure a good bond between the concrete and the tubes. Tubes may be extended with watertight mechanical couplings but all coupling locations shall be recorded. Tubes shall be installed in a manner that the CSL probes pass through the entire length of the tube without binding.

The Contractor shall fit all tubes with watertight shoes on the bottom and removable caps on the top. Tubes shall be secured to the interior of the reinforcement cage at least every 1.2 m along the length of the pile. Tubes shall be installed uniformly and equidistantly around the circumference of the pile such that all tubes are parallel for their full length. Tubes shall extend to within 150 mm of the drilled shaft bottoms, and shall extend a minimum of 600 mm above the drilled shaft tops or where they are accessible. Tubes shall be capped to prevent debris from entering the access tubes.

The Contractor shall ensure that CSL tubes are not damaged during the installation of the reinforcement cage. If testing equipment does not pass through the entire length of the CSL tube, a 50 mm diameter core hole shall be drilled. Special care must be taken to avoid tube debonding between the concrete and the tubes. If tube debonding occurs, the Contractor shall core drill a 50 mm diameter hole to the depth of debonding for each debonded tube.

The Contractor shall make CSL measurements at depth intervals of 65 mm from the bottom of the tubes to the top of each pile. Upon completion of testing and acceptance of the pile concrete, the tubes shall be filled with a grout mix accepted in advance and in writing by the Department.

a) Qualification

The Contractor shall hire an independent testing agency having a minimum of three years' experience in CSL testing. The independent testing agency retained by the Contractor shall be a legal entity not carrying out any design or construction for the Project, and that is at arm's length from and completely independent of the Contractor. The CSL agency shall have a Professional Engineer supervise testing and interpret results.

b) CSL Results

The CSL testing agency shall prepare a CSL report signed and sealed by the CSL engineer and include test summaries, results, analyses, and an opinion of the pile concrete's suitability for intended use. The Contractor shall not grout the CSL tubes or perform any further work on the CSL tested drilled piles until it has been demonstrated to the Department's satisfaction that the drilled pile is acceptable. Test summaries shall be in accordance with the criteria listed below.

Concrete Condition Rating Criteria

Rating	Velocity Reduction *	CSL Results
Good ("G")	≤ 10%	Good quality concrete
Questionable ("Q")	>10% & <20%	Minor contamination or intrusion: questionable quality concrete
Poor/Defect	≥ 20%	Defects exists, possible water/slurry contamination, soil intrusion and/or poor quality

("P/D")		concrete
No Signal ("NS")	No Signal Received	Soil intrusion or other severe defect absorbed the signal

** From highest measured signal velocity in the comparable zone*

CSL test results with ratings other than “G” shall be considered unacceptable and shall result in rejection of the pile. In the event that the Contractor elects to carry out further investigation to prove the acceptability of the pile, boundaries of any defective/unconsolidated zones shall be delineated by means of cross-hole tomography, supplemented by any additional testing required by the Design Engineer. This additional testing may include 3D tomographic imaging, single-hole sonic testing, sonic echo or impact response tests, or concrete coring. The Contractor shall then submit to the Department a full report signed and stamped by the Design Engineer that demonstrates the functionality of the pile, including test summaries, results and analyses. The pile shall not be considered acceptable until the Department has accepted the report and determined if further remedial action is required.

Pile edge defects are considered critical and any defects that expose the rebar are not acceptable under any circumstance and shall result in rejection of the pile.

The depth, location, diameter and number of core holes when concrete coring is required shall be proposed by the Contractor in a written submission to the Department. If the Department is concerned about concrete strength or requires the use of a borehole camera for inspection, large diameter cores may be required. A minimum of two cores would be required to intercept the suspected defect zones.

c) Correction of Unacceptable Drilled Pile

When a drilled pile is unacceptable and rejected by the Department, the Contractor shall submit a remedial action plan with supporting calculations for review and acceptance by the Department. The remedial action shall be designed by the Contractor and stamped by a Professional Engineer.

300.5.7.11 Placing HPC Concrete and HPC Concrete with Steel Fibres

300.5.7.11.1 General

Concrete shall not be placed when the air temperature is below 5 degrees Celsius, or is expected to fall below 5 degrees Celsius during the curing period, or when the air temperature is above 25 degrees Celsius, or in the event of rain or excessive wind or dust, or when there are other conditions detrimental to the concrete. When cold weather conditions are anticipated as per Section 300.5.7.13 (Concreting in Cold Weather) the placement of HPC shall not occur until the Contractor has a cold weather concreting procedure in place accepted in writing by the Department.

Deck, roof slab, approach slab and deck overlay concrete shall be placed between the hours of 6:00 pm and 10:00 am of the following day, unless reviewed and accepted by the Department in writing. Proper lighting shall be provided for night pours. Deck, roof slab, approach slab and deck overlay concrete shall not be placed when the evaporation rate exceeds 0.5 kg/m²/hr. The evaporation rate shall be determined using Figure D.1, of CSA A23.1 – Annex D. The rate of evaporation shall be recorded as concrete placing operations progress and the Contractor shall

make all necessary adjustments to ensure the evaporation rate does not exceed the specified limit.

The temperature of the concrete during discharge shall be in accordance with Section 300.5.7.6.4 (Discharge Temperature). The temperature of the mix shall be controlled by the inclusion of ice to the mix which shall not alter the design water cementing materials ratio. Prior to placing concrete, the substrate surfaces shall be brought to a saturated surface dry condition with clean water meeting the requirements of Section 300.5.7.4 (Materials) and be free of standing water.

All deck concrete and deck overlay concrete shall be consolidated in accordance with Section 300.5.7.9.2 (Consolidation) even when vibratory drum type placing/finishing machines are used.

All reinforcing steel projecting from deck surfaces (barriers, curbs, medians, and adjacent deck pour sequence stages) shall be covered during deck concrete placement, consolidation, screeding, and testing operations such that it is not contaminated with concrete.

300.5.7.11.2 Placing/Finishing Machines

For all deck concrete and deck overlay concrete, screeding shall be by one of the following concrete placing/finishing machines:

- Terex Bidwell Models: 2450, 3600, 4800;
- Gomaco Models: C450, C750; or
- Allen Models: 4836 B, 6036 B, 6048 B.

The Contractor shall provide two work bridges, separate from the placing/finishing machine, of adequate length to completely span the width of the pour, and shall provide details of these to the Department for review. The work bridges will facilitate the operations of concrete finishing and placing of filter fabric. The work bridges shall be supported parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall be at least 800 mm wide to permit diverse uses concurrently, and be rigid enough that dynamic deflections are insignificant.

300.5.7.11.3 Screed Guide Rails and Supports

Steel screed guide rails and supports shall be installed to suit the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge. Guide rails shall extend beyond the end of the bridge and the entire deck or deck overlay surface shall be screeded with a concrete placing/finishing machine. Guide rails and guide rail supports shall not be located within any concrete pour.

300.5.7.11.4 Dry-Run

The finishing machine shall be set-up to match the skew angle of the bridge, when the skew angle exceeds 15°. For skewed bridge structures on vertical curves, this requirement may be altered to suit actual site conditions.

The deck finishing machine shall be dry-run and measurements taken to determine deck thickness and reinforcing steel cover at locations corresponding with those detailed on the camber diagram. Adjustment of the deck finishing machine and/or guide rails shall be completed such that the design grades, deck designed thickness and reinforcing steel concrete cover are achieved. The deck finishing machine or guide rails shall not be adjusted after the dry-run has

been completed, checked and accepted by the Design Engineer. If the finishing machine is adjusted for any reason after acceptance, the dry-run, including all checks, shall be repeated.

Where screed rails are supported on cantilevered formwork that could deflect under the weight of the fresh concrete and the deck finishing machine, the Contractor shall pre-load a section of the cantilevered formwork on each side of the bridge to determine deflections that will occur during concrete placement. The formwork, machine and/or screed rails shall be adjusted to compensate for the expected formwork deflection.

300.5.7.11.5 Intentionally Deleted

300.5.7.11.6 Screeding Concrete

Concrete shall be placed as close as practical ahead of the finishing machine, and at no time more than 6 m in front of the trailing end of the finishing machine's roller. The screed shall be moved slowly and at a uniform rate. The direction of the pouring shall be from the low end of the bridge to the high end unless alternatives are reviewed in advance and accepted in writing by the Department. A roll of concrete shall be maintained along the entire front of the screed at all times to ensure the filling and consolidation of the surface concrete. The Contractor shall also ensure that the required concrete thickness is being placed by continually probing the concrete behind the finishing machine.

Screeding shall be completed in no more than two passes. The screeded surface shall not be walked on or otherwise damaged. Work bridges may need to be equipped or fitted with specialized work platforms to facilitate concrete finishing in front of curbs, barriers or medians.

300.5.7.11.7 Bull Floating/Surface Texturing

The concrete surface produced behind the finishing machine shall be manually bull floated with a magnesium bull float to ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions. Bull floating and surface texturing shall follow as close as practically possible behind the screed. It is imperative that competent workers be employed to carryout bull floating and surface texturing.

Evaporation reducer or water shall not be finished into the concrete at any time during finishing operations.

The surface shall be checked for by the Contractor with a 3 m long expanded polystyrene straight edge immediately after final bull floating and before texturing or application of evaporation reducer to ensure the required surface tolerances are met. Concrete surfaces that do not meet the surface tolerances described in Section 300.5.7.11.8 (Surface Defects and Tolerances) shall be corrected while the concrete is still plastic and before curing procedures are implemented.

300.5.7.11.8 Surface Defects and Tolerances

The finished surface of the concrete shall conform to the design gradeline indicated on the Detailed Designs. Any proposed gradeline modifications shall be reviewed and accepted by the Design Engineer and the Department in advance. For any required corrective work the Contractor shall submit a repair procedure for review and written acceptance by the Design Engineer and the Department a minimum of two weeks prior to commencement of the work.

The surface shall be free from open texturing, plucked aggregate and local projections.

Except across the crown, the surface shall be such that when checked with a 3 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the surface of the deck concrete.

Areas with surface defects or do not meet the required surface tolerances will be clearly marked out by the Field Review Engineer and the Contractor shall:

- (a) Remove and replace areas where the deviation exceeds 10 mm from the correct surface. As a minimum, the Contractor's repair procedure shall include saw cuts 25 mm deep in neat perpendicular lines and concrete removed to a depth of 35 mm below the top mat of reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hrs prior to concrete placement. Repair areas shall be free of standing water and surface dry immediately prior to placing class HPC concrete. Curing shall be in accordance with the requirements for class HPC concrete.
- (b) Grind down any areas higher than 3 mm but not higher than 10 mm above the correct surface.
- (c) Correct any areas lower than 3 mm but not lower than 10 mm below the correct surface, by grinding down the adjacent high areas.

Concrete surfaces that are damaged in any way by construction operations, or show signs of distress or scaling shall be repaired or replaced by the Contractor.

300.5.7.11.9 Deck Joint Assembly Installation

The finished surface of the concrete shall conform to the design grade line profiles as indicated on the Detailed Designs.

The Contractor shall check the deck joint assembly grade, elevation gap, and crown prior to concrete placement, and shall not place concrete if the deck joint assembly position is incorrect. The Contractor shall confirm the deck joint assembly grade, elevation gap, and crown immediately after the concrete curing period. Measurements shall be done by survey instrument. If the deck joint assembly position is incorrect, the Contractor shall promptly remove and replace the deck joint and concrete.

300.5.7.11.10 Placing Approach Slab and Roof Slab Concrete

After placing and consolidating the concrete, it shall be struck off and screeded to conform to the required cross-section and grades. Concrete placing shall be carried out in a manner such that the newly deposited concrete is continually placed against fresh concrete across the entire face of the pour and the formation of cold joints is avoided. A slight excess of concrete shall be kept in front of the screed at all times.

Once screeded, the concrete surface shall be manually bull floated longitudinally, transversely or in both directions as necessary to ensure that the surface is free from open texturing, plucked aggregates, and local projections or depressions. Evaporation reducer or water shall not be added to the concrete at any time during finishing operations.

The surface shall be such that it does not vary by more than 3 mm from the required lines, under a 3 m straightedge placed anywhere, in any direction except across the crown.

300.5.7.11.11 Concreting Shear Keys and Diaphragms

Form work for shear keys and diaphragms shall be designed to accommodate variations in girder dimensions, positioning, alignment, camber and sweep. Girder shear keys and diaphragms shall be brought to a saturated surface dry condition prior to concrete placement. Saturation with water shall not be less than 30 minutes prior to blowing free of standing water. Concrete placed in shear keys shall be adequately consolidated and trowelled smooth and level with the top surfaces of the girders. Immediately after trowelling, two layers of clean Nilex 4504 white coloured filter fabric or an equivalent acceptable to the Department shall be placed on the shear keys and kept continuously wet for 72 hours.

300.5.7.11.12 Concrete Slope Protection

The Contractor shall develop a detailed layout and forming plan for the concrete slope protection. The detailed layout and forming plan shall comply with Standard Drawing S-1409-16 (Standard Concrete Slope Protection for Grade Separations) and the Technical Requirements.

All thickness measurements indicated herein are perpendicular to the slope surface.

The slopes to be covered with concrete slope protection shall be trimmed and dressed by the Contractor to within 150 mm of the lines and grades shown on the Detailed Designs. The Contractor shall supply, place and compact Des 2 Class 25 crushed aggregate material to a minimum thickness of 100 mm over the trimmed slopes. Crushed aggregate material shall conform to the requirements of Section 300.5.11.3.5 (MSE Wall Backfill).

Sheet reinforcing mesh shall be placed in accordance with Section 300.5.14 (Reinforcing Steel). Mesh shall be secured and supported prior to concrete placement such that its location is maintained during all concreting operations.

The concrete shall be placed in either horizontal or vertical courses, with one course being allowed to cure for at least 12 hours before the adjoining course is placed. Formwork shall be provided below and above the wire mesh to ensure proper slab thickness, correct positioning of the mesh, and the formation of proper cold joints between courses. Vertical or horizontal joints shall be formed or grooved 50 mm to the depth of the reinforcing mesh. All joints shall be finished with suitable edging and grooving tools and left unfilled. The concrete surfaces shall be given a Class 5 finish prior to edging and grooving. Finishing work shall be carried out by competent and experienced personnel only.

Backfill at the toe, top or edges shall be non-granular material and not placed until concrete work is complete and the slope protection concrete has reached adequate strength.

300.5.7.12 Construction Joints

300.5.7.12.1 General

Construction joints shall be made only where indicated on the Detailed Designs.

If not detailed on the Detailed Designs, or in the case of emergency, construction joints shall be installed according to the Standard Drawings S-1412-99 (Standard Construction Joints). Shear keys or inclined reinforcement shall be used where necessary to transmit shear, or to bond the

two sections together. Construction joints should be located to allow a minimum of 50 mm minimum concrete cover on reinforcing steel running parallel to the joint.

Construction joints in deck slabs shall not be situated in locations where they will not be waterproofed in accordance with the details on Standard Drawings S-1838-15 and S-1839-15 (Deck Water Proofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement (Sheets 1 and 2)).

300.5.7.12.2 Bonding

Before depositing new concrete on or against concrete that has hardened, the forms shall be re-tightened and the surface of the hardened concrete shall be thoroughly cleaned and in a saturated surface dry condition. The placing of concrete shall be carried out continuously from joint to joint. The face edges of all joints that are exposed to view shall be carefully finished true to line and elevation.

300.5.7.13 Concreting In Cold Weather

When the air temperature is, or is expected to be below 5° Celsius as forecasted by the closest Environment Canada Meteorological Station during the placing and curing period, a cold weather concreting plan shall be implemented. In addition to the following requirements, all concrete shall be cured in accordance with Section 300.5.7.15 (Curing Concrete).

- (1) All aggregate and mixing water shall be heated to a temperature of at least 20 degrees Celsius but not more than 65 degrees Celsius. The aggregates may be heated by either dry heat or steam; in the latter case the quantity of mixing water shall be reduced as necessary to maintain the mix design water cement ratio. The temperature of the concrete at the time of placing shall be in accordance with Section 300.5.7.6.4 (Discharge Temperature).
- (2) The Contractor shall enclose the structure in such a way that the concrete and air within the enclosure can be kept at or above 15° Celsius for a period of 7 days after placing the concrete. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure and the concrete.

For class HPC or HPC with steel fibres the 7 day protection period shall be increased to 17 days (14 days of wet curing and 3 days of air drying). The enclosure for class HPC or HPC with steel fibres shall be constructed large enough to comfortably accommodate the men and equipment necessary to place, finish and cure the concrete. The underside of bridge decks shall be suitably enclosed and heated.

The relative humidity within the enclosure shall be maintained at not less than 85%. Heaters must be kept well clear of the formwork housing. Adequate ventilation is required to provide air for combustion, and to prevent the accumulation of carbon dioxide. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat is prohibited.

The system of heating, and positioning of steam outlets, heaters, and fans, shall be designed to give the most uniform distribution of heat possible.

- (3) Before placing concrete, the Contractor shall provide adequate preheat to raise the temperature of formwork, reinforcing steel, previously placed concrete, substrate surfaces,

and/or soil to between 10°C and 20°C.

- (4) When reviewed and accepted in advance and in writing by the Department, fully insulated formwork may be considered an alternative to providing heat during the curing period. The Contractor shall design and insulate the formwork such that the initial heat of the mix and the heat generated during hydration processes will maintain the specified curing conditions throughout the curing period. If the insulated formwork fails to maintain the specified conditions, the Contractor shall immediately implement measures to restore them.
- (5) Concrete curing shall be in accordance with the requirements of Section 300.5.7.15 (Curing Concrete).
- (6) The adequacy of protection shall be monitored and recorded a minimum of every 4 hours for the first 72 hours, and every 8 hours for the remainder of the curing period, including measurement of internal and surface concrete temperature and relative humidity. The protective measures shall be modified as necessary to maintain the specified curing conditions.
- (7) Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10 degrees Celsius per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced. The temperature differential between the core of the element and the surface of the element shall not exceed 20 degrees Celsius. In addition the temperature differential between the surface of the element and the ambient air shall not exceed 15 degrees Celsius. Ambient air temperature is defined as the temperature at mid-height and 300 mm from the surface of the element. The Contractor shall measure the temperature of internal concrete, surface of the concrete and ambient air temperatures a minimum of every 4 hours, and shall make adjustments as necessary to keep the rate of cooling within the specified parameters.
- (8) The Contractor shall demonstrate to the satisfaction of the Department that the requirements of the cold weather concreting plan are met.
- (9) Notwithstanding the forecasted temperatures as reported by Environment Canada the Contractor shall between October 15th and March 30th of any year have provisions, at a concrete pour location, to implement their cold weather concrete procedures should current or forecasted weather conditions warrant.

300.5.7.14 Depositing Concrete Under Water

Concrete shall not be deposited under water without the prior written approval of the Department. Concrete to be deposited in water shall be of the specified class, with the mix design modified to provide 170 mm ±30 mm slump without segregation and a 15% increase in cementing materials above the initial mix design quantity. Anti-washout admixtures incorporating viscosity modifiers may be used in the mix design. The modified concrete mix design for placement under water shall be submitted by the Contractor for review and written acceptance by the Department in accordance with Section 300.5.7.5.4 (Concrete Mix Design and

Aggregate Testing). The concrete temperature at discharge shall be between 10°C and 25°C.

To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a concrete pump. When specifically reviewed and accepted by the Department, a properly designed and operated tremie may be used. The concrete shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and any formwork underwater shall be watertight.

The discharge end of the concrete pump line shall be lowered to the bottom of the form or hole. Pumping shall then proceed with the end of the discharge line being continually buried no less than 500 mm below the surface of fresh concrete at all times to maintain a seal until the form or hole is completely filled with fresh uncontaminated concrete.

A tremie, when reviewed and accepted by the Department, shall consist of a rigid tube having a diameter between 200 mm and 300 mm, and if constructed in sections it shall have flanged couplings fitted with gaskets. The discharge end shall be closed at the start of the work to prevent water entering the tube. The tremie tube shall be kept full to the bottom of the hopper, and water shall be kept out at all times. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed. Sufficient tremies shall be used to place the concrete under water such that it is not necessary to move any of the tremies from one portion of the pour to another. The use of flexible or non-rigid tremie tubes will not be permitted.

Concrete shall not be placed in water which is below 4 degrees Celsius.

The surface of the concrete shall be kept as nearly horizontal as is practicable at all times. The discharge end of the tremie shall be kept buried at least 500 mm in previously placed concrete.

Dewatering will not be permitted while concrete is being placed. Dewatering may proceed when the concrete seal has gained sufficient strength such that dewatering is not harmful to the performance of the concrete. The Contractor shall remove all laitance or other unsatisfactory material from the exposed concrete surface by scraping, chipping or other means acceptable to the Department.

300.5.7.15 Curing Concrete

300.5.7.15.1 General

Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, water damage and moisture loss for the curing period.

All concrete surfaces consisting of Class C or D concrete shall be wet cured. The Contractor shall cover the concrete surface(s) with two layers of clean Nilex 4504 white coloured filter fabric or an equivalent acceptable to the Department as soon as the surface will not be marred by so doing. The filter fabric shall be kept continuously wet for 72 hours. Where the formwork is left in place for 72 hours or more, no additional curing will be required. Curing compounds shall not be used on any concrete surface other than concrete slope protection.

During the cure period the Contractor shall provide protection to ensure that the temperature of the centre of the in-situ concrete shall not fall below 10 degrees Celsius or exceed 70 degrees Celsius and the temperature difference between the centre and the surface shall not exceed 20

degrees Celsius. In addition, the requirements of Table 20 of CSA A23.1 shall apply. When a concrete element has a minimum dimension of 1.5 metres, the Contractor shall supply and install two thermocouples, one in the centre and one at the surface of the concrete for every 50 cubic metres of concrete. The Contractor shall monitor and record the temperatures every four hours for the first 72 hours after concrete placement and every 8 hours thereafter for the remainder of the specified cure period. If requested by the Department, the Contractor shall provide temperature records to the Department within 36 hours of the request.

300.5.7.15.2 Curing Requirements for Concrete Slope Protection

In addition to the general curing requirements, the following shall apply:

Concrete slope protection shall receive two coats of a “Type 2” curing compound meeting the requirements of ASTM C309 (or ASTM C1315). The first coat is to be applied immediately after the concrete has been satisfactorily finished, and the second coat is to be applied within three hours after the application of the first coat. Each application shall be at the rate specified by the manufacturer.

300.5.7.15.3 Curing Requirements for Class HPC Concrete and Class HPC Concrete with Steel Fibres

In addition to the general curing requirements, the following shall apply:

The Contractor shall prepare a procedure for the wet cure of class HPC concrete and class HPC concrete with steel fibres acceptable to the Department. Details shall include information with regards to the type and description of equipment and materials to be used, and the work methods/techniques employed to carry out the work. The wet cure procedure shall be prepared two weeks prior to the placement of class HPC concrete or class HPC concrete with steel fibres.

During the cure period the Contractor shall provide protection to ensure that the temperature of the centre of the in-situ concrete does not fall below 10 degrees Celsius or exceed 60 degrees Celsius and the temperature difference between the centre and the surface does not exceed 20 degrees Celsius. In addition, the requirements of Table 20 of CSA A23.1 shall apply. The Contractor shall supply and install two thermocouples, one in the centre and one at the surface of the concrete, for every 100 square metres of deck. The Contractor shall monitor and record the temperatures every four hours for the first 72 hrs after concrete placement and every 8 hours thereafter for the remainder of the specified cure period. If requested by the Department, the Contractor shall provide temperature records to the Department within 36 hours of the request.

Immediately after final bull floating and/or surface texturing an evaporation reducer, such as “Confilm” manufactured by BASF or an equivalent acceptable to the Department, having a monomolecular film forming compound intended for application to fresh concrete for temporary protection against moisture loss, shall be applied by a hand sprayer with a misting nozzle at the manufacturer’s recommended concentration and application rate.

Two layers of white filter fabric, Nilex 4504 or an equivalent acceptable to the Department, shall be placed on the concrete surface as soon as the surface will not be marred by its installation. The fabric shall be pre-wet or a fine spray of clean water immediately applied once placed. Edges of the filter fabric shall overlap a minimum of 150 mm and be held in place without marring the surface of the concrete. The filter fabric shall be kept in a continuously wet condition throughout the curing period by means of soaker hoses or other means. The use of polyethylene

sheeting above the two layers of filter fabric to reduce moisture loss will only be permitted if the sheeting is manufactured with regular perforations to permit the adequate application of curing water from above and reduce the heat generated by greenhouse effects.

Wet curing shall be maintained for a minimum period of 14 days. When concreting in cold the 14 day wet cure shall be followed by 3 days of air drying.

Where formwork is removed prior to the completion of the specified curing period, the resulting exposed concrete surfaces shall be wet cured for the remaining days.

Curb and barrier formwork shall be removed such that the concrete is not damaged by removal operations, but no later than 72 hours after concrete placement. Wet curing of the concrete surfaces exposed after formwork removal, shall commence immediately after formwork removal.

In the event that curing is unacceptable, or any portion of the HPC or HPC concrete with steel fibres becomes surface dry during the curing period, the Department may find the concrete unacceptable and it shall be replaced or repaired in a manner acceptable to the Department in advance and in writing.

300.5.7.15.4 Repairing Concrete Defects

Honeycomb, cavities, cracking, spalls, chips, and any other casting or construction defects shall be repaired. Repair procedures shall be developed by the Contractor and submitted for review and written acceptance by the Department prior to the commencement of the repair.

(a) Honeycomb, Cavities, Casting Defects

Honeycomb, cavities and other deficiencies are defined as those areas that are greater than 30 millimetres in depth or 0.05 square metres in area. Defects less than 30 millimetres in depth or 0.05 square metres in area shall be repaired in accordance with Section 300.5.7.16.3 (Class 2. Rubbed Surface Finish).

As a minimum, the Contractor's repair procedure shall include removing and replacing the defective concrete with the originally specified class of concrete. Repair extents shall be saw cut 25 millimetres deep in neat perpendicular lines and concrete removed to a depth of 35 mm below reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hrs prior to concrete placement. Repair areas shall be free of standing water and surface dry immediately prior to concrete placement. Curing shall be in accordance with the requirements for the class of concrete.

Formwork misalignment for highly visible elements, including medians, curbs, barriers, exterior deck fascia, pier shafts, and exterior faces of wingwalls shall be such that when checked with a 1.2 metre long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 millimetres between the bottom of the straight edge and the concrete surface. The gap for formwork misalignment of all other elements shall not be greater than 5 millimetres. Concrete elements with formwork misalignments exceeding the allowable tolerances shall be repaired or replaced as determined by the Department.

(b) Cracks

For class HPC and HPC with steel fibres the Contractor shall inspect and identify all cracks

after the curing period. The Contractor shall plot the width in millimetres and length in linear meters of cracks and report the findings to the Department. The Contractor shall complete all required crack repairs prior to Deck Waterproofing Systems.

The Contractor shall repair cracks with widths greater than or equal to 0.2 millimetres using the following procedure:

- (i) Clean and dry cracks with oil-free compressed air.
- (ii) Seal cracks with a gravity flow concrete crack filler in accordance with the manufacturer's recommendations. The crack filler shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, viscosity and pot life of the material. The crack filler shall be chosen from the Alberta Transportation Product List/Crack Treatment/Concrete Crack filler/Proven Products and have a viscosity less than 105 centipoises ("cP").
- (iii) When cracks extend the full depth of the deck slab, barriers or curbs or extend partial depth of decks that are cast to grade, epoxy injection will be required. The epoxy resin shall meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C and have a viscosity less than 500 cP. An injection procedure shall be submitted by the Contractor to the Department for review and acceptance prior to commencing repairs.

For all other classes of concrete, cracks 0.3 mm or greater in width, shall be repaired by epoxy injection in accordance with the manufacturer's recommendations. The epoxy for crack injection shall meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C. The viscosity shall not exceed 500 cP.

300.5.7.16 Concrete Surface Finish

300.5.7.16.1 General

On exposed concrete surfaces to 600 mm below grade or, in the case of river piers, 600 mm below lowest water level, surface finishes shall be applied as follows:

Class 1 Ordinary Surface Finish

- All exposed concrete surfaces unless other finishes are specified; and
- Top surfaces of pile caps, abutment seats, pier caps, curbs and barriers.

Class 2 Rubbed Surface Finish

- Piers except grade separation piers;
- Traffic side surfaces of curb, barrier, median and sidewalk; and
- Cast-in-place concrete girders except exterior vertical fascia.

Class 3 Bonded Concrete Surface Finish

- Abutment seats except top surface;
- Exterior faces of curtain walls/wingwalls;
- Cast-in-place walls, MSE precast concrete fascia panels, and wall copings;
- Grade separation piers except top surfaces;

- Exterior concrete girder faces;
- Exposed end surfaces of cast-in-place concrete diaphragms;
- Underside of the deck overhang to top flange of girder; and
- Exterior surfaces of deck slab, curb, barrier and sidewalk.

Class 4 Floated Surface Finish

- Top surfaces of concrete deck and roof slabs which are to receive waterproofing membranes and wearing surfaces.

Class 5 Floated Surface Finish, Broomed Texture

- Top surfaces of sidewalks, medians and pedestrian bridge decks without a deck protection system;
- Concrete slope protection; and
- Deck joint blockout concrete top surfaces.

Class 6 Floated Surface Finish, Surface Textured

- Top surfaces of deck, deck overlay, roof and approach slabs which will not be covered with either waterproofing membrane or wearing surface.

Wood or magnesium tools shall be used for finishing concrete. Finishing aids are not permitted during concrete finishing.

300.5.7.16.2 Class 1. Ordinary Surface Finish

Unformed Surfaces - Immediately following placing and consolidation, the concrete shall be screeded to conform to the required surface elevations, and then trowelled to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions.

Concrete surfaces shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface unless otherwise specified.

Formed Surfaces - Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces. On all surfaces the cavities produced by form ties, and all other holes, shall be thoroughly chipped out, cleaned, and shall be filled with a concrete patching material that is an Approved Product. The repair material shall be appropriate for the intended application and be placed in accordance with the manufacturer's published product data sheet. All repairs shall be wet cured for a minimum of 72 hours. Curing compounds are not permitted.

300.5.7.16.3 Class 2. Rubbed Surface Finish

Immediately following the removal of forms, all concrete fins and irregular projections shall be removed and concrete surfaces inspected for compliance with Section 300.5.7.15.4 (a) (Repairing Concrete Defects). After review, all surfaces shall be thoroughly exposed by diamond grinding wheels or similar tools. Surface voids greater than 19 mm diameter but less than 0.05 m² in area or 30 mm deep shall be filled with a concrete patching material that is an Approved Product in the Overhead/Vertical (OH-V) category and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be placed

over the entire prepared surface in accordance with the manufacturer's recommendations. Both sack rub and patching materials shall be wet cured for a minimum of 72 hours. When patching and sack rub materials have adequately hardened, a carborundum stone or an equivalent method acceptable to the Department shall be used to finish the surface to a smooth, uniform and closed texture. Any voids opened during the stone rubbing process shall be refilled. Parging or surface patching to correct irregularities will not be permitted.

Concrete surfaces shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface unless otherwise specified.

All prepared concrete surfaces, including all patching and sack rubbing shall be uniform in colour and texture. All portions of bridge elements, including those cast in more than one pour, shall be of the same colour and texture. Any staining caused by cement, water, weather, or other conditions shall be prevented, removed, or covered. After the surface preparation has been completed the Contractor shall apply a sealer as specified in Section 300.5.7.17 (Type 1c Sealer).

300.5.7.16.4 Class 3. Bonded Concrete Surface Finish

Surface preparation shall be done as is specified for Section 300.5.7.16.3 (Class 2. Rubbed Surface Finish), except that uniformity in colour and Type 1c Sealer application are not required.

After the surface preparation has been completed, the concrete surfaces shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours and before becoming contaminated with dust or other bond breaking materials, the Contractor shall apply an approved pigmented concrete sealer that meets the requirements for a Type 3 sealer of Alberta Transportation's *"Material Testing Specifications for Concrete Sealers"* (B388).

The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications and as a minimum two applications totalling the Department approved application rate of the pigmented sealer are required. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible, and shall match the colour of any previously painted adjoining surfaces. Acceptance of the pigmented sealer used will not relieve the Contractor of full responsibility for its acceptable appearance.

300.5.7.16.5 Class 4. Floated Surface Finish

Unless otherwise noted on the Detailed Designs, concrete surfaces receiving deck waterproofing shall be manually floated with a magnesium bull float and trowelled as necessary to provide a smooth surface.

Concrete surfaces shall meet the requirements of Section 300.5.7.11.8 (Surface Defects and Tolerances).

300.5.7.16.6 Class 5. Floated Surface Finish, Broomed Texture

The concrete surface shall be floated and trowelled as necessary to produce a smooth surface. The surface shall not vary more than 3 mm under a 3 m long straightedge.

After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of 2 mm. An edging

tool shall be used at all edges and control joints. Sidewalk control joints shall be installed at all curb/barrier control joints using an acceptable grooving tool.

300.5.7.16.7 Class 6. Floated Finish, Surface Textured

After the concrete has been manually bull floated, it shall be given texture with a “flat wire” texture broom having a single row of tines. The texture shall be transverse grooving which may vary from 1.5 mm width at 10 mm centres to 5 mm width at 20 mm centres, with a groove depth of 3 mm to 5 mm. This work shall be done at such time and in such manner that the texture is achieved while minimizing the displacement of coarse aggregates or steel fibres. The textured surface shall be uniform over the entire concrete surface.

Following the surface texturing, a 300 mm width of concrete surface adjacent to the curb, barrier or median shall be trowelled smooth and the surface left closed.

Concrete surfaces shall meet the requirements of Section 300.5.7.11.8 (Surface Defects and Tolerances).

300.5.7.16.8 Concrete Finishing Under Bearings

Concrete on which bearing plates, pads or shims are to be placed shall be finished or ground to a smooth and even surface. When checked with a straight edge placed anywhere in any direction on the concrete surface, there shall not be any gap greater than 1 mm between the bottom of the straight edge and the concrete surface.

Air voids created by forming grout pad recesses shall be filled with a concrete patching material that is an Approved Product in the Normal Horizontal category and placed in accordance with the manufacturer’s published product data sheet a minimum of 7 days in advance of girder erection. Concrete patching materials shall be wet cured for a minimum of 72 hours. Curing compounds are not permitted. In cold weather conditions this work shall be completed while the substrate concrete is at or above 5 degrees Celsius. If the filling of air voids does not occur while the substrate concrete is at or above 5 degrees Celsius it shall be carried out in accordance with Section 300.5.7.13 (Concreting in Cold Weather).

300.5.7.17 Type 1c Sealer

Type 1c sealer shall meet the Department’s “*Material Testing Specifications for Concrete Sealers*” (B388).

Type 1c sealer shall be applied to all concrete surfaces which are to receive a Class 2, Class 5, and Class 6 surface finish. This shall include all concrete surfaces to 600 mm below grade, or in the case of river piers 600 mm below lowest water level. Surfaces that are to receive a waterproofing membrane shall not have sealer applied. Sealer will not be required on the underside of bridge decks or on concrete diaphragms in the interior bay areas; however, the faces of the end diaphragms nearest the abutment backwalls, inside faces of backwalls and top surface of abutment seats, excluding bearing recess pockets shall be sealed.

The sealer shall be applied in accordance with the manufacturer's recommendations; however, the application rate shall be increased by 30% from that indicated on the “Products List” posted to the Department’s website. Before applying the sealer the concrete shall be cured for at least 28 days. The concrete surface shall be dry, and air blasted to remove all dust prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply

measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of two coats. Asphalt concrete pavement surfaces and other elements shall be adequately protected from overspray and runoff during sealer application.

300.5.7.18 Concrete Strength Requirements

The Contractor shall monitor all concrete strength and quality control test results and provide a monthly summary for review by the Department.

Concrete with Strength Test Results shown below shall be removed:

- Class D and Pile concrete less than 24 MPa
- Class C concrete less than 27 MPa
- Class HPC and HPC with steel fibres concrete less than 40 MPa
- Class S concrete less than 16 MPa

The Department reserves the right to reject any concrete whatsoever which does not meet all the requirements for that class of concrete as stated in Section 300.5.7.5 (Class and Composition of Concrete). However, provided that the Design Engineer is of the opinion that the low strength concrete will meet all performance requirements throughout the design life of the New Infrastructure, the Department may, at its sole discretion, accept concrete the strength of which falls below the specified strength requirements.

Payment Adjustments will be made in accordance with the following:

300.5.7.18.1 Class D Concrete, Pile Concrete, 30 MPa

Strength Test Results

29 MPa to 30 MPa	\$30 per cubic metre
28 MPa to 29 MPa	\$60 per cubic metre
27 MPa to 28 MPa	\$90 per cubic metre
26 MPa to 27 MPa	\$120 per cubic metre
25 MPa to 26 MPa	\$160 per cubic metre
24 MPa to 25 MPa	\$220 per cubic metre

300.5.7.18.2 Class C Concrete, 35 MPa

Strength Test Results

34 MPa to 35 MPa	\$30 per cubic metre
33 MPa to 34 MPa	\$60 per cubic metre
32 MPa to 33 MPa	\$90 per cubic metre
31 MPa to 32 MPa	\$120 per cubic metre
30 MPa to 31 MPa	\$160 per cubic metre
29 MPa to 30 MPa	\$220 per cubic metre
28 MPa to 29 MPa	\$300 per cubic metre

27 MPa to 28 MPa \$400 per cubic metre

300.5.7.18.3 Class HPC Concrete, 45 MPa

Strength Test Results

44 MPa to 45 MPa \$40 per cubic metre

43 MPa to 44 MPa \$100 per cubic metre

42 MPa to 43 MPa \$180 per cubic metre

41 MPa to 42 MPa \$280 per cubic metre

40 MPa to 41 MPa \$400 per cubic metre

300.5.7.18.4 Class S Concrete, 20 MPa

Strength Test Results

18 MPa to 20 MPa \$30 per cubic metre

16 MPa to 18 MPa \$70 per cubic metre

The Payment Adjustments for all classes of concrete shall apply to the volume of concrete represented by the Strength Test as defined in Section 300.5.7.7.1 (Strength Tests).

300.5.7.18.5 Coring for Compressive Strength Testing

Coring to confirm or contest low concrete Strength Test results shall be subject to review and acceptance by the Department. When coring is accepted by the Department, arrangements shall be made by the Contractor, to employ an independent CSA Category 1 or higher level certified testing laboratory, all at the expense of the Contractor. The independent laboratory shall not be employed to perform any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or the fabricator. The cores shall be taken and tested within seven days of the testing of the 28-day cylinders representing the concrete in question. Where practical, three 100 mm diameter cores shall be taken for each non-compliant Strength Test previously taken, and there shall be no doubt that the cores taken and the cylinders under consideration, represent the same batch of concrete. Cores may not be taken unless the Department is present. Cores shall be tested by an independent CSA certified Category 1 or higher level testing laboratory and in accordance with the requirements of CSA Standard A23.2-14C. CSA Standard A23.1-09, Clause 4.4.6.6.2 (Cores Drilled from a Structure) shall not apply. The average strength of each set of three cores shall be equal to or greater than the 28-day specified strength. The average strength of the cores as reported by the independent testing service shall constitute a test.

In cases where the concrete strength, as indicated by the cores, is higher than the strength based on the concrete cylinder results, the core results shall be used as the basis for acceptance of the concrete. If the core strengths are lower than the strength from the concrete cylinder tests, the cylinder tests shall govern.

The average strength of each set of three cores shall be equal to or greater than the 28-day specified strength. CSA A23.1-09 Clause 4.4.6.6.2 "Cores Drilled from a Structure" does not apply.

300.5.8 STRUCTURAL STEEL**300.5.8.1 General**

This Section 300.5.8 is for the supply, fabrication, delivery and erection of structural steel. Structural steel shall include steel girders, trusses, diaphragms, bracing, splice plates, deck drains, anchor rods, dowels, deck joint assemblies, buffer angles, connector angles, anchor rod sleeves, curb and median cover and trough plates, pier nose plates, pier bracing, bridgerails, handrails, safety rails and miscellaneous components.

300.5.8.2 Submissions

The following information shall be submitted to the Department reasonably in advance of the design and construction process and in any event within the times noted below. In the event that the Department requests any of the following information, the requested information shall be provided within seven days, notwithstanding the times noted below.

- As part of the plant's quality management plan, the following items shall be submitted to the Department at least four weeks prior to start of fabrication:
 - Plant certification;
 - List of equipment;
 - Welding procedures, including welding procedure datasheets for all welds;
 - Qualification of welding engineer;
 - Certification of welding supervisor;
 - Repair procedures for the following items prepared by a Professional Engineer:
 - Damaged base metal;
 - Girder camber correction, flame straightening, web panning and sweep;
 - Unsatisfactory weldments and accidental arc strikes;
 - Damaged galvanizing;
 - Procedure for heat curving, when required in the Detailed Designs. It shall include temperatures and applied pressures prepared by a Professional Engineer;
 - Fabrication procedures including witness points;
 - Inspection forms and reporting details. It shall include visual inspection and non-destructive testing of all components, dimensional checks and traceability of material;
 - Welder's certification;
 - Independent welding inspector's certification;
 - Independent non-destructive testing inspector's certification;
 - Quality control procedures;
- Welding procedures, including welding procedure datasheets for all welds specific to each structure for all welds (at least seven days prior to fabrication);
- Shop drawings including girder and bracing layout drawing reviewed by the Design Engineer (at least seven days prior to fabrication);
- Mill test reports for all material (within 5 days of delivery of material at the plant);
- Product data sheets for all material;
- All results from Testing and Inspection (Section 300.5.8.4.4), i.e. independent

- inspection reports and final independent inspection report;
- Erection procedures, including drawings for falsework, berms and traffic accommodation prepared by a Professional Engineer (at least 14 days prior to erection); and
- Procedures for straightening bent or repairing damaged material during transportation or erection, if required.

300.5.8.3 Supply and Fabrication

300.5.8.3.1 Standards

Fabrication of structural steel shall conform to AASHTO LFRD Bridge Construction Specifications and the American Welding Society (AWS) - Bridge Welding Code, D1.5.

All welding, cutting and preparation shall be in accordance with the AWS - Bridge Welding Code, D1.5. The fabrication of steel structures composed of structural tubing shall be in accordance with the American Welding Society (AWS) – Structural Welding Code D1.1

300.5.8.3.2 Qualification

The Contractor shall be responsible for the work of all subcontractors.

The fabricator shall operate a recognized steel fabricating shop and be fully approved by the CWB as per Canadian Standards Association (CSA) Standard W47.1 in the following Divisions:

- Fabrication of steel girders, girder components and welded steel trusses – Division 1;
- All other bridge components – Division 1 or Division 2;
- Field welding/repairs – Division 1 or Division 2.

In addition, fabricators of steel girders, girder components and welded steel trusses shall be certified by the Canadian Institute of Steel Construction (CISC) as meeting the quality compliance requirements in the category of steel bridges.

Only welders, welding operators and tackers approved by the CWB in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for auditing by the Department.

300.5.8.3.3 Engineering Data

(1) Welding Procedures

Welding procedures, including welding procedure datasheets shall be prepared for each type of weld used in the structure. The procedures shall bear the approval of the CWB and shall also be submitted for review and written acceptance by the Department prior to use on the structure.

(2) Shop Drawings

Shop drawings showing all details shall be prepared by the Contractor.

In addition to specific details, the shop drawings shall include the following:

- (a) All dimensions shall be correct at 20 degrees Celsius unless otherwise noted;
- (b) Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;

- (c) All material splice locations shall be shown on the drawings;
- (d) Bearings shall be centred at -5 degrees Celsius;
- (e) Shop assembly drawings shall indicate camber and splice joint offsets measured to the top of top flange at a maximum spacing of 4 m;
- (f) The hardware and stud shear connector sizes shown on the shop drawings shall be in the actual units (Imperial or Metric) the material is supplied; and
- (g) The Department's bridge file number and project name shall be shown on all the shop drawings.

(3) List of equipment

Prior to commencement of fabrication, the Contractor shall provide details of equipment which will be used for the fabrication. If any equipment causes repeated defective work it shall be substituted with a suitable alternative.

(4) Mill Test Reports and Product Data Sheets

Mill test reports (MTR) and product data sheets for all material shall be submitted to the Department within 5 days of delivery of material at the plant. If material cannot be identified by mill test reports, coupons shall be taken and tested at a Canadian certified laboratory noted below and these test reports shall be made available to the Department. Mill test reports and product data sheets shall be legible and in English.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test report. The mill test report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the Technical Requirements.

(5) Material Traceability

A list of all material except hardware shall be provided for each structure showing the component designation from the shop drawings and the associated mill test report heat numbers. The structure number shall be noted on the hardware mill test reports.

300.5.8.4 Materials

(1) Structural Steel

Structural steel shall conform to the standard noted on the Detailed Designs. Interpretation of equivalent steels will be as per Appendix "A" of the CSA Standard G40.21 (1976 only). Mill test reports and results of impact tests shall be obtained prior to shipment of material from the mill to provide sufficient time for replacement or for heat treating of material that does not meet the Technical Requirements.

Repair of steel plated or rolled shapes by welding at the producing mill is not permitted.

All steel for bridgerail shall conform to the standard noted on the Detailed Designs. The silicon content for various bridgerail and handrail components shall be as follows:

- structural tubing less than 0.04%
- structural sections, handrail bars, base plate less than 0.04% or between 0.15%

to 0.25%.

(2) Bolts

All bolts shall conform to ASTM Standard F3125, Grade A325/A325M. Nuts shall be heavy hex style and conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M. The Contractor shall provide certified mill test reports for the fastener material to the Department.

(3) Stud Shear Connectors

All stud shear connectors shall conform to the chemical requirements of ASTM Standard A108, Grades 1015, 1018 or 1020. In addition they shall meet the mechanical properties specified in AWS D1.5, Table 7.1 for Type B studs. The Contractor shall provide certified mill test reports for the stud material.

(4) Bridge Bearings

Bearings shall be in accordance with Section 300.5.18 (Bridge Bearings).

300.5.8.4.1 Welding

(1) Filler Metals and Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas processes, are not considered as conforming to low hydrogen practice, and will not be permitted.

(a) Submerged Arc Welding (“SAW”)

Submerged arc welding process is allowed for all flat and horizontal position welds. All flange and web butt joints shall be made by an approved semi or fully automatic submerged arc process. All web to flange fillet welds and all longitudinal stiffener to web fillet welds shall be made by an approved fully automatic submerged arc process.

(b) Shielded Metal Arc Welding (“SMAW”)

Shielded metal arc welding is allowed for girder vertical stiffener to flange fillet welds and for miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles. SMAW filler metal shall have AWS designation of H4.

(c) Metal Core Arc Welding (“MCAW”)

Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed for vertical stiffeners and horizontal gussets of the girders, bridgerails, handrails and miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles.

Field application of metal core arc welding is not allowed.

(2) Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

(3) Intentionally Deleted

(4) Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. Tack welds shall be sufficiently ground out prior to final weld in order to obtain a uniform weld bead. Cracked tack welds shall be completely removed prior to re-welding.

(5) Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of tabs shall replicate the joint detail being welded and shall be a minimum of 100mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

(6) Preheat and Interpass Temperatures

Preheat and interpass temperatures requirements shall be as per AWS D1.5, except that all welds on girder flanges shall be preheated to a minimum temperature of 100 degrees Celsius unless a higher temperature is required by AWS D1.5 for the flange thickness. The preheat temperature of the web to flange joint shall be measured 75 mm from the point of welding on the side of the flange opposite to the side where the weld is being applied.

(7) Welding at Stiffener Ends

To prevent notching effects, stiffeners and attachments fillet welded to structural members shall have the fillet welds terminate 10 mm short of edges.

(8) Submission of Repair Procedures

Repair procedures for damaged base metal and unsatisfactory weldments shall be prepared by an experienced welding engineer registered as a Professional Engineer and submitted to the Department for review and acceptance prior to repair work commencing.

(9) Arc Strikes

Arc strikes will not be permitted. In the event of an isolated accidental arc strike a repair procedure shall be prepared by an experienced welding engineer registered as a Professional Engineer and shall be submitted to the Department for review and acceptance. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. The procedure shall also include MPI and hardness testing of the affected area. The hardness for the repaired areas shall be as specified in Section 300.5.8.4.4 (12) (Hardness Test).

(10) Repairs and Grinding of Welds

Repaired welds shall be blended to the same contour and throat dimensions as the remaining sound weld.

Flange groove welds shall be ground flush or to a specified slope on both sides. Web groove welds which are sufficiently smooth with a neat appearance and uniform profile, as determined by the Contractor's independent welding inspector but subject to the Department's review, will not require grinding. Fillet welds shall be continuous with uniform size and profile. Locations which are not conforming to acceptable profile shall be ground to the proper profile without

damaging of the base metal. Grinding shall be smooth and parallel to the line of stress. Over grinding that results in reduced thickness of the base metal or size of the weld shall not be permitted.

(11) Plug and Slot Welds

Plug welds or slot welds shall not be permitted.

(12) Field Cutting, Drilling and Welding

Where field cutting, drilling and welding of structural members is carried out, the following requirements shall be met:

- (a) All welding, cutting and preparation shall be in accordance with the American Welding Society (“AWS”) - Bridge Welding Code, D1.5.
- (b) Only welders approved by the Canadian Welding Bureau in the particular category shall be permitted to perform weldments.
- (c) Welding procedures approved by the Canadian Welding Bureau shall be prepared and submitted for review by the Department prior to use on the structure.
- (d) Low hydrogen filler, fluxes and welding practices shall be used in accordance with Section 300.5.8.4.1(1) (Filler Metals & Welding Processes).
- (e) When the air temperature is below 10 degrees Celsius, all material to be welded shall be preheated to 100 degrees Celsius for a distance of 80 mm beyond the weld and shall be sheltered from the wind.
- (f) When the air temperature is below 0 degrees Celsius, welding shall not be permitted unless suitable hoarding and heating is provided. The air temperature inside the enclosure shall be a minimum of 10 degrees Celsius. If the steel temperature is less than 10 degrees Celsius, preheat as in (e) above.
- (g) All field welds of structural members shall be visually inspected by an independent welding inspector certified to Level 3 of CSA W178.2 as specified in Section 300.5.8.4.4(4) (Independent Inspection, Testing and Reporting by the Contractor).

Where field welding of non-structural members is carried out, the following requirements shall be met:

- (h) Journeyman welders with Class B tickets shall be permitted to perform weldments.
- (i) Welding procedures prepared and stamped by a Professional Engineer shall be prepared.
- (j) Low hydrogen filler, fluxes and welding practice shall be used in accordance with Section 300.5.8.4.1 (1) (Filler Metals & Welding Processes).
- (k) When the air temperature is below 5 degrees Celsius, all material to be welded shall be preheated to 100 degrees Celsius for a distance of 80 mm beyond the weld and shall be sheltered from the wind.

- (l) When the air temperature is below 0 degrees Celsius, welding shall not be permitted unless suitable hoarding and heating, is provided.

Structural field welds are welds that are required to maintain the integrity of the structure. An example of non-structural member would be field welding of Type 1 strip seal deck joint splices and culvert struts.

(13) Welding to Girder Flanges and Webs

With the exception of longitudinal web to flange welds, all stiffener, gusset plate, or any other detail material welds to girder flanges shall be a minimum of 300 mm from the flange groove welds. Stud shear connectors shall not be welded on top of flange welded splices.

With the exception of longitudinal web to flange welds and longitudinal stiffener to web welds, all stiffener, gusset plate, or any other detail material welds to girder webs shall be a minimum of 300 mm from the web groove welds.

300.5.8.4.2 Fabrication

Fabrication shall be performed in a fully enclosed area which is adequately heated. The shop temperature shall be at least 10 degrees Celsius.

Pre-fabrication Meeting

A pre-fabrication meeting is required prior to commencement of fabrication of steel girders or any other steel superstructure, deck joints, and bridgerail. The meeting will be held at fabricator's plant and the Contractor shall ensure the Field Review Engineer, plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Field Review Engineer will conduct this meeting after the shop drawings and welding procedures have been reviewed. The Contractor shall provide two week's notice to the Department prior to the meeting.

(1) Heat Number Transfer

As the plate is subdivided for webs and flanges, all heat numbers shall be transferred to each individual section. The numbers shall remain legible until such time as the material location in the final assembly has been recorded. Mill identification numbers stamped into the material shall be removed by grinding at an appropriate time.

(2) Marking Systems

Steel stamps shall not be used. The only exception is the match marking of splice plates which may be steel stamped using low stress stamps. The stamps and specific locations of such stamps must be shown on the shop drawings.

(3) Cutting of Plate

All plate material for main members, splice plates and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed.

(4) Flange Stripping

All flange material shall be cut so that the direction of the applied stress will be parallel to the direction of the plate rolling.

(5) Flame Cut Edges

The flame cut edges of girder flanges shall have a maximum Brinell hardness as stated by Section 300.5.8.4.4 (12) (Hardness Tests). The surface roughness of the flame cut edge shall not be greater than ANSI B46.1 500 $\mu\text{in.}$ (12.5 μm) and be such that to allow Brinell hardness testing without spot grinding. The Contractor shall report all blow backs or signs of lamination observed during the cutting of the material. The Contractor will perform Brinell hardness tests on the as is flame cut edge. If the hardness exceeds the requirements, the Contractor shall submit to the Department for review and written acceptance the Contractor's procedures for repairing the edges to meet the Technical Requirements.

The surface of flame cut apertures shall be finished by grinding and shall be free of nicks and gouges.

In case of plate lamination or any discontinuity detected on plate cut edges for tension members, the Contractor shall arrange for a CAN/CSA 178.1 certified NDT company to determine the extent. The ultrasonic testing technician shall be certified to Level II of CGSB. The damage inspection report and repair procedure shall be prepared by a Professional Engineer indicating the material is suitable for the girder fabrication and shall be forwarded to the Department for review and written acceptance of the material.

(6) Vertical Alignment

The structure shall be fabricated to conform to the requirements of the deflection and vertical curve, as noted on the Detailed Designs. For rolled shapes, advantage shall be taken of mill camber that may be inherent in the material.

(7) Shop Assembly

(a) Plate Girders

Shop assembly of girders shall be by the progressive assembly method according to AASHTO, LFRD Bridge Construction Specifications except that only two, instead of three, sections need to be assembled. The submitted fabrication procedure shall include a detailed method of assembly, including points of support, dimensional checks, method of trimming to length, drilling and marking of splices, shall be to the procedure prepared as per Section 300.5.8.2 (Submissions). Each individual girder section shall meet the camber requirements for that particular length, with the splices between these sections falling on the theoretical camber line for the entire span. Correction for variation in flange thickness must be considered. When the camber of the girder fails to meet the required tolerance, the Contractor shall develop a method of repair prior to commencement of repair. The camber of each individual girder section must be known for the next two girder sections in the girder line prior to shop assembly of any particular girder section. This is to allow the use of a best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange. The camber of plate girders shall be measured in the "no load" condition.

(b) Box Girders

The progressive shop assembly for box girders shall be as per Section 300.5.8.4.2(7) (a) (Plate Girders); items described in this section are specific to box girders.

The camber of box girders shall be measured on the top of the top flange, and each top flange of a box shall individually meet the required camber. Girder sections assembled for splicing shall be supported within 2 m of the end of each section. Girder sections shall be

supported in such a manner as to provide the correct angular relationship at the splice between girder sections while the splices are being reamed or drilled. Shop drawings shall clearly indicate the expected dead load deflection of each section and the elevations of the sections while supported for the drilling or reaming of each splice.

(c) Drilling

All splices shall be drilled from solid material while assembled or shall be sub-punched or sub-drilled and then reamed to full size while in the shop assembly position.

(8) Splice Plates

After shop assembly, splice plates and girders shall be clearly match marked to assure proper orientation and location of splice material for erection. All holes shall align with holes in the attached member. Splice plates shall then be removed, de-burred, solvent cleaned to remove all oil and sandblasted to remove all mill scale in order to provide a suitable faying surface. These plates shall then be securely ship-bolted to the girders. The match marking system shall be shown on the shop drawings.

(9) Bolt Holes

Clause 11.4.8 in AASHTO *LFRD Bridge Construction Specifications* shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or sub-punched 5 mm smaller and reamed to full size. Punching of full size holes for secondary members such as some bracings which are not welded to main member is allowed for material less than 16 mm thick. Punching of full size holes in bracings for kinked or curved girder bridges shall not be allowed. All holes in girder splices and structural members shall be circular and perpendicular to the member. The plasma arc cutting shall only be allowed for slotted holes provided there are no gouges. All holes shall be deburred to ensure a proper faying surface.

(10) Dimensional Tolerances

Normal tolerance for structural steel fabrication and fitting between hole groups will be ± 3 mm unless specified otherwise. The dimensional tolerances for structural members shall be within the AWS Standard D1.5, section 3.5, except as otherwise noted below:

(a) Girder Camber

Camber of beams and girders shall be uniform, true and accurate to the centreline of the top flange. Permissible variation in camber shall be within $\pm (0.2L_t + 3)$ mm; where L_t is the test length in metres. This applies to fabricated pieces only, prior to shop assembly. During shop assembly, splice points shall be located on the theoretical camber line or at a specified amount from the line.

Where field splices are eliminated by combining girder segments into longer girder lengths, the cambers of the girders at the eliminated splice points shall be within ± 3 mm.

(b) Box Girders

Tolerances for box girder camber, sweep and depth shall be measured relative to two imaginary surfaces: a vertical plane passing through the centre line of the girder; and a surface located at the theoretical underside of the top flanges following the theoretical camber of the girder.

(c) Splices

Fill plates shall not be permitted at main girder field splices unless specified. The tolerance

for girder depth or box girder geometry shall be as specified by AWS D1.5, except that the difference between similar dimensions of the adjoining sections being spliced shall not exceed ± 3 mm.

(d) Splice Gap Between Adjacent Girder Ends

At field splice locations, the gap between adjacent girder ends shall be within 10 ± 3 mm.

(e) Fitted Stiffeners

The bearing ends of bearing stiffeners shall be flush and square with the web and shall have at least 75% of this area in contact with the flanges, whereas fitted stiffeners may have a gap of up to 1 mm between stiffener and flange.

(f) Facing of Flanges

Surfaces of flanges which are in contact with bearing sole plates shall have a flatness tolerance of $0.001 \times$ bearing dimension.

(g) Bearing to Bearing Dimension

Bearing to bearing distance is a set dimension and therefore has no tolerance.

(h) Deck Joint Assemblies

Deck joint assemblies shall be assembled for inspection in a relaxed condition with erection and shipping angles removed. Written acceptance of the assembly by the independent welding inspector and the Department is required prior to application of the shipping and erection angles. Tolerances for straightness shall be considered over the length of the assembly between the crown and gutter line both before and after galvanizing. Deviation from straightness in a vertical plane shall not exceed ± 5 mm. Horizontal sweep shall not be greater than 6 mm. Additional tolerances are listed on the Standard Drawings in Appendix B. All tolerances shall be met after fabrication and after field installation. The Contractor shall provide tolerance measurements to the Department.

(i) Combined Warpage and Tilt

Combined warpage and tilt of flange at any cross section of welded I-shape beams or girders shall be determined by measuring the offset at the toe of the flange from a line normal to the plane of web through the intersection of the centerline of the web with the outside surface of the flange plate. This offset shall not exceed $1/200$ of the total width of the flange or 3 mm whichever is greater at bolted splice location. Bolted splices of main stress carrying members shall have parallel planes and the surfaces shall be in full contact without any gap.

(11) Corner Chamfer

Corners of all flanges shall be ground to a 2 mm chamfer. Corners of stiffeners, structural sections and plates shall be ground to a 1 mm chamfer.

(12) Milling Tolerances

Tolerance for milled to bear stiffeners shall be 0.05 mm with at least 75% of the area in bearing.

(13) Web Panning

The maximum variation from flatness for webs shall be $0.01d$ where d is the least dimension of the panel formed by the girder flanges and/or stiffeners. Should the panning in one panel be convex and the panning in the adjacent panel be concave then the sum of the panning in the two adjacent sections shall not exceed that allowed for one panel. Localized deformation in the web shall not exceed 3 mm in 1 m.

(14) Flame Straightening and Heat Curving

Flame straightening and heat curving shall not be performed on any material or member without the development of a procedure prepared by a Professional Engineer and submitted to the Department for review and written acceptance. The procedure shall address locations, temperatures and cooling rates. Straightening or heat curving shall be witnessed by the independent welding inspector and the Department.

(15) Stress Relieving

When stress relieving is specified, it shall be performed in accordance with AWS D1.5. Copies of the furnace charts shall be supplied to the Department.

(16) Handling and Storage

All lifting and handling shall be done using devices that do not mark, damage, or distort the assemblies or members in any way. Girders shall be stored upright, supported on sufficient skids and safely shored to maintain the proper section without buckling, twisting or in any way damaging or misaligning the material.

300.5.8.4.3 Surface Preparation and Coating

(1) Blast Cleaning

Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the *Society for Protective Coating Standard (SSPC) No. SP6*. The surface shall have all oil, grease, dirt, rust, foreign matter, mill scale and old paint completely removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder. The exterior face of exterior girders shall be uniform in appearance.

(2) Coating

At all bearing locations, a complete SF2, SF3 or SF4 approved bridge coating system that is an Approved Product shall be applied to the bottom flange surfaces (underside, top and edges), with the exception that the faying surface of the underside of bottom flange in contact with the bearing sole plate shall only receive the organic zinc epoxy prime coat. For abutment bearings, the coating system shall extend longitudinally from the girder end to a distance 100 mm beyond the bearing sole plate or 100 mm beyond the jacking stiffener, whichever distance is greater. For pier bearings, the coating shall extend longitudinally in both directions from the centreline of pier bearing to a distance 100 mm beyond the bearing sole plate or 100 mm beyond the jacking stiffener, whichever distance is greater.

In addition, at all deck joint locations, the selected SF2, SF3 or SF4 coating system shall be applied to the full height of the bridge webs (both sides of web and including any applicable bearing/jacking stiffeners) and to the underside of the top flanges. The longitudinal extent of this coating shall be the same as described above.

The approved organic zinc epoxy primer shall meet the requirements of a Class B coating, in accordance with the “Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints” as described in Appendix A of the Research Council on Structural Connections “Specification for Structural Joints Using High-Strength Bolts”. A certificate of compliance shall be provided to the Department for review and acceptance prior to application. The top coat shall be colour matched to the anticipated patina of the weathering steel girders and the colour reviewed and accepted by the Department prior to application.

(3) Galvanizing

Galvanizing shall be by the hot dip method, after fabrication, in accordance ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specifications for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners with additions and exceptions as described in the Technical Requirements. The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be prepared by a Professional Engineer prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. However repair for areas not exceeding 100 mm² may be done in accordance with ASTM Method A1 "Repair Using Zinc-Based Alloy". The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association ("AHDGA") publication "Wet Storage Stain". Any evidence of wet storage stain shall be removed to the satisfaction of the Department.

(4) Additional Galvanizing Requirements for Bridgerail, Handrail and Light Standards

The bottom surface of each base plate shall be protected by a medium grey colour barrier coating to prevent contact between the zinc and the concrete. The galvanized surface must be roughened prior to application of barrier coating. The surface preparation of the galvanized surface and the dry film thickness ("DFT") of the coating shall be in accordance with the coating manufacturer's recommendations. The Contractor shall test the adhesion of fully cured coating as per ASTM D3359. The method selected for testing (Method A or B) shall depend on the dry film thickness of the coating. The coating manufacturer's product data sheets shall be obtained prior to the application of the coating. The adhesion test result shall meet a minimum of "4B" classification, i.e. a maximum allowable flaking of 5%. The Contractor shall provide the report to the Department.

The galvanized finish shall meet the aesthetic requirements of the application and shall have a continuous outer free zinc layer without any significant zinc-iron alloy showing through the outside surface. Lumps, globules or heavy deposits of zinc will not be permitted. Handrails shall be free of any sharp protrusions or edges.

Double dip galvanizing is not advised but will be accepted if a surface finish similar in appearance, colour and quality to that of single dip galvanizing is produced. The lapped area of the double dip shall be straight, the coating smooth, adherent and free of uncoated areas, blisters, flux deposits, dross inclusions, acid and black spots.

300.5.8.4.4 Testing and Inspection

(1) Access

The Contractor shall provide full access for the inspection of material and workmanship by the Department. Free access shall be allowed to the Department to all parts of the works. When required by the Department, the Contractor shall provide needed manpower for assistance in inspection duties.

(2) Responsibility

It is the Contractor's responsibility to ensure that the supply of material and the fabrication are in accordance with the Technical Requirements. Any inspection and testing by the Department shall not be deemed to relieve the Contractor of any of its obligations.

(3) Testing by the Department

The Department may perform visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be required at its own expense.

The Contractor shall be responsible for all wages, travel, boarding and lodging costs for the Department's representative to attend pre-fabrication meetings and subsequent monthly visits to the plants when the fabrication of steel superstructure, bridgerails, handrails, and deck joints is done outside Canada.

(4) Independent Inspection, Testing and Reporting by the Contractor

Any test records made by the fabricating shop in the course of normal quality control shall be open to the Department for inspection.

The Contractor shall arrange to have visual inspection and NDT performed and reports submitted to the Department as follows:

Independent Inspectors Qualification

As part of Contractor's quality control, the Contractor shall retain independent inspectors. The independent inspectors shall be employed by a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or its subcontractors. The inspectors shall have direct communication with the Department. The independent inspectors shall include independent welding inspectors and independent NDT inspectors.

Independent Welding Inspectors

- Independent welding inspector – Steel Girder Fabrication:
 - The welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have at least two years of steel bridge girder fabrication inspection experience in Canada accepted in writing by the Department.
 - For out-of-country fabrication, the welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have at least five years of steel bridge girder fabrication inspection experience in Canada accepted in writing by the Department.
- Independent welding inspector – Miscellaneous Material Fabrication:
 - For the fabrication inspection of miscellaneous material such as bridgerails, deck joints, miscellaneous iron, and culverts being fabricated in Canada, the welding inspector shall be a Level II or Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59.
 - For out-of-country fabrication inspection of miscellaneous material listed above, the welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have

at least two years of steel fabrication inspection experience in Canada accepted in writing by the Department.

- Independent welding inspector – Field Welding & Repairs:
 - The welding inspector for any field welding or repairs shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59.

Independent NDT Inspectors

- NDT inspectors:
 - The non-destructive testing shall be done by a company certified to CSA W178.1. All NDT procedures developed by the company shall be submitted to the Department for review. The NDT inspectors shall have the following qualifications:
 - Radiographic Testing (R/T), Ultrasonic Testing (U/T), Magnetic Particle Inspection (MPI) and Dye Penetrant Inspection (DPI) inspectors shall be certified to Level II of CGSB in the appropriate category.
 - Hardness Testing (H/T) inspector shall have at least one year experience in operating the telebrineller hardness testing apparatus.

DUTIES & REPOSIBILITIES OF THE INDEPENDENT WELDING INSPECTOR

- For fabrication within Canada, the welding inspector shall be in the fabrication plant and performing inspection functions for at least 50% of the fabrication time required for the steel girders. During the fabrication of finger plate and cover plated “V” seal deck joints the inspection time may be reduced to 20% of the fabrication time required with a further reduction to 15% for the inspection of bridgerail, strip seal deck joints and miscellaneous iron.
- The welding inspector shall be present 100% of the time during any field welding or repairs.
- For fabrication outside of Canada, the welding inspector shall be in the fabrication plant and performing inspection functions for 100% of the fabrication time required for the steel girders. During the fabrication of finger plate and cover plated “V” seal deck joints the inspection time may be reduced to 30% of the fabrication time required with a further reduction to 20% for the inspection of bridgerail, strip seal deck joints and miscellaneous iron.
- As a minimum, the welding inspector shall perform the following duties and ensure all the requirements of the Detailed Designs and the Technical Requirements are met:
 - Attend a pre-fabrication meeting and any subsequent meetings.
 - Develop inspection forms to be reviewed by the Department.
 - Verify plant certification.
 - Identity of parent material, review of MTRs and traceability of material. Traceability of miscellaneous steel noted below is not required:
 - Diaphragms and connector plates/angles for precast concrete girder bridges.

- Buffer angles and Type 1 strip seal deck joint assemblies.
- Barrier plates.
- Bridgerails and handrails.
- Pier nose plates.
- Troughs.
- Review of Product Data Sheets.
- Review welders' certificates.
- Review welding supervisor's certification.
- Review of welding consumables as well as storage and moisture control.
- Review of material quality, surface and internal defects and discontinuities on cut edges.
- Check for the use of most recent approved shop drawings.
- Confirm use of only Department reviewed and CWB approved welding procedures.
- Verify joint preparation such as shape, dimensions and fit-up.
- Verify current calibration of the equipment.
- Review of welding parameters such as welding current, arc voltage and travel speed.
- Confirm appropriate use of run-off-tabs.
- Check applicable preheat and interpass temperatures are being observed (post heat if required).
- Check cleaning between weld passes and layers.
- Check correct back gouging is performed.
- Visual inspection of all welds: check size and shape and ensure all welds meet the acceptance criteria.
- Perform shear stud bend testing as well as ring testing.
- Witness or perform dimensional checks of weldments, ensure all tolerances are met and report tolerance measurements.
- Review certification of independent NDT inspectors.
- Check and ensure all NDT is done as per the Technical Requirements.
- Check all witness points. All testing and repairs specific to witness point must be completed prior to commencement of next stage of fabrication.
- Witness shop trial assembly including preparation of faying surfaces and shop assembly of bolted connections.
- Report and write non-conformances.
- Witness all repairs are done according to the accepted procedures.
- Witness flame cambering, straightening and heat curving when procedure is accepted by the Department.
- Inspect surface preparation prior to coating application.
- Inspect coating application and measurements of dry film thicknesses (“DFT”).
- Check and report galvanizing and metallizing quality and coating thicknesses.
- Perform visual inspection of all loaded components prior to shipment.
- Submission of weekly inspection reports to the Department.

INDEPENDENT INSPECTION REPORTS

Weekly inspection reports reviewed by the Field Review Engineer shall be submitted

electronically to the Department and shall include:

- Lead material; such as the Department's bridge file number, structure name/number, report number, report date, inspector's name, applicable codes and standards.
- Documents acquired during week; such as MTRs, Product Data Sheets, welders' certificates, NDT reports.
- Inspection summary of the week highlighting problems occurred and resolution.
- Traceability of material.
- Inspection forms.
- Photographs.
- Tolerance measurements.
- NCRs generated and witnessed repairs.

FINAL INDEPENDENT INSPECTION REPORT

A final report prepared by the independent welding inspector reviewed by the Field Review Engineer shall be electronically submitted to the Department within four weeks after the fabrication of each structure. It shall include:

- Signed and stamped certificate by the Field Review Engineer.
- Final shop drawings.
- Installation/Erection procedures.
- Company certification.
- Signed certificate by the independent inspector.
- Welding procedures specific to the structure/components.
- Welders' certificates specific to the structure/components.
- Equipment calibration certificates.
- MTRs with material traceability and Product Data Sheets.
- Records of material testing performed during course of fabrication (if any).
- Heat treatment records (if any).
- Weekly inspection reports.
- NDT Reports which shall include:
 - Hardness test records.
 - Dye penetrant records.
 - Radiography test reports.
 - Radiographic films.
 - Ultrasonic test reports.
 - MPI test reports.
- Individual girder camber and shop assembly camber measurement records.
- Sweep measurements.
- Surface preparation.
- Coating application, testing and thickness measurements.
- Shop and field tolerance measurements where required.
- Bolt pre-tensioning reports.
- Leak test reports for strip seal and cover plated V- seal deck joints.

- Non-Conformance Reports and any site instructions or design changes.

The Field Review Engineer shall review the work and associated documentation and provide a certificate that the fabricated materials have been built according to the Detailed Designs and the Technical Requirements.

(5) Witness Points

To ensure that each stage of inspection is performed in an orderly manner, during the fabrication of major structures, inspection stations shall be set up at specific witness points. Sub-assemblies of the work will then be checked by the Contractor and the independent welding inspector, and all deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication.

Typical witness points for a steel girder are:

- Flange plates prepared.
- Web plates prepared.
- Web to flange welds completed prior to fitting any stiffeners.
- Completion of all welding prior to splicing.
- Splice set-up prior to drilling.
- Surface preparation and coating.
- NCR disposition.
- Final inspection and clearance to ship.

(6) Non-destructive Methods of Examination

The methods of non-destructive examination shall be in accordance with the following standards:

Radiography	- AWS Standard D1.5
Ultrasonic	- AWS Standard D1.5
Magnetic Particle	- ASTM Standard E-709
Dye-Penetrant	- ASTM Standard E-165
Hardness tests	- ASTM Standard E-103

(7) Radiographic Inspection Schedule

Unless otherwise noted, radiographic inspection of welded plate girders shall be performed by the Contractor in accordance with the following schedule:

- (a) 100% of all tension flange and stress reversal groove welds, all stiffener groove welds and all diaphragm groove welds, and any groove welded attachments to flange plates.
- (b) A minimum of 25% of all other flange groove welds randomly selected for each structure. Additional testing may be required to ensure the quality of welds.
- (c) 100% of all web groove welds.
- (d) If defects are found during testing, additional areas shall be tested to ensure the quality of welds.

(8) Ultrasonic Testing

The Contractor shall arrange to have all post to base plate and bridgerail splice full penetration welds inspected by ultrasonic testing. The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic Testing procedure shall be prepared by a CGSB Level III U/T

inspector and stamped by a Professional Engineer. Ultrasonic testing inspectors shall be certified to Level II of CGSB. Calibration blocks for each thickness shall be prepared for ultrasonic testing to establish sensitivity levels and acceptance criteria. The procedure shall be submitted to the Department for review and written acceptance.

In addition to Radiographic Inspection, 25% of all tension groove welds shall be inspected by ultrasonic testing for plates ≥ 65 mm in thickness.

(9) Radiographic Inspection of Welds for Miscellaneous Material

Unless otherwise noted, radiographic inspection of miscellaneous material shall be performed by the Contractor in accordance with the following schedule:

- a. 100% of all tension groove welds.
- b. 50% of all other groove welds.

(10) Magnetic Particle Inspection Schedule

Unless otherwise noted, magnetic particle inspection of welded plate girders shall be performed by the Contractor for each girder section in accordance with the following schedule:

- (a) 50% of the web to flange welds or any fillet welds placed on flange plates. The tests shall be in 1.5m lengths including 1.5m length at each end.
- (b) 20% of the web to stiffener welds.
- (c) 100% of the stiffeners to flange welds.
- (d) 100% of the bearing sole plate to flange welds.
- (e) 20% of the diaphragm connector plate welds.
- (f) 100% of all SMAW welds completed in the plant or in the field.
- (g) 25% of all fillet welds for other bridge components.

(11) Dye Penetrant Inspection

Dye penetrant inspection (“DPI”) shall be performed by the Contractor at the ends of the weld metal of all flange groove welds after the removal of run-off tabs. DPI shall be done for all flange plate edges regardless of whether or not the plates are cut before or after welding. Defects discovered by this inspection shall be repaired by the Contractor, and the suspect area re-inspected.

(12) Hardness Tests

Hardness tests shall be performed by the Contractor on the as-is flame cut edges of the girder flange prior to assembly. A minimum of three readings per plate for each cut edge (at both ends and the middle) shall be taken. Unless otherwise noted, the hardness of the flame cut edges shall not exceed a maximum Brinell as noted below:

- (a) For carbon steels with a yield strength less than and including 300 MPa, the maximum Brinell shall be 200 BHN.
- (b) For carbon steels with a yield strength greater than 300 MPa, the maximum Brinell shall be 220 BHN.

Remedial work to the edges which exceed the specified hardness shall be performed and re-inspected prior to assembly.

(13) Testing Stud Shear Connectors

Stud shear connectors shall meet all requirements as outlined by AWS D1.5. The Contractor

shall perform bend testing in accordance with AWS D1.5. When bend testing, the studs shall be bent towards the centre of the girder. All the remaining studs shall be tested by striking with a hammer. A dull sound indicates incomplete fusion and a bend test will then be required for a potentially defective stud to ensure the integrity.

(14) Testing of Strip Seal and Cover Plated V-Seal Deck Joints

The installation of strip seals and V-seals in deck joints shall be tested by the Contractor for leakage. The failed areas shall be corrected and retested. The defective or torn seal shall be replaced at the Contractor's expense.

(15) Structural Steel Fabricated Out-of-Country

The structural steel, (listed in Section 300.5.8.1 (Structural Steel – General)) when fabricated out-of-country, shall be re-inspected after its arrival into Canada. All steel components shall be brought into a CSA W47.1, Division 1 certified shop for inspection. In addition, the shop shall also be CISC certified in the category of steel bridges.

The Contractor shall arrange for inspection by qualified personnel. The inspection requirements are as follows:

- Inspection shall take place inside an enclosed shop. The shop shall be maintained at a minimum temperature of 10 degrees C.
- The qualification of welding and NDT inspectors shall be as per Section 300.5.8.4.4(4) (Independent Inspection, Testing and Reporting by the Contractor).
- The welding inspector shall inspect:
 - Verification of components to ensure that they were undamaged during transportation.
 - All welds.
 - All fabricated components.
 - Dimensional checks and tolerance measurements of all the components.
 - Check studs for additional bend testing as well as 100% ring testing.
 - Camber and sweep check of each component.
 - Plate and Box girders shall be assembled for inspection as per Section 300.5.8.4.2 (7) (a) & (b) (Fabrication).
- The NDT, i.e. Radiographic Inspection, Ultrasonic Testing, Magnetic Particle Inspection, Dye Penetrant Inspection and Hardness Testing shall be done as per Section 300.5.8.4.4 (7) to (12) (Testing and Inspection).

The Contractor shall submit visual and NDT reports including radiographic films to the Department within one week of inspection. Non-conforming components shall not be released from the Canadian shop until the proposed remedial action has been reviewed and accepted in writing by the Department and all re-inspection is complete.

300.5.8.5 Structural Steel Erection

The Contractor shall erect the structural steel, remove any temporary construction, and do all work required to complete the erection in accordance with the Detailed Designs and the Technical Requirements. No drilling of additional holes or any other modifications including field welding shall be made to steel elements other than deck joints. Lifting devices shall not be

welded to girders. The Contractor shall not erect the structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement. Without restricting generality, erection includes:

- erection of temporary supporting structures;
- removing anchor rod grout can void form;
- erection of structural steel;
- placing of expansion assemblies; and
- touch-up painting as required.

300.5.8.5.1 Transporting, Handling and Storing Materials

Material to be stored shall be placed on timber blocking. It shall be kept clean free from dirt, grease and any other foreign matter and stored in a properly drained area. Handling and lifting devices shall not mark, damage or distort members. Girders and beams shall be placed upright and shored. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage from deflection.

After steelwork has been delivered to site it shall be inspected by the Field Review Engineer. The Contractor shall clean the steelwork after it has arrived at site of any dirt, road salts, slush or other contaminants accumulated during transport and shall carry out any other surface preparation work necessary to meet the specified surface preparation requirements.

Girders and beams shall be transported in the vertical position. However these elements may be transported in other positions provided:

- A Professional Engineer (structural discipline) shall determine static and dynamic forces during handling, transportation, and storage using a dynamic load allowance of 100%. Computed stresses shall be according to CAN/CSA-S6, clause 10.10 and the maximum cyclic stress range shall not exceed the constant amplitude fatigue threshold for the appropriate fatigue categories specified in CAN/CSA-S6, Table 10.4. All the calculations and associated sketches, including reasons why the girders cannot be shipped with the webs in the vertical plane, shall be submitted by the Contractor to the Department for review and acceptance two weeks prior to shipping. The calculations and sketches shall be signed and sealed by the Professional Engineer who performed the analysis and includes a written statement that the proposed method will not damage the elements.
- Upon arrival at the site and prior to erection, the elements shall be checked by an Independent Level III certified welding inspector hired by the Contractor to ensure there is no damage to the girders. The Contractor shall provide an adequate flat storage area for the inspection. The Contractor shall provide a report to the Department within seven days of inspection.
- Any structural steel member damaged during transportation, handling, storage or erection shall be immediately reported to the Department, and an engineering assessment prepared by a Professional Engineer experienced in evaluation and inspection of damaged steel members. The assessment report along with the repair procedure shall be submitted to the Department for review and written acceptance. The Contractor shall also provide three days' notice for access, and

facilitate any activities required for an independent assessment by the Department if requested. All costs associated with the independent inspection and assessment is the responsibility of the Contractor.

300.5.8.5.2 Bridge Girders

(1) Temporary Supporting Structures and Berms

The temporary supporting structures and berms shall be designed, constructed and maintained to safely support all loads. Berms shall be constructed in a manner and of such materials that they will not be eroded by stream flow nor introduce silt into the water. The Contractor shall prepare drawings for temporary supporting structures, berms, and for traffic control and accommodation where applicable. All drawings submitted shall bear the seal of a Professional Engineer.

Temporary supporting structures and/or berms will not be permitted to remain in any stream channel during spring break-up or run-off periods, unless all necessary approvals have been obtained from pertinent regulatory agencies.

Repair to any damage to other property, such as earth fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.

(2) Erection Procedure

The Contractor shall prepare, and provide to the Department forthwith, a detailed erection procedure in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following:

- (a) Traffic accommodation strategy, as applicable;
- (b) Access to work, earth berms and work bridges;
- (c) Type and capacity of equipment. Cranes shall be used for handling and erecting structural steel girders;
- (d) Sequence of operation including position of cranes and trucks with members;
- (e) Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers;
- (f) Lifting devices and lifting points. No drilling of additional holes or any other modifications, including field welding, shall be made to steel elements other than deck joints. Lifting devices shall not be welded to the girders;
- (g) Details of temporary works, supporting structures drawings, including proposed methods to be used to ensure the required splice elevations and structure shape prior to bolt torquing method of providing temporary supports for stability, top of girder elevations at each bearing and each splice location where appropriate;
- (h) Bolt tightening sequence;
- (i) Grout Pad Construction for Bearings and Bridgerail posts (refer to Section 300.5.18.4.3 (Anchor Rod Voids and Grout Pads));

- (j) Details of release of temporary supporting structures; and
- (k) Provide an “As-Constructed” detailed survey of the substructure showing the following:
- location and elevation of all bearing grout pad recesses including all anchor rod voids, shim height at each bearing location,
 - top of girder elevations at each bearing (and each splice location where appropriate), and
 - longitudinal measurements between centrelines of bearings of all substructure units.

The erection procedure shall be stamped by a Professional Engineer who shall assume full responsibility to ensure that its erection procedure is being followed. Safety and compliance with the *Occupational Health and Safety Act* (Alberta) and regulations thereunder shall be an integral part of the design.

Before erection begins the Contractor shall do a complete superstructure layout by means of chalk lines and markings applied to all substructure units, showing bearing and girder positions in accordance with the layout plan.

(3) Fall Protection for Girder Erection and Deck Forming

In order to provide a safe working area for girder erection and deck formwork, the Contractor shall provide 100% fall protection and a safe work procedure.

(4) Intentionally Deleted

(5) Straightening Bent Material

Straightening of plates, angles or other shapes will not be permitted without a detailed procedure prepared by a Professional Engineer, and provided to the Department for its review and written approval, prior to any straightening being undertaken.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fractures, which may include non-destructive testing.

(6) Assembly

The parts shall be accurately assembled as shown on the shop drawings and all match-marks shall be followed. The material shall be carefully handled to avoid damage. Hammering, which will injure or distort the members, shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be clean before the members are assembled.

Splices and field connections shall have one half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins evenly distributed throughout the splice or connection) before bolting. Splices and connections carrying traffic during erection shall have three-fourths of the holes filled.

Fitting-up bolts shall be of the same nominal diameter as the bolts, and cylindrical erection pins shall be sized to accurately fit the holes.

Should adjustments in elevation of the girder splices become necessary to allow free rotation of the joint, only enough pins or bolts shall be removed.

(7) High-Tensile-Strength Bolted Connections

(a) General

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, paint, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts. Unless otherwise noted, bolts in exterior girders shall be installed with the heads on the outside face of the girder web and bolts in all girders shall be installed with the heads on the bottom faces of lower flanges. Nuts for bolts that will be partially embedded in concrete shall be located on the side of the member that will be encased in concrete.

Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.

For sloped surfaces, bevelled washers shall be used. The bevelled washers shall be designed to produce a bearing surface normal to the bolt axis.

Bolts shall be of new quality and stored in weatherproof containers to prevent loss of lubrication or accumulation of dirt.

All girders shall be erected with elevations and alignments checked prior to any bolt tightening.

(b) Bolt Tension

Tightening of all high strength bolts shall be by the turn-of-nut method. Before final tightening there shall be a sufficient number of bolts brought to a “snug tight” condition to ensure that the parts of the joint are brought into full contact with each other. “**Snug tight**” is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. After all bolts have been taken to the snug tight condition, the Contractor shall match mark the outer face of each nut and protruding end of bolt to have a common reference line to determine the relative rotation. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified below, with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

Amount of rotation of nut relative to bolt, regardless of which is turned:

- 1/3 turn where bolt length is 4 bolt diameters or less
- 1/2 turn where bolt length is over 4 bolt diameters and not exceeding 8 bolt diameters
- 2/3 turn where bolt length exceeds 8 bolt diameters

Notes:

- tolerance 1/6 turn (60°) over, nothing under
- length of bolt measured from underside of head

(c) Reuse of Fasteners

High strength bolts shall be tensioned only once and shall not be reused. Retightening previously tightened bolts, which may have been loosened by tightening adjacent bolts shall not be considered as reuse.

(d) Department Inspection

The Contractor shall provide safe and adequate access meeting *Occupational Health and Safety Act* (Alberta) requirements to all working areas, including all necessary scaffolding to enable the Department to carry out its inspection. The Contractor shall provide a competent workman to assist the Department in the inspection of bolt tightening work.

(e) Contractor Inspection

The Contractor shall provide safe and adequate access meeting *Occupational Health and Safety Act* (Alberta) requirements to all working areas, including all necessary scaffolding to enable the Department to carry out its inspection.

The Contractor shall visually check 100% tightening of the bolts by observing match-marking. In addition, the Contractor shall check 10% of all the bolts by “Calibrated Wrench Tightening”. The wrenches shall be calibrated at least once each working day in a device capable of indicating actual bolt tension. From the bolts to be installed a minimum of three typical bolts of each diameter and length shall be tested.

(8) Misfits

The correction of minor misfits involving reaming, cold cutting and chipping for secondary members may be allowed by the Department. If such field corrections are proposed by the Contractor they shall immediately be reported, and a repair procedure submitted, to the Design Engineer and to the Department for review and written acceptance. If the repair procedure is accepted, it shall be done in the presence of both the Field Review Engineer and the Department.

(9) Girder Adjustment

It is essential that the girders are erected with utmost attention being given to girder positioning, alignment, and elevation. Adjustment to girder position, bearing location and bearing elevation shall be done in order to achieve as closely as possible the lines and grades shown on the Detailed Designs.

The Contractor shall ensure that the structural steel is maintained in correct alignment at all times during construction.

(10) [Intentionally Deleted]

(11) [Intentionally Deleted]

(12) Removal of Falsework, Berms and Clean-Up

Upon completion of the erection the Contractor shall remove all earth material or falsework placed in the stream channel or elsewhere during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of its work.

The Contractor shall leave the bridge site, roadway and adjacent property in a neat restored and presentable condition. When required, the Contractor shall provide written evidence to the Department that affected property owners or regulatory agencies have been satisfied.

All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

300.5.9 PRECAST CONCRETE UNITS AND POST-TENSIONING

300.5.9.1 General

This Section 300.5.9 (Precast Concrete Units and Post-Tensioning) is for the supply, manufacture, delivery and erection of prestressed and precast concrete bridge units and miscellaneous precast components.

300.5.9.2 Submissions

The Contractor shall submit the following information to the Department by a date that is reasonable having regard to the design and construction process and in any event within the times noted below. Units fabricated without meeting the time limits noted below will be rejected. In the event that the Department requests any of the following information related to ongoing production, the requested information shall be provided within seven days.

- Plant certification (at least 14 days prior to fabrication);
- Independent inspector's certification;
- CSA certified Concrete Testing Laboratory's name and location;
- Fabrication schedules and location of manufacture (at least 14 days prior to fabrication);
- Shop drawings reviewed by Design Engineer (at least five days prior to fabrication);
- Stressing calculations including jack calibration data reviewed by Design Engineer (at least five days prior to fabrication);
- Mill test reports and load/elongation curve for prestressing strand (at least five days prior to fabrication);
- Concrete and grout mix designs, including test data showing conformance of cement, silica fume, aggregate and admixtures to required standards (at least 14 days prior to fabrication);
- Details of concrete curing systems (at least 14 days prior to fabrication);
- Time-Temperature-Humidity graphs showing concrete curing rates;
- Mill test reports for miscellaneous steel and reinforcing steel;
- Repair procedures for galvanizing, if required;
- Repair procedures, for repair of casting defects or other damage to precast concrete units;
- Concrete cylinder strength results;
- Concrete core strength results, if required;
- Quality Control procedures;
- Weekly independent inspection reports and final independent inspection report; and
- Erection procedures, including drawings for falsework, berms and traffic accommodation (two copies) (at least 14 days prior to erection and grading).

300.5.9.3 Reference Drawing

Drawing SK-1 (Finishes and Sealing for Exterior Concrete Girders) is attached in Appendix B.

300.5.9.4 Supply and Manufacture

A pre-fabrication meeting is required prior to commencement of fabrication of precast concrete elements. The meeting will be held at fabricator's plant and the Contractor shall ensure the Field Review Engineer, plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Field Review Engineer will conduct this meeting after the shop drawings and stressing calculations (prestressed elements) have been reviewed. The Contractor shall provide two weeks' notice to the Department prior to the meeting.

300.5.9.4.1 Standards

The manufacture of prestressed and precast concrete bridge units shall be in accordance with CSA A23.4.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN3-Z234.1-79 shall be used as the basis of conversion.

300.5.9.4.2 Qualification

The fabricator shall operate a recognized precast concrete fabricating plant and shall be fully certified by the Canadian Precast/Prestressed Concrete Institute (CPCI) Certification Program in the applicable Product Group classification.

The fabrication of precast concrete and precast prestressed concrete units shall be done in a sufficiently large environmentally-controlled permanent building capable of manufacturing products in a well organized continuous operation. The building shall be capable of maintaining controllable temperature and humidity while preventing contamination and deterioration of materials.

300.5.9.5 Engineering Data

(1) Shop Drawings

Shop drawings showing all necessary fabrication details of the precast units, such as reinforcing steel, blockouts, stressing system, anchorage devices, void support system and screed rail shall be prepared. The shop drawings shall be legible and of adequate quality to be reproduced. Fabrication shall not commence prior to review and acceptance of the shop drawings by the Design Engineer.

The Department's bridge file number and project name shall be shown on all shop drawings.

(2) Stressing Calculations

Stressing calculations showing elongations and gauge pressures as well as the prestressing strand release sequence data shall be prepared. Jack calibrations, performed within the previous six months, shall be obtained. Fabrication shall not commence prior to review and acceptance of the stressing calculations by the Design Engineer.

(3) Mill Test Reports and Stressing Steel Certificate

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test report. The mill test

report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the Technical Requirements.

A copy of the load/elongation curve for each lot of prestressing steel shall be submitted to the Department.

(4) Concrete and Grout Mix Design

A concrete mix design and grouting mortar mix design including applicable material test reports shall be prepared by the Contractor and submitted a minimum of two weeks prior to manufacturing for review by the Department. Material test reports shall be current and fully represent materials to be used in production. The mix design shall indicate the design strength, proportions of the constituent materials, type and brand of cement, type and brand of silica fume, origin of aggregates and brand names of all admixtures.

The mix design shall specify the upper slump limit for the superplasticized concrete at which the mix is stable without any segregation. The slump limit of the concrete used in the production shall be 10mm below the upper limit identified in the mix design.

The sampling and testing of aggregates, and the concrete mix design, shall be completed by a concrete testing laboratory certified to CSA A283, which shall have the appropriate permit to practice in the Province of Alberta. Concrete mix designs, including the review of all material test reports, shall be signed and sealed by a Professional Engineer employed by a concrete testing laboratory certified to CSA A283. The Professional Engineer shall also provide a professional opinion indicating that the concrete mix is suitable for the intended use and can be expected to meet the Technical Requirements. The Professional Engineer shall also provide the upper slump limit for the superplasticized concrete.

Alternatively, concrete mix designs, including the sampling and testing of aggregates and review of material test reports may be completed by a qualified professional employed by the concrete supplier. When the concrete mix design is completed by the concrete supplier it shall be reviewed for compliance with the respective specifications, signed and sealed by a Professional Engineer employed by an independent concrete testing laboratory. The independent concrete testing laboratory shall be certified to CSA A283 and it shall be a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or its subcontractor.

The concrete mix design information shall include one microscopic air-void analysis performed by a CSA A283 certified testing laboratory in order to determine the spacing factor of the hardened concrete. The test sample shall be made from a trial concrete batch, vibrated into a cylinder mould so as to represent the level of vibration of the production concrete in the forms. If adjustments to the mix design are necessary, the air-void analysis shall be repeated.

Only the reviewed mix design shall be used to cast units. Changes in cement type, and/or decreasing cement content shall be construed as a change in mix design and will not be allowed.

(5) Intentionally Deleted

(6) Construction Data Sheets

During manufacture, the construction data sheets shall be kept up to date and available for the

Department's review.

300.5.9.6 Materials

(1) Hydraulic Cement

Hydraulic cement conforming to the requirements of CSA Standard A 3001 shall be used.

(2) Water

Water to be used for mixing concrete or mortar shall conform to the requirements of CSA Standard A23.1 and shall be free from injurious amount of alkali, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

(3) Silica Fume

Ten percent condensed silica fume by weight of cement (plus or minus 0.5%) shall be used in all precast concrete. Condensed silica fume shall conform to CSA Standard A3001, for a Type SF supplementary cementing material, with a SiO₂ content of at least 85%, a maximum loss on ignition of 10%, and SO₃ content shall not exceed 1%. An acceptable compatible superplasticizing admixture shall be used together with the silica fume.

(4) Aggregates Testing

Aggregate tests and analysis shall be performed and submitted to the Department for review with the concrete mix design as follows:

(a) Standard Weight Aggregates

Fine and coarse normal weight aggregates shall be as per section 300.5.7.5.4 (Concrete Mix Design and Aggregate Testing), with maximum aggregate size of 14 mm, except that the required frequency of analysis (maximum days prior to and during production) for the fine and course aggregate sieve and the amount of material finer than 80 µm in aggregate shall be 14 days instead of 90 days.

(5) Air Entraining Agent

Air entraining agent shall conform to the requirements of the ASTM C260.

(6) Chemical Admixtures

Chemical admixtures shall conform to the requirements of ASTM C494. All chemical admixtures must be suitable for use in precast concrete, be supplied by the same manufacturer as the air entrainment agent, and be compatible with each other. The addition of calcium chloride, accelerators, retarders or set controlling admixtures and air reducing agents will not be permitted.

Acceptable admixtures are air-entraining agents, superplasticizers and water-reducing agents.

(7) Concrete

Concrete shall consist of hydraulic cement, condensed silica fume, aggregates, water and acceptable admixtures. The type of concrete to be used will be specified on the Detailed Designs.

The density, entrained air and air void spacing requirements for the various types of concrete are specified in Table 300.5.9.6 below.

Table 300.5.9.6

Type of Concrete	Aggregates	Concrete Unit Weight, Plastic State kg/m ³	Minimum Entrained Air %	Maximum Air Void Spacing Factor (hardened concrete) mm
Standard Weight	Fine and Coarse Standard Weight	--	5	0.23
Lightweight	Fine and Coarse Lightweight	1680 ± 5%	6	0.23
Semi-Lightweight	Fine Standard Weight & Coarse Lightweight	1920 ± 5%	6	0.23

(8) Reinforcing Steel

Reinforcing steel shall conform to Sections 300.5.2.7 (Durability) and 300.5.2.8 (Materials).

(9) Prestressing Strand

Prestressing strand and wire shall be uncoated Grade 1860, low relaxation 7-wire strand conforming to the requirements of the ASTM A416. Shop drawings and stressing calculations shall clearly show the type of prestressing strand to be used, and changes will not be allowed during production.

(10) Lifting Hooks

Lifting hooks made of prestressing strand shall conform to the requirements of ASTM A416, and shall be fabricated in a manner that distributes the load evenly to all prestressing strands.

(11) Miscellaneous Steel

Miscellaneous steel shall conform to the requirements of the CSA *CAN/CSA G40.21M-300W* or *ASTM A36* or as specified on the Detailed Designs. The Contractor shall obtain mill test reports (“MTR”) to prove conformance to the standard. Fabrication and high-tensile bolted connections shall conform to Section 300.5.8 (Structural Steel).

(12) Anchor Rods for Bridgerail

Anchor rods for bridgerail anchor assemblies shall be as per Section 300.5.2.19 (Barriers). The assemblies shall be hot dip galvanized after fabrication. All nuts and washers shall be shop assembled on the anchor rods.

(13) Voids and Ducts

All void and duct material must remain dimensionally stable during the casting and curing of the units. Voids shorter than 400 mm shall be eliminated except when noted otherwise on the Detailed Designs.

(14) Bearings

Elastomeric bearings and pot bearing shall be in accordance with Section 300.5.18 (Bridge Bearings).

(15) Galvanizing

Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating *Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners*, with additions and exceptions as described in the Technical Requirements. The Contractor shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small and suitable for repair. A detailed repair procedure shall be prepared by a Professional Engineer, and submitted to the Department for review and written acceptance prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. However repair for areas not exceeding 100 mm² may be done in accordance with ASTM Method A1 "*Repair Using Zinc-Based Alloy*". The thickness of the *coating for both methods* shall be 180 µm, and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing.

300.5.9.7 Manufacture

(1) Forms

Precast concrete units are to be manufactured in steel forms which are acceptable to the Department.

For all beam members, the forms shall be designed such that they can be removed without damaging the beam. For all "I" or "T" beam members, the side forms shall be removed horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. The top flange shall not be subjected to a vertical force at anytime.

Holes or voids shall not be cast into girders to accommodate formwork.

MSE precast concrete fascia panels shall be manufactured in smooth steel forms, mortar tight, and set on a rigid foundation.

(2) Reinforcing Steel

Fabrication, handling, storage, placement and fastening of all steel reinforcement shall conform to Section 300.5.14 (Reinforcing Steel).

(3) Prestressing Strand

Prestressing strand shall be free from corrosion, dirt, grease, rust, oil or other foreign material that may impede the bond between the steel and the concrete. Prestressing strand shall be protected at all times from manufacture through to encasing concrete or grouting. Prestressing strand that has sustained physical damage at any time shall be rejected. Prestressing strand splices shall not be placed within a precast concrete unit.

Prestressing strands shall not be stressed for more than 36 hours prior to being encased in concrete. The force in each prestressing strand shall be measured by both elongation and

pressure gauge.

Each prestressing strand shall be stressed to a calculated elongation, and a gauge pressure reading shall be taken as a check against the calculated force. During stressing, each prestressing strand shall be first pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed at the front of the stressing jack. A second mark shall be placed away from the first with a distance corresponding to the calculated elongation on the stressing sheet. Each prestressing strand shall then be pulled to the second reference mark and the gauge pressure reading taken.

This process may be reversed, i.e. each prestressing strand shall be stressed to a calculated force (determined by a gauge pressure calibration chart) and the elongation shall be measured as a check against the calculated force. During stressing, each prestressing strand shall be first pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed at the front of the stressing jack. Each prestressing strand shall then be stressed to the gauge pressure corresponding to the stressing sheet and a second reference mark be placed at this gauge pressure. The elongation shall be the distance measured between the two reference marks.

The maximum allowable discrepancy between jack pressure and elongation shall be within 5%. Alternatively, the factors contributing to the difference must be identified and corrected before proceeding. Changes in prestressing strand temperature and slippage at prestressing strand anchorages shall be measured between stressing and concrete encasement. Any changes in prestressing strand stress due to these effects shall be accounted for in the design. The stressing procedure and stressing calculations shall be submitted for review by the Design Engineer.

Seven wire prestressing strand with any broken wire shall be removed and replaced. All prestressing strands shall be checked for wire breaks before placement of concrete.

The precast unit ends shall have 15 mm deep prestressing strand termination recesses formed around the prestressing strands. All prestressing strands shall be cut flush with the bottom of the recesses, and the recesses shall then be filled flush with the ends of the girders with a moisture insensitive epoxy paste adhesive meeting the requirements of ASTM C881, Type IV, Grade 3, Class B or C. The paste shall be grey in colour. An approved Type 1C sealer shall be applied over the patched recessed areas as per Section 300.5.7.17 (Type 1c Sealer). Sealer shall not be applied to the patched recessed areas when girder ends are designed to be encased in field cast concrete.

The Contractor shall be responsible for recording and reporting the elongation to the Department, or tension of each prestressing strand during the stressing operation, if requested by the Department.

(4) Void and Duct Placement

Voids and ducts shall be placed as shown on the Detailed Designs and must be tied and securely held in the required positions to prevent movement. Continuous ducts shall align precisely. The ends of the voids shall be sealed. Voids found to be distorted, damaged or of insufficient strength will be rejected. Blow holes caused by air expanding within the voids and rising to the surface, shall be repaired when the concrete is in the plastic state.

(5) Concrete Measuring, Mixing and Placing

The procedures outlined in American Concrete Institute (“ACI”) Standard 304 *Guide for Measuring, Mixing, Transporting and Placing Concrete* shall be followed. The time from initial

mixing of the concrete until placing the concrete in the forms shall not exceed one hour. The elapsed time between the successive placement of concrete onto previously placed concrete shall not exceed 45 minutes.

(6) Concrete Temperature

The concrete temperature shall be between 10 degrees Celsius and 30 degrees Celsius at the time of placing it in the forms.

(7) Finished Riding Surface

Where the top surface of the girder is designed to be the riding surface, the use of a continuous screed rail, independent of the top of the grout keys, shall be employed. The top surface shall follow a smooth profile, which incorporates the required camber adjustments.

(8) Camber Hubs

Three camber hubs shall be placed in each girder, located along the centreline of the girder at the midpoint and 150 mm from each end. The camber hubs shall consist of 10 mm galvanized bars, of sufficient length to project vertically 10 mm above the riding surface.

The Contractor shall store the members in such a manner as to provide access for measuring camber. The Contractor shall record the girder camber at the midpoint of each girder within 24 hours of girder destressing.

(9) Concrete Finish

The exterior concrete girder faces shall have a Class 3 Bonded Concrete Surface Finish. Except the top, all the remaining surfaces shall have a Class 1 Form Surface Finish.

(a) Class 1 Form Surface Finish

This finish is essentially that obtained when concrete has been cast and adequately compacted in a properly oiled steel form. All fins, honeycomb, irregularities, cavities over 10 mm diameter or other similar defects shall be thoroughly chipped out. These areas shall be saturated with water for a period of not less than 30 minutes, carefully pointed and trued with mortar of a colour which will match the existing concrete. Mortar used for pointing shall be less than one hour old.

The patches shall be properly cured by placing the repaired unit in the curing enclosure for a period of four days immediately after patching.

The finished surfaces shall be true and uniform. All surfaces which cannot be repaired satisfactorily shall be finished as specified for Class 2.

(b) Class 2 Rubbed Surface Finish

Class 2 finish shall be essentially the same as Class 1 except that all holes, cavities and defects shall be repaired so that the finished surface presents a smooth, true, dense, uniformly coloured, and non-stained appearance. The concrete surfaces shall be thoroughly wire brushed to expose any hole or cavity prior to repairs. All residue of form oil shall be removed from the surface.

(c) Class 3 Bonded Concrete Surface Finish

Surface preparation shall be done as is specified for (b) Class 2 (Rubbed Surface Finish) above, except that uniformity in colour is not required. After the surface preparation has been completed, the concrete surfaces shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. The concrete surface shall be dried for a minimum of 24 hours. The Contractor shall then apply a pigmented concrete sealer, which meets the requirements for a Type 3 sealer in Alberta Transportation's "*Specifications for Concrete Sealers*" (B388).

The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications. A minimum of two applications, totalling the approved application rate of the pigmented sealer, are required. The colour(s) of the proposed coating scheme shall be as specified in the design. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible, and shall match the colour of any previously painted adjoining surfaces

(d) Class 4 Floated Surface Finish

After the concrete has been consolidated and the surface carefully screeded to the cross section and profile shown on the Detailed Designs, it shall be floated and trowelled as necessary to provide a closed, uniformly textured surface without brooming.

(e) Class 5 Floated Surface Finish, Broomed Texture

After the concrete has been consolidated, the surface shall be carefully screeded to the cross section and profile shown on the Detailed Designs. When the concrete has hardened sufficiently, the surface shall be finished with a broom of an accepted type. The broom strokes shall be perpendicular to the edge of the unit, and extended from edge to edge, with adjacent strokes slightly overlapped producing corrugations of 2 to 3 mm in depth. Brooming shall be done when the concrete has set sufficiently to produce clear, crisp brooming marks which do not sag or slump, without tearing the surface or disturbing coarse aggregate particles. After final brooming the surface finish shall be free of porous spots, irregularities, depressions, pockets and rough spots and must not vary more than 5 mm when measured using a 3 m straight edge.

Accepted finishing and edging tools shall be used on all edges and expansion joints after brooming.

(10) Curing

All prestressed concrete units shall be cured at an elevated temperature. The curing of prestressed concrete units shall essentially be in accordance with CSA A23.4 unless otherwise specified. The ambient curing temperature shall be increased at a rate not exceeding 20 degrees Celsius per hour until a maximum temperature of not more than 60 degrees Celsius is attained. After curing, the temperature of the units shall be reduced at a rate not exceeding 10 degrees Celsius per hour until the temperature of the concrete has fallen to within 10 degrees Celsius of ambient temperature outside the enclosure.

Care must be exercised to protect prestressed and non prestressed concrete units from thermal shock at all times until fully cured.

(a) Prestressed Concrete

(i) Curing in the Form

The initial application of heat shall commence only after the last of the freshly placed concrete has attained its initial set, which is normally two to four hours after casting. Heat shall not be applied directly to the concrete, but by a method that will produce a consistent ambient temperature throughout the entire form and enclosure. The increase in temperature and the holding temperature shall be monitored and permanently recorded on a chart at a minimum of 3 quarter points along the form.

(ii) Curing After Removal From the Form

Upon removal from the forms the units shall be cleaned, patched and finished within a period not exceeding 12 hours. The units shall be placed in a manner that will facilitate any clean up or repair work, and that will allow full inspection of all surfaces. Within 24 hours of removal from

the form, the units shall be placed within a suitable enclosure, for curing.

The curing enclosure shall provide a minimum of 150 mm of free air space between the concrete surfaces and the coverings. Flexible coverings shall be secured to prevent any moisture loss.

The difference in ambient air temperature adjacent to the concrete at different locations within the enclosure shall not exceed 10 degrees Celsius at any time.

The curing process shall be continued for a period of 4 days with one of the following methods:

1) Steam Curing

Steam jets shall not directly impinge on the concrete surfaces. The steam must be in a saturated condition maintaining an atmosphere of 95% to 100% relative humidity and a uniform ambient temperature between 40 degrees Celsius and 60 degrees Celsius.

For days with periods of four or more hours within a 24-hour period, where measured temperature or humidity levels do not meet the required limits, these days will not count as a full day of steam cure. An additional day of steam cure beyond the specified four days will be required for each non-compliant day.

2) Curing with Continuous Misting & Heat

Sufficient number of atomizing misting nozzles shall be strategically located to produce a fine mist with 100% relative humidity in the enclosure. The water shall be preheated to a temperature which will produce a misting temperature compatible with the ambient temperature. The enclosure shall be heated with radiant heaters to a temperature of between 40 degrees Celsius and 60 degrees Celsius. Dry heat shall never touch the concrete surface at any time. A control system shall be installed to shut off the heat when the humidity level drops below 90% in the enclosure. Should the temperature in the concrete rise above 40 degrees Celsius without the misting, the unit will be rejected.

Two continuously recording thermometers and two continuously recording hygrometers shall be provided for each curing enclosure to monitor the concrete and curing rates. All time-temperature and time-humidity recordings shall be clearly shown on the graph.

(b) Non Prestressed Concrete

Curing of all non prestressed concrete shall be in accordance with one of the following methods.

(i) Elevated Temperature Curing

Upon removal from the forms the units shall be cleaned, patched, finished and elevated temperature cured for four days as per Section 300.5.9.7 (10) (a) (Prestressed Concrete).

(ii) Moist Curing

The units may be moist cured in lieu of elevated temperature curing as noted below:

Upon removal from the forms the units shall be cleaned, patched, finished, and ready for inspection within a period not exceeding 12 hours. Patching shall be performed with an Approved Product and at an ambient temperature of between 15 degrees Celsius to 30 degrees Celsius. After completion of patching and finishing, within 24 hours of removal from the form, the units shall be placed under two layers of light coloured filter fabric (Nilex C-14 or equivalent) at an ambient temperature of not less than 15 degrees Celsius. The filter fabric shall be kept in a continuously wet condition throughout the curing period by means of a soaker hose

or other means as reviewed and accepted by the Department. Curing with filter fabric and water shall be maintained for a minimum period of seven days.

For curing of MSE precast concrete fascia panels, covering with filter fabric is not required provided that the moist curing system maintains a continuously wet condition at all panel surfaces.

(c) Curing Data

- The Contractor shall record and provide “In the Form” and “After Removal from the Form” including ramp-up and ramp-down curing data to the Department as follows:
 - Structure number;
 - Precast unit serial number;
 - Date cast;
 - Curing start date;
 - Additional curing days due to non-compliance; and
 - Curing completion date.
 - The above noted information also showing Time-Temperature-Humidity shall be provided in a coloured graphical format.

(11) Release of Prestressing Strand

The prestressing strand shall not be released until the specified concrete release strength is attained, and the release shall be in accordance with the accepted sequence.

Evidence of casting defects shall be repaired prior to release of the prestressing strands.

(12) Repairing Damaged Concrete

Serious damage, honeycombing and other casting defects shall be immediately reported to the Design Engineer and to the Department.

Repairs to defects such as cracks, honeycombs or spalls shall be carried out in accordance with this section. Units with unacceptable cracks, honeycombs or spalls shall be rejected.

All repair procedures shall be developed by a Professional Engineer accepted by the Design Engineer and reviewed by the Department prior to the commencement of the repair. All repairs shall be completed prior to curing of the unit at an ambient temperature of 15 degrees Celsius to 30 degrees Celsius, and units shall be protected from dehydrating prior to curing.

In this section, the “bearing area” of an NU or ‘I’ shape girder is defined as the portion of the girder bottom flange up to the underside, but not including the radiused transition between the bottom flange and the web, directly above the bearing. The bearing area for a box girder is the thickness of bottom soffit or 145mm whichever is greater. The bearing area extends from the end of the unit to 75 mm beyond the edge of the shoe plate. The “anchorage area” of a girder is defined as the full-height portion of the girder that is within two times the girder depth from the end of the girder but is not in the bearing area.

(i) Cracks

The following cracks are unacceptable and shall result in rejection of the unit unless accepted and signed off by the Design Engineer and accepted in writing by the Department:

- Cracks in the bearing area of a girder;

- Cracks in the anchorage area of a girder exceeding 0.5 mm in width or longer than 300mm; and
- Cracks outside of the girder bearing and anchorage areas exceeding 0.2 mm in width or longer than 300 mm.

All repairable cracks 0.2 mm or greater in width shall be repaired by epoxy injection in accordance with the manufacturer's instructions. Coring shall be carried out to confirm the penetration of the epoxy into the crack, if so requested by the Department.

The Contractor shall immediately notify the Design Engineer and the Department if a crack that has the potential to be a shear crack exceeds 0.15 mm in width and is longer than 0.25 times the girder depth. The crack length shall be measured along the horizontal axis, and a crack shall be considered to be a shear crack if it is inclined at an angle between 30° and 60° from the horizontal.

(ii) **Honeycombs and Spalls**

The following conditions of honeycomb or spall are unacceptable and shall result in rejection of the unit unless accepted and signed off by the Design Engineer and accepted in writing by the Department:

- Any honeycomb or spall in the bearing or anchorage areas of a girder;
- Major honeycombs and spalls in areas outside the bearing or anchorage areas of a girder; and
- Honeycombs and spalls in precast units shall be considered major if more than 30 mm deep or more than 0.1 m² in area.

When approved by the Design Engineer and reviewed by the Department, repairs for honeycombs and spalls may be made using a cementitious material. Repairs of minor honeycombs and spalls may be made after destressing of the girder. However major honeycombs and spalls shall be repaired before destressing the girder.

(13) Sealers

The Contractor shall supply and install an approved Type 1c sealer to the girder surfaces as shown on Drawing SK-1 (Finishes and Sealing for Exterior Concrete Girders) in Appendix B. Type 1c sealers shall be in accordance with Section 300.5.7.17 (Type 1c Sealer) and pigmented sealer shall be in accordance with Section 300.5.7.16.4 (Class 3. Bonded Concrete Surface Finish). The sealer shall be applied on clean dry surfaces free of form oil, and in accordance with the manufacturer's recommendations.

The Contractor shall ensure that the sealer is not applied in the grout pockets, lifting hook pockets or areas of the girders that will have field concrete cast against them.

The Department reserves the right to sample and test the sealer supplied by the Contractor.

(14) Sandblasting

The roughening of concrete surfaces in shear key, block out, diaphragm and girder end void locations shall be achieved by sandblasting or other methods acceptable to the Department. The roughening shall be sufficient to remove all laitance and uniformly expose the aggregate particles.

(15) Dimensional Tolerances of Cast Units

The maximum dimensional deviation in mm, of cast units from that as detailed on the Detailed Designs shall not exceed the following:

Length	-	$\pm 20 \text{ mm} \times \text{length (m)} \div 50$
Width	-	$\pm 3 \text{ mm}$
Depth	-	$\pm 5 \text{ mm}$
Camber	-	$\pm 20 \text{ mm} \times \text{length (m)} \div 50$
Sweep (NU Girders)*	-	1 mm/m
Sweep (Other Girders)*	-	deviation from true, $20 \text{ mm} \times \text{length (m)} \div 50$
Projection of Stirrups		
Top of Girder	-	$\pm 12 \text{ mm}$
Bearing Areas	-	out of flatness of bearing areas, 3 mm
Bulkheads	-	warpage or tilt of ends, 5 mm
Rail Anchor Rods	-	out of line, 5 mm
	-	in spacing, 5 mm
	-	in projection, 5 mm
Dowel Holes	-	out of plumb, 5 mm
Void Location	-	surface to void dimension, $\pm 15 \text{ mm}$ after casting

* Measured in the plant immediately prior to shipping to site.

(16) Handling and Storage

Precast units shall be handled by means of accepted lifting devices at designated locations. Units shall be maintained in an upright position, supported near the ends and on stable foundations.

(17) Identification of Units

Fabricator's name, year of manufacture, unit serial number and design loading shall be cast into the bottom of the units in 50 mm letters about 1.0 m from the unit end.

(18) Intentionally Deleted

300.5.9.8 Testing and Inspection

(1) Access

The Contractor shall provide the Department with suitable and safe access to the works for the purposes of testing and inspection of the precast concrete units. The Contractor shall provide the following:

- (a) Cylinder storage box with temperature control and a max./min. thermometer, as per CSA A23.2-3C; and
- (b) A calibrated weigh scale.

(2) Responsibility

The Contractor shall be responsible for all quality control and relevant testing. Inspection of the units by the Department shall not relieve the Contractor of its responsibility for quality control.

(3) Witness Points

To ensure that each stage of inspection is performed in an orderly manner, during the fabrication of major structures, witness points shall be set up at specific points. The following stages of fabrication shall be checked by the Contractor and the independent inspector, and all deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication.

Typical witness points for a prestressed/precast concrete unit are:

- (a) Form dimensions and set-up;
 - (b) Placement and stressing of prestressing strands;
 - (c) Pre-pour inspection;
 - (d) Concrete testing;
 - (e) Form stripping and de-stressing operation;
 - (f) Clean-up, patching and repairs;
 - (g) Curing;
 - (h) Post-pour inspection;
 - (i) Finishing and application of sealers;
 - (j) Storage of units; and
 - (k) Final inspection prior to shipping.
- The witness points for a non-prestressed unit shall be the same as those noted above except the stressing.

(4) Test Methods

Sampling, making, curing and testing concrete specimens shall be in accordance with the requirements of the following CSA standards:

- Sampling - A23.2-1C;
- Concrete Test Cylinders - A23.2-3C;
- Testing Concrete Cylinders - A23.2 - 9C;
- Air Content - A23.2-4C;
- Density of Concrete - A23.2-6C; and
- Air Void Determination – A23.2-17C.

(5) Independent Inspection, Testing and Reporting by the Contractor

The Contractor shall perform quality control inspection, testing and reporting as described below. All test records made by the fabricating shop in the course of normal quality control shall be open to the Department for inspection.

Independent Inspector's Qualification

As part of the Contractor's quality control the Contractor shall retain an independent inspector. The independent inspector shall be employed by a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor. The inspectors shall have direct communication with the Department.

The independent inspector shall have the following qualification:

- ACI/CSA Level I training; and
- Precast/Prestressed Concrete Institute (PCI) Level II training, in addition the inspector must have experience of a minimum of three major projects of the appropriate category accepted by the Department.

DUTIES & REPOSNSIBILITIES OF THE INDEPENDENT INSPECTOR

The independent inspector shall be in the plant and perform inspection duties at least 50% of the time throughout the course of fabrication for precast concrete units. The independent inspector shall ensure that all the requirements of the Detailed Designs and the Technical Requirements are met. The independent inspector shall perform inspection during all phases of fabrication and shall include, but not limited to:

- Develop inspection forms to be reviewed by the Department;
- Verify plant certification;
- Attend a pre-fabrication meeting and any subsequent meetings;
- Review of concrete batching as per the accepted mix design (weekly);
- Review of all MTR's and provide material traceability for prestressing strands and stainless steel rebar;
- Check form set-up;
- Check post tensioning (PT) ducts (size, duct measurements, splices and supports);
- Witness stressing operation, including de-bonding of prestressing strands;
- Perform pre-pour inspection;
- Check concrete casting and witness concrete testing;
- Observe application of concrete finishing & curing in the form;
- Perform post-pour inspection, i.e. removal from the form and finishing. Dimensional and tolerance check including measurement of camber and sweep;
- Identify crack and honeycomb areas;
- Check and report all non-conformances.
- Witness all repairs are done according to the accepted procedure/s;
- Check curing records including ramp-up and ramp-down phases;
- Check storage/dunnage;
- Check sealer application;
- Check areas that require roughening;
- Shipping; and
- Records & reports.

CONCRETE TESTING

The Contractor shall engage an independent concrete testing laboratory certified to CSA A283 to conduct all the required concrete testing and ensure that the concrete supply meets all requirements of the Technical Requirements. The Independent Concrete Testing Laboratory shall be a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or its subcontractors.

The Contractor shall maintain the required air entrainment by testing and making adjustments to the mix prior to and during the placing of concrete in the forms.

The Independent Concrete Testing Laboratory shall make and test concrete cylinders to determine the 28-day compressive strength. Samples for testing shall be taken from the fresh concrete being placed in the forms at the rate of one set of cylinders for every three bridge units cast continuously. A set shall consist of a minimum of three cylinders. A strength test will be the

average of the 28-day strengths of the three cylinders (one set). Continuous casting shall mean no break in the casting longer than one hour.

INDEPENDENT INSPECTION REPORTS

Weekly inspection reports for the precast concrete units reviewed by the Field Review Engineer shall be electronically submitted to the Department and as a minimum shall include:

- Lead material; such as the Department's bridge file number, structure name/number, report number, report date, inspector's name, applicable codes and standards;
- MTRs and load/elongation curves for the prestressing strand;
- Pre-pour check list;
- PT Duct profile (for PT girders);
- Daily stressing sheets;
- Curing records;
- Concrete test results;
- NCRs and repairs; and
- Post-pour check list.

FINAL INDEPENDENT INSPECTION REPORT

A final report prepared by the independent inspector reviewed by the Field Review Engineer shall be electronically submitted to the Department four weeks after the fabrication of each structure. It shall include:

- Signed and stamped certificate by the Field Review Engineer.
- Final shop drawings.
- Installation/Erection procedures.
- Company certification.
- Signed certificate by the independent inspector.
- Stressing calculations and equipment calibration certificates.
- Concrete Mix Design including supporting documents for all the components.
- Load/Elongation curves for the prestressing strand.
- Mill Test Reports for all material with traceability of prestressing strand and stainless steel rebar.
- Product data sheets for all material.
- The following information for each prestressed concrete girder shall be included:
 - Weekly inspection reports.
 - Pre-pour check list.
 - Curing graphs.
 - Post pour check list.
 - Dimensional check.
 - Camber, sweep and tolerance measurements.
 - Concrete test results.
 - Stressing records.
- Non-Conformance Reports and any site instructions or design changes.

- The Field Review Engineer shall review the work and associated documentation and provide a certificate that the fabricated materials have been built according to the Detailed Design and the Technical Requirements.

(6) Release Strength Test Cylinders

The Contractor shall arrange to make and test concrete cylinders to prove that the required release strength as stated on the Detailed Designs has been attained prior to release of the prestressing strand. When one or more units are cast continuously, at least two cylinders shall be taken from the concrete of the last unit poured to represent the release strength for all units. These cylinders shall be cured with the bridge unit. Only testing of the first cylinder will be necessary if the required release strength is obtained. In the event all cylinders are tested without the required strength being obtained, the Contractor's Design Engineer and the Department shall be notified.

300.5.9.9 Failure To Meet Strength Requirements**(1) Right of Rejection**

The Department reserves the right to reject any concrete whatsoever which does not meet the specified strength determined in accordance with this Section 300.5.9 (Precast Concrete Units and Post-Tensioning).

In the event that the concrete tested is more than 4 MPa below the specified 28-day compressive strength, the bridge units fabricated from the concrete represented by the test specimens shall be rejected. In the event that the unit has been delivered and/or erected in the field, it shall be removed and returned to the Contractor's plant for replacement.

(2) Coring for Compressive Strength Testing

If any concrete tested fails to meet the specified strength, the Contractor may request permission to core. If the coring is accepted by the Department, the Contractor shall make arrangements, to employ a qualified testing laboratory at the Contractor's expense.

The Field Review Engineer shall specify the location of the coring to ensure that the cores represent the same concrete as the cylinders. The average of three adjacent cores taken from one bridge unit shall constitute a test. The cores shall be taken and tested by an Independent Concrete Testing Laboratory in accordance with CSA Standard A23.2-14C within seven days of the date of testing the 28-day cylinders. CSA Standard A23.1-09, Clause 4.4.6.6.2 "Cores drilled from a structure" shall not apply. The average strength of each set of three cores shall be equal to or greater than the 28-day specified strength. The core test will represent all bridge units represented by the strength test. Alternatively, the Contractor may choose to take a core test from each of the other units in question, in which case each of these core tests will then represent a bridge unit.

The acceptability of the as-delivered concrete shall be determined using the concrete cylinders, with the modification set out in the next two sentences. In cases where the concrete strength, as indicated by the cores, is higher than the strength based on the concrete cylinder results, the core results shall be used as the basis for acceptance of the concrete. If the core strengths are lower than the strength from the concrete cylinder tests, the cylinder tests shall govern.

300.5.9.10 Erection of Precast Concrete Units**300.5.9.10.1 General**

The Contractor shall erect the units, remove any temporary construction, and do all work required to complete the erection in accordance with the Detailed Designs and the Technical Requirements. No drilling, coring, nailing, retrofitting of any fastening or anchoring systems, or any other modifications shall be made to the concrete elements. The Contractor shall not erect precast concrete girders until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28-day specified concrete strength requirements.

Without restricting generality, erection includes:

- Removing anchor rod grout can void form;
- Erecting the girders;
- Placing and grouting of connector bolts and diaphragms;
- Post-tensioning; and
- Cutting-off lifting hooks and grouting lifting holes on exterior girders and all lifting hook pockets.

300.5.9.10.2 Handling And Storing Materials

Precast concrete units to be stored shall be placed upright and shored on timber blocking and kept clean and properly drained.

300.5.9.10.3 Temporary Supporting Structures And Berms

The temporary supporting structures and berms shall be properly designed and substantially constructed and maintained for the forces which may come upon them. Berms shall be constructed in a manner and of such materials that they will not be eroded by stream flow nor introduce silt into the water. The Contractor shall prepare drawings for temporary supporting structures and berms, and for traffic control and accommodation where applicable. All drawings shall bear the seal of a Professional Engineer.

Temporary supporting structures and/or berms will not be permitted to remain in any stream channel during spring break-up or run-off periods, unless all necessary approvals have been obtained by the Contractor from pertinent agencies.

Incidental damage to other property, such as fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.

300.5.9.10.4 Erection Procedure

The Contractor shall prepare a detailed erection procedure for review in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following:

- (a) Access to work, earth berms and work bridges;
- (b) Type and capacity of equipment. Cranes shall be used for handling and erecting precast concrete units;
- (c) Sequence of operation, including position of cranes, trucks with girders, and traffic

accommodation;

- (d) Detailed crane position on the ground, particularly adjacent to substructure elements, such as abutment backwalls, with details of load distribution on wheels and outriggers;
- (e) Details of crane position on the structure, showing wheel loads and axle spacing of equipment moving on structure;
- (f) Loads and their position from crane wheels and outriggers during all positions of lifting when crane is on structure;
- (g) Details of temporary works, supporting structure drawings, including proposed methods to be used to ensure the required splice elevations and structure shape prior to placing concrete, and/or post-tensioning and method of providing temporary supports for stability;
- (h) Details of lifting of units, showing vertical forces at lifting hooks;
- (i) Provisions for control and adjustment of errors for width and positioning of curbs or exterior units;
- (j) Complete details of blocking for bearings where necessary to constrain movements due to horizontal forces and/or gravity effects;
- (k) Details of post-tensioning procedures, including prestressing strand specifications, jack dimensions, pressures, forces and elongations, and grouting;
- (l) Details of release of temporary supporting structures; and
- (m) Provide an “as-built” detailed survey of the substructure showing the following:
 - o location and elevation of all bearing grout pad recesses;
 - o shim height at each bearing location; and
 - o top of girder elevations at each bearing (and each splice location where appropriate).
 - o

The erection procedure shall bear the seal of a Professional Engineer, who shall assume full responsibility to ensure that its design is being followed. Safety and compliance with the *Occupational Health and Safety Act* (Alberta) and regulations thereunder, shall be integral parts of the design.

Before erection begins the Contractor shall do a complete superstructure layout by means of chalk lines and markings applied to all substructure units, showing bearing and girder positions in accordance with the approved layout plan.

300.5.9.10.5 Girder Adjustments

It is essential that the girders be erected with utmost attention being given to girder positioning, alignment, and elevation. The Contractor shall adjust girder position, bearing location and bearing elevation in order to achieve as closely as possible the lines and grades shown on the

Detailed Designs. The Contractor shall minimize any differential camber (girder to girder), and the sweep of the girders, by jacking, loading of girders, winching, or whatever means are necessary, and shall provide the necessary temporary attachments to hold the girders in position.

The maximum dimensional deviation in mm, of erected precast concrete units from that as detailed on the Detailed Designs shall not exceed the following:

- Sweep (NU and I shaped Girders) 1 mm/m
- Sweep (Other Units) ... deviation from true, 20mm x length (m) divided by 50

300.5.9.10.6 Intentionally Deleted

300.5.9.10.7 Intentionally Deleted

300.5.9.10.8 Intentionally Deleted

300.5.9.10.9 Assembly

The parts shall be accurately assembled as shown on the Detailed Designs. The material shall be carefully handled so that no parts will be distorted, broken or otherwise damaged. Bearing surfaces, and surfaces to be in permanent contact, shall be cleaned before the members are assembled. Diaphragms shall be erected as indicated on the Detailed Designs.

300.5.9.10.10 Lifting Hooks and Lifting Holes

After the girders are properly erected and positioned, all lifting holes on exterior girders shall be filled with a patching material that is an Approved Product. All lifting hooks shall be cut off 50 mm below surface, and all lifting hook pockets shall be grout filled with a patching material that is an Approved Product.

300.5.9.10.11 Removal of Falsework and Site Clean-Up

Upon completion of the erection the Contractor shall remove all earth material or temporary supporting structures placed in the stream channel or elsewhere during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of its work.

The Contractor shall leave the bridge site, roadway and adjacent property in a neat restored, and presentable condition, and when required, the Contractor shall provide the Department with written evidence that affected property owners or regulatory agencies have been satisfied.

300.5.9.10.12 Post-Tensioning

300.5.9.10.12.1 General

This work consists of post-tensioning and grouting of cable ducts, both for cast-in-place and precast concrete.

300.5.9.10.12.2 Submissions

The following information shall be submitted to the Department:

- Certification of post-tensioning operation & grouting personnel;

- Quality control test data for grout indicating requirements listed in Tables 10.9.3-1 and 10.9.3-2 of AASHTO LRFD Bridge Construction Specifications are met (seven days prior to grouting);
- Post-tensioning drawings illustrating the stressing system and, where appropriate, design details and sequence of stressing reviewed by the Design Engineer;
- Stressing calculations taking into account all applicable losses;
- Equipment calibration certificates;
- Load/elongation curves for the prestressing strand;
- Mill test reports and material traceability for the prestressing strand bearing plates, wedge plates, trumpets and wedges (seven days prior to stressing and grouting);
- Details of permanent anchoring devices;
- Field inspection reports; and
- Grout testing reports.

300.5.9.10.12.3 Standards

Applicable requirements of the current edition of the following standards shall be followed:

- CSA A23.1/23.2 – Concrete Materials and Method of Concrete Construction;
- CSA A23.4 – Precast Concrete Materials and Construction;
- Section 300.5.7 (Cast-in-Place Concrete);
- Guide Specification Acceptance Standards for Post Tensioning Systems – Post Tensioning Institute (“PTI”);
- Specifications for Grouting of Post Tensioned Structures (“PTI”); and
- AASHTO LRFD Bridge Construction Specifications.

300.5.9.10.12.4 Qualification

The Contractor, or its subcontractor, shall have extensive experience in this work and shall utilize only fully trained, competent and experienced operators. The Contractor shall ensure that the site supervisor responsible for the tensioning and grouting operations is at the site whenever these operations are being carried out. The qualification of stressing and grouting operations personnel shall be as follows:

- The direct supervisor of post tensioning operations shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each installation and stressing crew shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each grouting crew shall be certified to PTI Level 2 Bonded PT Field Specialist; and
- At least 25% of each crew shall be certified in PTI Level 1 Bonded PT – Field Installation.

300.5.9.10.12.5 Materials

(1) Prestressing Strand

Prestressing strand shall conform to the requirements of Sections 300.5.9.6(9) and 300.5.9.7(3) (Prestressing Strand).

The complete operation of placing and stressing of prestressing strands as well as grouting of all

the ducts shall be completed within 20 days. The stressing records shall be forwarded to the Field Review Engineer for approval. The grouting operation including Field Review Engineer's approval shall be completed within 72 hours of stressing the prestressing strands.

(2) Anchorages and Distribution

All stressing steel shall be secured at the ends by means of permanent anchoring devices. These devices shall comply with *CAN/CSA S6* Clause 8.4.4.1.

Steel distribution plates or assemblies may be omitted when the anchoring devices are sufficiently large and used in conjunction with an embedded steel grillage that effectively distributes the compressive stresses to the concrete.

(3) Ducts

Ducts shall be corrugated, semi-rigid galvanized metal tubes and be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of cement paste during the placement of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of supports. The interval between supports shall not exceed 1.0 m.

The Contractor shall provide mortar tight inlets and outlets in all ducts with a nominal diameter of 20 mm in the following locations:

- The anchorage area;
- All high points of the duct, when the vertical distance between the highest and lowest point is more than 500 mm;
- Place an inlet at or near the lowest point; and
- Place a free draining outlet at all low points of duct.

The Contractor shall provide inlets and outlets with valves, caps or other devices capable of withstanding the grouting pressure. The ducts and vents shall be securely fastened in place to prevent movement. The Contractor shall provide details of inlets and outlets on the shop drawings.

(4) Concrete

Concrete shall be supplied in accordance with Section 300.5.7 (Cast-in-Place Concrete), however the maximum size of coarse aggregate shall be 10 mm and the 28 day compressive strength shall be a minimum of 50 MPa.

(5) Grout

Grout shall be Class C as described in Table 10.9.3-1 of, and the properties as described in Table 10.9.3-2 of, the AASHTO LRFD Bridge Construction Specifications. In addition to the requirements noted in these tables, a test for wet density shall also be performed in accordance with the "Standard Test Method for Density" ASTM C138. Prebagged grouts shall be packaged in plastic lined bags or coated containers, stamped with the date of manufacture, lot number and mixing instructions. Copies of the quality control data for each lot number and shipment sent to the job site shall be provided to the Department for review prior to grouting. Materials with a total time from manufacture to usage in excess of six months shall be retested and certified by the supplier before use, or shall be removed from the job site and replaced.

The average minimum compressive strength of 3 cubes at 28 days shall be a minimum of 50 MPa as per CSA A23.2-1B. The results for bleed test and fluidity test shall meet the requirements noted in Table 10.9.3-2 of the AASHTO *LRFD Bridge Construction Specifications*.

The Contractor is responsible to perform all grout testing in the field and shall notify the Department a minimum of 24 hours prior to grouting and grout testing in the field. The frequency of grout testing shall be as follows:

Strength Test

Precast Concrete Girders: One strength test per girder line
 Cast-In-Place Girders: One strength test for every four longitudinal ducts
 Straddle Bent: One strength test for every two longitudinal ducts
 The strength test shall be done by an Independent Concrete Testing Laboratory certified to CSA A283.

Bleed Test

At the beginning of each day's grouting operation, perform a wick induced bleed test in accordance with ASTM C940 and with modifications noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.

Fluidity Test

At the inlet and outlet, perform fluidity test in accordance with the standard ASTM C939 flow cone test or the modified ASTM C939 flow cone test.

Wet Density Test

Perform wet density test in accordance with American Petroleum Institute Mud Balance Test API Practice 13B-1 "Standard Procedures for Field Testing Water-Based Drilling Fluids".

300.5.9.10.12.6 Equipment

(1) Stressing

- Hydraulic jacks and pumps of sufficient capacity shall be used for tensioning of prestressing strands;
- The force induced in the prestressing strand shall be measured using calibrated jacking gauges, load cells or a calibrated dynamometer;
- The pressure gauge shall have an accurate reading dial at least 150 mm in diameter;
- The forces to be measured shall be within 25 and 75% of the total graduated capacity of the gauge, unless calibration data clearly establishes consistent accuracy over a wider range; and
- The measuring devices shall be calibrated at least once every six months. The jack and the gauge shall be calibrated as a unit. A certified calibration chart shall be kept with each gauge.

(2) Grouting

- A high speed shear mixer shall be used that is capable of continuous mechanical mixing and producing grout that is free of lumps and undispersed cement. The water supply to the mixer shall be measured by an accurate gauge;
- The holding tank shall be capable of keeping the mixed grout in continuous motion until it is used. The outlet to the pump shall have a screen with 3 mm

maximum clear opening;

- A positive displacement type pump shall be used which is capable of producing an outlet pressure of at least 1.0 MPa. A pressure gauge having a full-scale reading of no greater than 2 MPa shall be placed at some point in the grout line between the pump outlet and the duct inlet. A spare fully functional pump shall also be on site;
- Standby flushing equipment with water supply shall be available at the site prior to commencing grouting;
- The grouting equipment shall be of sufficient capacity to ensure that grouting of the longest duct can be completed within 30 minutes after mixing; and
- Grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grout pressure. All connections from the grout pump to the duct shall be airtight so that air cannot be drawn into the duct.

300.5.9.10.12.7 Construction

(1) Checking Post Tensioning Ducts

Prior to placing post-tensioning steel, the Contractor shall verify that all ducts are unobstructed.

(2) Welding

Welding of stressing tendons shall not be permitted. Stressing tendons shall not be used as an electrical “ground”. Where the ends of prestressing strands are welded together to form a tendon so that the tendon may be pulled through the ducts, the length of the prestressing strands used as an electrical “ground” or 1.0 m, whichever is greater, shall be cut off from the welded end prior to stressing.

(3) Tensioning

Post-tensioning shall be carried out as per the Detailed Designs and stressing calculations. The stressing and release of tendons shall be done in the sequence specified on the Detailed Designs. All prestressing strands in each tendon shall be stressed simultaneously with a multi-strand jack. The force in the tendons shall be measured by means of pressure gauge and shall be verified by means of tendon elongation. All tendons shall be tensioned to a preliminary force as necessary to eliminate any slack in the tensioning system before elongation readings are started. This preliminary force shall be between 15 and 25 percent of the final jacking force.

Stressing tails of post-tensioned tendons shall not be cut off until the record of gauge pressures and tendon elongations has been reviewed by the Field Review Engineer. A record of the following post-tensioning operations shall be kept for each tendon installed and shall include the following:

- Project Name and File Number;
- Subcontractor;
- Tendon location and size;
- Date tendon installed;
- Tendon pack/heat number;
- Modulus of elasticity (E);
- Date stressed;
- Jack and gauge identifier;
- Required jacking force and gauge pressures;

- Elongation (anticipated and actual);
- Anchor set (anticipated and actual);
- Stressing sequence;
- Witnesses to stressing operation;
- Grout information (Brand Name);
- Time for grouting each tendon; and
- Date grouted.

Stressing records and field grout testing reports accepted by the Field Review Engineer shall be forwarded to the Department within five weeks of stressing and grouting operations of each structure.

(4) Concreting

The anchorage recesses shall be concreted after tensioning but before grouting the tendons.

The concrete surface of the anchorage recesses shall be abrasive blasted. The recesses shall be thoroughly wetted and covered with a thin cement scrub coat immediately before placing fresh concrete.

(5) Grouting

All ducts or openings shall be clean and free of all deleterious matter that would impair bonding of the grout to the ducts and stressing steel. All ducts shall be thoroughly blown out with compressed oil free air. All inlets and outlets shall be checked for their capacity to accept injection of grout by blowing compressed oil free air through the system.

Before stressing and grouting internal or external tendons, install all grout caps, inlets and outlets and test each tendon with compressed air to determine whether duct connections need repair. Pressurise the tendon to 345 kPa (50 psi) and lock-off the outside air source. Record pressure for 1 minute. A pressure loss of 170 kPa (25 psi) is acceptable for tendons up to 45 m long, and a pressure loss of 100 kPa (15 psi) is acceptable for tendons longer than this. If the pressure loss exceeds the maximum allowed, repair leaking connections using methods accepted by the Department, and retest.

A thoroughly mixed grout, meeting all the requirements described in this Section 300.5.9.10.12.7 (5) (Grouting) shall be passed through a screen with 3 mm maximum clear openings before entering the pump. All grout vents shall be opened prior to commencement of grouting. The duct shall be completely filled by injecting grout from the lowest end of the tendon in an uphill direction. Grout shall be pumped continuously through the duct until no visible signs of water or air are ejected at the outlet. A fully operational grout pump shall be on site for all pumping procedures. A continuous, one way flow of grout shall be maintained at a rate of 5 to 15 lineal metres of duct per minute. The grouting of a tendon shall be completed within 30 minutes of mixing of the grout.

Normal pumping pressure shall be between 0.1 MPa and 0.4 MPa measured at the inlet. The pumping pressure at the injection vent shall not exceed 1 MPa. If the actual pressure exceeds the maximum allowed, the injection vent shall be closed and the grout shall be injected at the next vent that has been or is ready to be closed as long as one-way flow is maintained. Grout shall not be injected into a succeeding vent from which grout has not yet flowed. For each tendon, immediately after uncontaminated uniform grout discharge begins, a fluidity test shall be performed on each tendon from the discharge outlet. The measured grout efflux time shall not be

faster than the efflux time measured at the inlet or the minimum efflux time established. If the grout efflux time is not acceptable, additional grout shall be discharged from the discharge outlet. Grout efflux time shall be tested. This cycle shall be continued until acceptable grout fluidity is achieved. In addition to fluidity test, check the grout density using the wet density method. The density at the final outlet shall not be less than the grout density at the inlet. To ensure the tendon remains filled with grout, the ejection and injection vents shall be closed in sequence, respectively under pressure when the tendon duct is completely filled with grout. Valves and caps are not to be removed until the grout has set.

Grouting shall not be done when the air temperature is below 5 degrees Celsius or above 25 degrees Celsius, nor when there are other conditions that would be detrimental to the grouting operations.

The Contractor shall provide 50 mm deep grout tube termination recesses formed around the tubes projecting from top of the deck. After grouting, all tubes shall be cut flush with the bottom of the recesses, and the recesses shall then be grouted flush with the top of the deck.

300.5.10 CONSTRUCTION OF CSP AND SPCSP STRUCTURES

300.5.10.1 General

This Section 300.5.10 (Construction of CSP and SPCSP Structures) is for the supply, fabrication, handling, delivery and installation of Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe with an equivalent diameter of 1.5 m or greater.

Abbreviations for the various types of metal pipe are as follows:

- CSP Corrugated Steel Pipe
- CSP Arch Corrugated Steel Pipe Arch
- SPCSP Structural Plate Corrugated Steel Pipe
- SPCSP Arch Structural Plate Corrugated Steel Pipe Arch

300.5.10.2 Submissions

The following information shall be submitted to the Department by the Contractor by a date that is reasonable having regard to the design and construction process and in any event no later than 21 days after request by the Department, acting reasonably:

- Shop drawings (two copies); and
- Dates fabricated materials are to be shipped from the fabricating plant. This information shall be provided to the Department a minimum of two days prior to shipping.

300.5.10.3 Reference Drawings

Standard Drawing S-1418-03 (Installation of Large Steel Pipes).

300.5.10.4 Reference Tables (attached in Appendix B)

Details of Standard 2:1 Sloped End Sections for CSP Round Culverts	Table A
Details of Standard 2:1 Sloped End Sections for CSP Arch Culverts	Table B
Details of Standard 2:1 Sloped End Sections for SPCSP Round Culverts	Table C

300.5.10.5 Supply and Fabrication**300.5.10.5.1 Standards**

The supply and fabrication of all galvanized, polymer coated and aluminum coated Corrugated Steel Pipe including couplers and appurtenances and Structural Plate Corrugated Steel Pipe shall be in accordance with the current edition of CAN/CSA Standard G401 with additions and exceptions as described in this Section 300.5.10 (Construction of CSP and SPCSP Structures).

300.5.10.5.2 Engineering Data**(1) Shop Drawings**

Shop drawings for SPCSP structures and any non-standard materials (e.g. elbows, bottomless arch details, horizontal ellipses, etc.) as well as bevel end details shall be prepared.

(2) Plate Arrangement

The arrangement of the plates for SPCSP structures shall be shown on the shop drawings. The shop drawings shall also indicate that the bolts in the valley of each longitudinal seam are nearer to the visible edge of the plate than the bolts in the crest. With the exception of “change of radii” locations, all longitudinal seams shall be staggered a minimum of 2N.

300.5.10.5.3 Materials

Previously installed pipe shall not be used. All pipe supplied shall be supplied in accordance with CAN/CSA G401.

300.5.10.5.4 Fabrication**(1) Fabrication of CSP****(a) Sloped Ends**

Sloped end sections are required for each culvert unless otherwise shown in the Detailed Designs. When 2:1 sloped end sections are specified, the Reference Tables A and B (see Section 300.5.10.4 (Reference Tables (attached in Appendix B))) will apply unless stated otherwise.

(b) Termination of Lockseams

On pipes 1.0m diameter or larger all lockseams terminating at the cut edges of a sloped or square end section shall have a 75mm length of fillet weld run along both sides of the lockseam (staggered 300mm apart) at each cut edge. The weld and surrounding area shall be zinc coated in accordance with CAN/CSA G401.

(c) Cut Ends

All cut edges of a sloped or square end section shall be made smooth by grinding so that all the burrs are removed. Any damaged protective coating shall be recoated with appropriate material in accordance with CAN/CSA G401.

(d) Re-corrugated Ends

All corrugated steel pipes shall have ends re-corrugated to provide annular corrugations for couplers.

(e) Couplers

Only annular corrugated couplers will be accepted unless specified otherwise. The couplers for pipes 1.6 m and over in diameter shall be a minimum of 600 mm width. There shall be a minimum of five bolts per coupler.

(2) Fabrication of SPCSP**(a) Sloped Ends**

Sloped end sections are required for each culvert unless otherwise noted on the Detailed Designs. When 2:1 sloped end sections are specified, the Reference Table C (see Section 300.5.10.4 (Reference Tables (attached in Appendix B))) will apply unless stated otherwise.

300.5.10.5.5 Shop Inspection**(1) Inspection, Sampling, and Testing**

All materials shall be subject to inspection by the Department. The Contractor shall provide safe, convenient access acceptable to the Department for inspection and sampling of the materials, and shall cooperate in the inspection and sampling process when requested to do so.

(2) Notification

The Contractor shall contact the Department prior to contemplated shipment. This is to facilitate inspection of the materials at the plant.

300.5.10.5.6 Storage of Material**(1) Storage Stains**

In addition to CAN/CSA G401, SPCSP material is to be stored concave down. This requirement is to reduce the occurrence of storage stain damage on plates that are not going to be assembled immediately.

300.5.10.5.7 Handling of Material

All culvert material shall be handled carefully and in such manner as to prevent bruising, scaling or breaking of the galvanized coating. Culvert material shall also be handled and unloaded without undue stress and in such a manner that the radii or dimensions of the pipes remain true. Coupling bands shall be shipped with all necessary hardware and fittings attached thereto, or in suitable shipping containers. All SPCSP bolts are to be shipped with plates. Where the material supplied is damaged, the Contractor shall immediately separate nested sections of plate or pipe to facilitate more detailed inspection.

300.5.10.6 Installation

Metal pipes are flexible, and their resistance to deformation depends on careful bedding and backfilling. As they deflect under vertical load they must build up wide support and therefore, to obtain maximum load bearing capacity, it is essential that the material under and beside the pipe be of good quality, carefully placed and properly shaped and compacted as specified on the Detailed Designs. It is essential that the structure be kept dewatered to the bottom of the excavation until all backfilling is complete.

300.5.10.6.1 Bedding

Where the bottom of the excavation lies at 600 mm or less below the pipe invert the fill material shall be compacted by the Contractor to a minimum of 95% of Standard Proctor Density at optimum moisture content. Where the bottom of the excavation extends more than 600 mm below the pipe invert, the fill material shall be compacted at the 600 mm level to a minimum of 95% of Standard Proctor Density at optimum moisture content. The structural fill shall be placed in lifts not exceeding 150 mm when compacted. The Contractor shall use whatever materials,

labour, equipment and incidentals are necessary to achieve a stable bed.

When foundation conditions are considered soft and unstable, the Contractor shall supply and place woven geotextile filter fabric at the base of the excavation between the clay seals as shown on Standard Drawing S-1418-03 (Installation of Large Steel Pipes) (refer to Section 300.5.10.3 (Reference Drawings)). The woven geotextile filter fabric shall be in accordance with the following table:

Woven Geotextile Filter Fabric	
Specifications and Physical Properties	
Grab Strength (ASTM D4632)	1275 N
Elongation (Failure) (ASTM D4632)	15%
CBR Puncture Strength (ASTM D6241)	275 N
Trapezoidal Tear (ASTM D4533)	475 N
Minimum Fabric Lap to be 1.0 m	

The granular material within 150 mm of the bottom of pipe shall be placed in a loose uncompacted state. All other structural fill, including the clay seepage cutoffs, shall be compacted to a minimum of 95% of Standard Proctor Density at optimum moisture content.

The top of the bedding is that portion of the structural fill in contact with the bottom of the pipe and shall be constructed to the exact grade. Where camber is specified, the top of the bedding shall be constructed on a gradual crest curve with no sudden breaks in the grade. Where preshaping is specified, the top of the bedding shall be constructed to the exact curvature of the bottom plates. The top of the preshaping shall be 200 mm to 300 mm below the horizontal seam which joins the sidewall to the bottom plates, or as shown on the Detailed Designs.

300.5.10.6.2 Assembly

Assembly of CSP

CSP sections shall be laid so that the ends are in close contact. Couplers shall be well fitted and evenly tightened all around the pipe.

Assembly of SPCSP

SPCSP shall be assembled as shown on the drawings which will be provided by the pipe supplier and as outlined below:

- (a) All bolted seams shall be properly lapped and plates shall be in contact for the full width and length of the lap. The bolts in the valley of each longitudinal seam shall be nearer to the visible edge of the plate than the bolts in the crest.
- (b) After two complete rings have been loosely assembled, the vertical dimensions shall be checked and where necessary adjusted with horizontal cables and/or supports to obtain design rise dimensions.

- (c) Each adjacent ring shall then be assembled and adjusted in a similar manner until the entire structure is loosely assembled and conforms to design geometry with nested plates.
- (d) The vertical axis shall be upright and the longitudinal seams shall be straight. Rotation of the pipe and/or spiralling of the longitudinal seams shall not be permitted.
- (e) Adjustments shall be made to produce design dimensions with fully nested laps. When horizontal tie cables are used for shape adjustment, adequate means shall be taken to ensure distribution of concentrated forces at the pipe walls. Distortion of the pipe side walls at the cable points will not be tolerated.
- (f) Unless otherwise indicated by the manufacturer's specifications, bolts shall be torqued to not less than 200 Nm and not more than 340 Nm. This includes bolts which connect special features to the pipe.
- (g) Distortion of bolt holes caused by over-torquing, or poor assembly methods will not be permitted. Where additional holes are required they shall be drilled. Torch cutting of holes or welding on the pipe will not be permitted.
- (h) The shape of the pipe shall be maintained within two percent of design dimensions. This includes the rise, the span, and any chords or chord offsets.

300.5.10.6.3 Backfilling

When the assembly of the structure has been completed, backfilling with granular and or non-granular materials as specified on the Detailed Designs may proceed. In addition, the requirements set out in the four paragraphs below shall be met.

When the air temperature is below 0 degrees Celsius, no backfilling is allowed. All backfill materials shall be in a thawed state when placed and compacted. No backfill material will be permitted to be placed on frozen substrate.

The backfilling under the haunches shall be compacted in thin layers filling all corrugations and ensuring firm contact with the entire bottom surface of the pipe.

The backfilling shall fill each corrugation, be free of voids and provide uniform support to the pipe. The backfill shall be placed such that the level of fill on one side of the pipe does not exceed the level of fill on the other side of the pipe by more than 300 mm.

The Contractor shall supply suitable material for the compacted non-granular backfill. Generally the material shall consist of clay or till materials. Highly plastic clay material or material with a high silt content will not be permitted.

300.5.10.6.4 Strutting for Composite Concrete/SPCSP Structure

For composite concrete/SPCSP structures strutting and scaffolding shall be supplied and installed as shown on the Detailed Designs.

300.5.10.7 Concrete Work

Where detailed and specified, concrete work shall be constructed as shown on the Detailed

Designs and in accordance with the relevant sections of Section 300.5 (Bridge Structures):

- Section 300.5.7 - Cast-In-Place Concrete
- Section 300.5.14 - Reinforcing Steel

300.5.10.8 Fish Baffles

Fish baffles shall be constructed as shown in the Detailed Designs.

300.5.10.9 Rock Riprap

Rock riprap shall be placed as shown in the Detailed Designs.

300.5.11 MECHANICALLY STABILIZED EARTH WALLS

300.5.11.1 General

This Section 300.5.11 (Mechanically Stabilized Earth Walls) is for the supply, fabrication and construction of mechanically stabilized earth (“MSE”) retaining walls with precast concrete fascia panels. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete levelling pads, precast concrete fascia panels, compacted granular backfill, soil reinforcement, inspection wires, perforated drain pipe complete with filter fabric sock, geotextiles and geomembranes, surface drains, cast-in-place concrete wall coping, traffic barrier, pedestrian railing, permanent safety railing, hardware and all associated materials.

MSE retaining walls shall be constructed in accordance with the drawings and the provisions contained herein.

300.5.11.2 Submission

Shop drawings shall be authenticated in accordance with Section 100.2.1.1 (Design), and submitted in accordance with Section 300.3.3.7 (Bridge Shop Drawing Submission Requirements).

As minimum, shop drawings shall contain design criteria and materials lists, wall layout plan and elevation with dimensions and elevations and typical wall cross-sections, all components and connection details, site drainage and drainage details, reference to relevant Detailed Design drawings by drawing number, and construction procedures and construction sequence.

300.5.11.3 Materials

300.5.11.3.1 Concrete

Concrete for MSE wall precast concrete fascia panels, MSE wall levelling pad concrete, MSE wall anchor blocks, MSE wall backing blocks and MSE wall cast-in-place coping cap shall be as specified in Section 300.5.2.7 (Durability). The maximum aggregate size for HPC concrete used in precast concrete fascia panel production shall suit the precast concrete fascia panel design and the requirements of CAN/CSA S6 and CAN/CSA A23.1.

300.5.11.3.2 Concrete Reinforcing Steel Bars

Reinforcing steel bars shall be as specified in Section 300.5.2.7 (Durability).

300.5.11.3.3 Soil Reinforcement

Steel soil reinforcing, including inspection wires, shall meet the requirements of ASTM Standard A1064 and shall be galvanized in accordance with ASTM Standards A123/A123M and ASTM A123/A123M and ASTM F2329. All damage to galvanizing shall be repaired in accordance with ASTM A780.

Geosynthetic reinforcements shall meet AASHTO LRFD Bridge Design Specifications clause 11.10.6.4.3b and the requirements “for applications involving severe consequences of poor performance or failure” shall apply. Product specific durability studies shall be carried out to determine the product-specific long term strength reduction factor (RF). These studies shall be used to estimate the short term and long term effects of the environment factors on the strength and deformational characteristics of the geosynthetic reinforcement throughout the specified design life.

Geosynthetic reinforcing materials shall satisfy the requirements of the following tests with the understanding that the test methods are current at the time of construction:

- ASTM D7737-11 “Standard Test Method for Individual Geogrid Junction Strength”
- GG 2-87 “Standard Test Method for Geogrid Rib Junction Strength”
- ASTM D5262 - 07(2012) “Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics”
- GG4-05 “Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids”
- GG4(a) Revised 2012, “Standard Practice for Determination of the Long-Term Design Strength of Stiff Geogrids”
- GG4(b) Revised 2012, “Standard Practice for Determination of the Long-Term Design Strength of Flexible Geogrids”
- ASTM D6706 - 01(2013) “Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil”

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

The nominal long-term reinforcement design strength (T_{al}) values for specific products shall be determined by third party agencies such as the Highway Innovative Technology Evaluation Centre (“HITEC”) or AASHTO National Transportation Product Evaluation Program (“NTPEP”), and product lines shall be re-tested every 3 years at a minimum.

300.5.11.3.4 Safety Rail

Safety Rail shall be fabricated in accordance with Section 300.5.8 (Structural Steel).

300.5.11.3.5 MSE Wall Backfill

Backfill for construction of MSE walls shall be “crushed aggregate material” conforming to the gradation requirements listed in the following table, and shall be free of organic matter and other deleterious substances:

Designation/Class			
Metric Sieve Size (CGSB 8-GP-2M)	Crushed Aggregate Material	Crushed Aggregate Material	Crushed Aggregate Material
	Des 2 Class 20	Des 2 Class 25	Des 2 Class 40
Sieve Size	Percent	Percent	Percent
µm	Passing	Passing	Passing
40 000			100
25 000		100	70 - 94
20 000	100	82 - 97	
16 000	84 - 94	70 - 94	55 - 85
10 000	63 - 86	52 - 79	44 - 74
5 000	40 - 67	35 - 64	32 - 62
1 250	22 - 43	18 - 43	17 - 43
630	14 - 34	12 - 34	12 - 34
315	9 - 26	8 - 26	8 - 26
160	5 - 18	5 - 18	5 - 18
80	2 - 10	2 - 10	2 - 10
% fractures by weight (2 faces)	60+	60+	50+
Plasticity Index		NP - 6	NP - 6
L.A. Abrasion Loss Percent Maximum		50	50

The physical properties of the MSE wall backfill material selected by the Contractor from the table above shall be used by the MSE wall supplier in the Detailed Design of the MSE walls.

In no case shall any backfill material placed within 2.0 m of the precast concrete fascia panels have more than 5% passing the 0.080 mm (80 µm) sieve size.

Soil filters between soil zones shall be designed based on the properties of the adjacent materials.

The selected backfill shall also meet the following parameters based on soil reinforcement type used in the MSE wall system:

BACKFILL REQUIREMENTS FOR GALVANIZED STEEL REINFORCING

Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
Resistivity	≥ 3000 ohm-cm	G57	T 288

pH	5 - 10	G51	T 289
Chlorides	≤ 100 ppm	D512	T 291
Sulphates	≤ 200 ppm	D516	T 290
Organic Content	≤ 1.0%	D2974	T 267

BACKFILL REQUIREMENTS FOR GEOSYNTHETIC REINFORCING

Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
pH	3 – 12	G51	T 289
Organic Content	≤ 1.0%	D2974	N/A
Design Temperature at the Wall Site	≤ 30°C	N/A	N/A

Collection of samples for testing shall be from proposed stockpiles at the top, middle, and bottom portions, approximately 0.6 m in from the face of the stockpile. Resistivity testing shall be completed on 6 samples (2 top, 2 middle, 2 bottom). PH, chloride, sulphate, and organic content testing shall be completed on 9 samples (3 top, 3 middle, 3 bottom).

300.5.11.3.6 Intentionally Deleted

300.5.11.3.7 Geotextiles

Non-woven geotextile filter fabric shall comply with the following minimum physical properties:

NON-WOVEN GEOTEXTILE FILTER FABRIC REQUIREMENTS

Fabric Requirements		Test Method (ASTM)
Grab Strength	≥ 650 N	D4632
Elongation - Failure	≥ 50%	D4632
CBR Puncture Strength	≥ 275 N	D6241
Trapezoidal Tear	≥ 250 N	D4533

Minimum Fabric Lap length to for non-woven geotextile filter fabric shall be 300 mm.

IMPERMEABLE GEOMEMBRANE REQUIREMENTS

Impermeable Geomembrane Requirements		Test Method (ASTM)
Tear Strength	≥ 45 N	D1004
CBR Puncture Strength	≥ 140N	D6241

Impermeable geomembrane shall be PVC, HDPE or LLDPE with a minimum thickness of 0.75 mm, and comply with the following physical properties:

300.5.11.4 Construction

300.5.11.4.1 Precast Concrete Fascia Panel Production

The fabrication of precast concrete fascia panels shall conform to the requirements of Section 300.5.9 (Precast Concrete Units and Post Tensioning), CAN/CSA A23.4, and as modified by this Section.

All edges of precast concrete fascia panels shall be chamfered.

Geosynthetic reinforcing embedded into precast concrete fascia panels shall exit perpendicular to the face of the precast concrete fascia panel.

Concrete shall have a minimum strength of 18 MPa prior to formwork removal.

Exposed precast concrete fascia panels shall be finished in accordance with Section 300.5.7 (Cast-in-Place Concrete) with the exceptions that all surface cavities shall be filled with an Approved Product for ‘approved pre-bagged concrete patching material for bridges’. The entire exposed precast concrete fascia panel fascia finish texture shall be a form finish and not a washed or rubbed finish.

Precast concrete fascia panels with the following defects shall be rejected and new precast concrete fascia panels provided:

- Units with variation in precast concrete fascia panel face trueness for any line across a precast concrete fascia panel face from a straight edge more than 2 mm over 1 m;
- Units with honeycombing, cracks, spalls or broken corners;
- Units with more than 10 surface cavities per square metre with cavity diameters from 2 mm up to 5 mm;
- Units with more than three surface cavities per square metre with a cavity diameter from 5 mm up to 10 mm; and
- Units with any surface cavities greater than 10 mm in diameter.

Inspection and assessment of surface cavities shall be carried out by the Contractor immediately after stripping of forms. On precast concrete fascia panels surface cavities of 5 mm or less meeting the above acceptance criteria will not require further repair.

Repair of surface cavities shall be done in a sheltered environment with a minimum ambient air temperature of 10 degrees Celsius. Saturation of the face of the precast concrete fascia panels in preparation for the repair of surface cavities shall begin immediately after stripping. During repair of surface cavities, and up to the start of elevated temperature curing or moist curing, precast concrete fascia panel faces shall be kept in a continuously wet condition. As an alternative to moist curing with filter fabric, precast concrete fascia panels may be moist cured in an enclosure with controlled temperature and humidity such that all exposed concrete surfaces remain saturated for the duration of the curing period. If stacked during curing, sufficient space shall be maintained between precast concrete fascia panels to permit airflow and inspection of surfaces.

300.5.11.4.2 MSE Wall Construction

The Contractor shall employ qualified personnel experienced in constructing MSE walls to

supervise and perform the work. The construction of the MSE wall system shall conform to the details on the shop drawings, and shall be in accordance with the supplier's recommendations, and the Technical Requirements.

The Contractor shall also require the supplier of the MSE wall system to provide a full-time qualified representative on site during construction to advise the Contractor's personnel regarding construction procedures and to monitor that the MSE wall construction is being done in accordance with the shop drawings, supplier's recommendations, and the Technical Requirements. The Field Review Engineer shall produce a stamped certificate confirming the constructed wall meets the Technical Requirements.

MSE wall components that are damaged during any construction operation shall be removed and replaced.

300.5.11.4.3 Conformance Criteria

Prior to starting wall construction the Contractor shall:

- Document details of the foundation base preparation details, and have these signed off by the Contractor's geotechnical Design Engineer;
- Document details of on-site delivery of all MSE wall components for each wall, including mill certificates;
- Document that the backfill material meets the Technical Requirements, and have these signed off by the Contractor's geotechnical Design Engineer; and
- Document that precast concrete fascia panel gap and alignments meets the Technical Requirements.

The Contractor shall maintain soil reinforcing placement records, soil compaction records, and precast concrete fascia panel alignment and tolerance records throughout wall construction.

300.5.11.4.4 Excavation and Levelling Pads

Excavation shall be completed to the design grades shown on the Detailed Design drawings and, shop drawings. The foundation subgrade shall be proof rolled to identify any soft spots. Soft material shall be removed and replaced with compacted granular material to the satisfaction of the geotechnical Design Engineer.

Concrete levelling pads shall project a minimum of 75 mm on both sides of the precast concrete fascia panels. Precast concrete fascia panels shall be centred on the concrete levelling pad. Construction of concrete levelling pads shall conform to the Section 300.5.7 (Cast-In-Place Concrete). Concrete levelling pad elevations shall be set by instrument. The deviation from the Detailed Design profile shall not exceed 3 mm over a 3 m length and panels shall be centered on the levelling pad. After erection of the first row of precast concrete fascia panels, any openings between levelling pad steps shall be filled.

300.5.11.4.5 Backfill

Backfill shall be placed in conformance with the MSE wall supplier's specifications and the Technical Requirements. If there is any conflict between the MSE wall supplier's specifications and the Technical Requirements, the Technical Requirements shall govern.

The Contractor shall not place any backfill material on frozen substrate.

Backfill placement shall closely follow erection of each course of precast concrete fascia panels. Backfill shall be placed in such a manner as to avoid any damage or disturbances of the MSE wall components or misalignment of the precast concrete fascia panels. All MSE wall components that are damaged during backfill placement shall be removed and replaced, and any misalignment or distortion of the precast concrete fascia panels due to placement of backfill shall be corrected before continuing with the work.

Where geosynthetic reinforcement is used, overlap of geosynthetic reinforcement can occur in walls with curves or acute angle corners as illustrated on drawing SK-19 (Standard Details Associated with MSE Walls) in the "Layout of Geosynthetic Reinforcement For Curved Walls" detail in Appendix B. For any wall layout where overlap of geosynthetic reinforcement occurs, a minimum 75 mm of compacted backfill shall be placed between geosynthetic reinforcement layers to ensure proper anchorage.

No equipment shall be allowed to run directly on the soil reinforcement. Backfill compaction shall be performed such that equipment moves parallel to the precast concrete fascia panels and away from the precast concrete fascia panels toward the end of the soil reinforcement. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the precast concrete fascia panels. At the completion of each day's work the Contractor shall slope the last level of backfill material away from the precast concrete fascia panels, so as to direct potential run-off away from the precast concrete fascia panels. In addition, the Contractor shall not permit any surface runoff from adjacent areas to enter the MSE wall construction site.

Backfill compaction testing of the reinforced backfill shall be done at a minimum frequency of one test per lift for every 45 m of wall or part thereof with no less than one test per day. Backfill compaction shall be measured in accordance with Alberta Transportation Test Method ATT-58A, "DENSITY TEST, Control Strip Method". The density of compacted backfill shall be a minimum of 98% of the control strip density.

The Contractor shall also complete the following sampling and testing of the backfill during construction to demonstrate continued compliance:

SAMPLING AND TESTING OF BACKFILL PROPERTIES DURING CONSTRUCTION

Range of Resistivity (ohm-cm)	Sample Interval for Resistivity Testing (m³)	Sample Interval for PH, Chlorides, Sulphates, Organic Testing (m³)
>5000	3000	1500
<5000	1500	750

If any test result does not meet the Technical requirements, the Contractor shall stop backfilling operations immediately and resample and test the backfill. Additional testing of material already placed may be required and will be determined by the Department. Backfilling operations shall not recommence until all additional sampling and testing is completed and any non-compliant backfill removed and replaced.

A minimum 300 mm wide strip of filter fabric shall be installed behind all precast concrete fascia panel joints. An adhesive shall be used to hold the fabric securely against the precast concrete

fascia panels.

300.5.11.4.6 Precast Concrete Fascia Panel Placement Tolerance

1. Installation tolerance of precast concrete fascia panels shall be: The out-of-flatness of wall surfaces measured in any direction shall not exceed 25 mm under a 3 m straight edge.
2. The offset of adjacent precast concrete fascia panel edges at joints shall not exceed 10 mm.
3. The overall out-of-vertical alignment of the completed wall shall not exceed 4 mm/m of wall height from top to bottom of wall.
4. The joint gap width shall be between 10 mm and 30 mm.

Should any precast concrete fascia panel be out of tolerance, the backfill shall be removed and the panels reset to the specified tolerance before continuing construction.

Should any precast concrete fascia panel be damaged, including cracks, spalls or broken corners, the precast concrete fascia panel shall be rejected and a new precast concrete fascia panel shall be provided.

All precast concrete fascia panel lifting hook pockets shall be patched with an ‘approved type NH or HEH concrete patching material’ that is an Approved Product.

300.5.11.4.7 Material Storage

The Contractor’s lay-down area shall be graded level to ensure precast concrete fascia panels are safely and uniformly supported on timber bearing blocks with plastic separators. The precast concrete fascia panels shall be stacked on timber planks and separated by timber bearing blocks with dimpled plastic separators designed by the precast supplier’s engineer. Soil reinforcement and connectors shall be stored above the ground. All materials shall be covered and protected from rain, snow, dirt, ultraviolet light and damage. The precast concrete fascia panels shall be stored such that the uniform colour of the precast concrete fascia panels is maintained and protected from staining or discoloration. Precast concrete fascia panels with stained, discoloured or damaged front faces shall not be incorporated into the wall.

300.5.11.4.8 Cast-in-Place Concrete Coping

Construction of cast-in-place concrete wall copings and surface finishes shall conform to Section 300.5.7 (Cast-In-Place Concrete). Cast-in-place concrete wall coping elevations shall be set by instrument. The deviation from the Detailed Design profile shall not exceed 3 mm over a 3 m length.

Galvanized anchor rod assemblies for railings shall be cast into the concrete.

Cast-in-place concrete wall coping sections at corners shall be isolated from contact with other concrete components with 12 mm thick closed cell foam.

300.5.11.4.9 Safety Rail

All steel components of safety railing shall be constructed in accordance with Section 300.5.8 (Structural Steel).

300.5.11.4.10 Impermeable Geomembrane

Seams of impermeable geomembranes shall be placed parallel to the MSE wall and lapped in the direction of positive drainage to produce a shingling effect. Seams shall be welded in accordance with the manufacturer's recommendations and in weather conditions acceptable to the manufacturer.

300.5.12 SIGN STRUCTURES

300.5.12.1 General

This Section 300.5.12 (Sign Structures) is for the, supply, fabrication, erection and all associated work pertaining to overhead and cantilevered sign structures, panels and high mast poles.

300.5.12.2 Submissions

The following information shall be submitted to the Department by a date that is reasonable having regard to the design and construction process and in any event no later than 21 days after request by the Department, acting reasonably:

- Plant certification;
- List of Equipment;
- Certification of welding supervisor;
- Welders' certification;
- Independent welding inspector's certification;
- Independent NDT inspector's certification;
- Fabrication procedures including witness points;
- Welding procedures including welding procedure data sheets for all welds;
- Repair procedures for the following items prepared by a Professional Engineer;
 - Damaged base metal;
 - Unsatisfactory weldments and accidental arc strikes;
 - Damaged galvanizing;
- Shop drawings reviewed by Design Engineer;
- Proposed fabrication schedules;
- Mill test reports for all material;
- Product data sheets for coatings required between galvanized steel and concrete and for grout under base plates;
 - Inspection forms and reporting details. It shall include visual inspection and NDT of all components, dimensional checks and traceability of material;
 - Independent weekly inspection reports and independent final inspection report; and
- Method for forming and placing of grout.

300.5.12.3 Reference Drawings

Sign Structure Steel Identification Plaque, Standard Drawing S-1682-04 (Sign Structure Steel Identification Plaque).

300.5.12.4 Engineering Data

(1) Shop Drawings

Shop drawings shall be authenticated in accordance with 100.2.1.1 (Design), and submitted in accordance with 300.3.3.7 (Bridge Shop Drawing Submission Requirements).

In addition to specific details, the shop drawings shall include the following:

- (a) The Department’s Bridge File numbers, A-Ident numbers and project title, as provided by the Department, shall be shown on all the shop drawings;
- (b) Design criteria for each individual overhead sign structure, including:
 - AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* 6th Edition and 2015 interim revisions unless noted otherwise in the Technical Requirements;
 - Initial sign panel area and/or minimum design sign panel areas;
 - Design wind pressure;
 - Fatigue category and fatigue loadings;
 - Design ice thickness;
 - Other dead loads;
 - Design temperature range;
 - Foundation soils parameters; and
 - Critical anchor rod forces;
- (c) Each individual shop fabricated section or assembly, shown separately with complete and clearly identified welded or bolted details;
- (d) Weld procedure identification shown in the tails of the weld symbols;
- (e) The hardware shown on the shop drawings shall be in the actual units (Imperial or Metric) the material is supplied;
- (f) All material splice locations;
- (g) Complete material list; and
- (h) Erection procedure including any temporary supports, grouting and tightening procedure for anchor rod nuts.

300.5.12.5 Supply and Fabrication

300.5.12.5.1 Standards

Fabrication of sign structures shall conform to the AASHTO LFRD Bridge Construction Specifications and the American Welding Society (“AWS”) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN 3-Z234.1-79 shall be used as the basis of conversion.

All welding, cutting and preparation shall be in accordance with the American Welding Society (“AWS”) - Bridge Welding Code, D1.5, and Structural Welding Code – Steel D1.1.

300.5.12.5.2 Qualification

300.5.12.5.2.1 Certification

The Contractor, or its subcontractor shall operate a recognized steel fabricating shop accepted in advance by the Department.

The Contractor, or its subcontractor shall be fully approved by the Canadian Welding Bureau

(CWB) as per CSA Standard W47.1 in Divisions 1 or 2.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Department.

300.5.12.5.2 Intentionally Deleted

300.5.12.5.3 Engineering Data

(1) Welding Procedures

Welding procedures, including Welding Procedure Datasheets, shall be prepared for each type of weld used in the structure. The procedures shall bear the approval of the Canadian Welding Bureau and shall also be submitted for review by the Department prior to use on the structure.

(2) List of Equipment

Prior to commencement of fabrication, the Contractor shall provide the details of all the equipment that will be used during fabrication. If any equipment causes repeated defective work it shall be substituted with a suitable alternative.

(3) Mill Test Reports and Product Data Sheets

Mill test reports (“MTR”) and product data sheets for all material shall be submitted to the Department. If material cannot be identified by mill test reports, coupons shall be taken, and tested at a Canadian certified laboratory noted below and these test reports shall be made available to the Department. Mill test reports and product data sheets shall be legible and in English.

Where mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test certificate verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the Technical Requirements.

(4) Material Traceability

A list of all material except hardware shall be provided for each structure showing the component designation from the shop drawings and the associated mill test report heat numbers. The structure number shall be noted on the hardware mill test reports.

(5) Schedules

The Contractor shall prepare and keep current a complete fabrication schedule.

300.5.12.5.4 Materials

- (a) All materials shall be new.
- (b) The use of aluminium and aluminium alloy are not acceptable.
- (c) Structural steel plate material shall conform to CSA G40.21M grade 300W* or 350W* or ASTM A572 GR. 50*. However, the yield strength of the steel plate shall be limited to 300 MPa when designing for fatigue regardless of the material used. **(Silicon content less than 0.04% for the shafts, whereas for flanges, base plates, and tenons the silicon content shall be either less than 0.04% or between*

0.15% to 0.25% inclusive.

Steel shafts, structural flange plates, base plates and any material welded to the structure shall meet a Charpy V-Notch minimum average absorbed energy of 20J at -20 degrees C. Charpy V-Notch testing shall be in accordance with CSA G40.20.

All other structural shapes except HSS incorporated in the design shall conform to CSA G40.20M Grade 300W or 350W with silicon content less than 0.04%.

- (d) HSS members shall conform to CSA G40.20M 350W Class H with silicon content less than 0.04%. The steel for HSS members shall meet a Charpy V-Notch minimum average absorbed energy of 20J at -20 degrees C. Charpy V-Notch testing shall be in accordance with CSA G40.20.
- (e) All bolts shall conform to American Society for Testing and Materials (“ASTM”) Standard F3125, Grade A325/A325M. The nuts shall be heavy hex style and conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M. Certified mill test reports for the fastener material shall be provided.
- (f) Anchor rods shall be manufactured from smooth rods conforming to the requirements of ASTM F1554 Grade 55 (Fy=380 MPa). The anchor rod assembly shall consist of, but not limited to: anchor rods complete with nuts and washers, top temporary templates complete with clamping nuts, bottom anchor plates complete with anchor nuts and clamping nuts.
- (g) All steel materials including all hardware and anchor rod assemblies shall be hot dip galvanized.

300.5.12.5.5 Welding

(1) Filler Metals

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. Filler metal with AWS designation of hydrogen level of H4 will only be permitted for SMAW and MCAW processes. The low hydrogen covering and flux shall be protected and stored as specified by AWS D1.5. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas processes are not considered as conforming to low hydrogen practice. These methods will not be permitted. Metal core arc welding shall not be permitted in the field. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal.

(2) Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

(3) Longitudinal Seams

All longitudinal seams shall be made by a semi or fully automatic submerged arc or metal core welding process.

(4) Weld Penetration

The column to base plate and flange to horizontal arm full penetration welds shall be completed using backing bars. All other full penetration welds shall be made by using backing bars or back-gouged to sound metal. The longitudinal seams shall have a minimum 60% penetration. Backing bars will not be allowed for longitudinal seam welds.

The following welds shall have 100% penetration:

- (a) Column to base plate;

- (b) Horizontal arm to flange plate;
- (c) Flange plate to gusset plate;
- (d) Longitudinal seam welds within 150 mm of circumferential welds and 150 mm beyond hand holes (when provided) shall be full penetration groove welds. The transitions between full and partial penetration welds shall be ground smooth;
- (e) Longitudinal seam welds 150mm on either side of a slip connection for high mast poles; and
- (f) Backing bar splices.

Backing bars shall be minimum dimensions of 8 x 30 mm for full penetration welds. These shall be properly fitted and welded all around top and bottom of the member. The groove weld shall be placed in a minimum of two passes. A reinforcing fillet weld shall be placed all around the joint.

(5) Preheat and Interpass Temperatures

Preheat and interpass temperatures shall be as per AWS D1.5. All full penetration welds shall be preheated and interpass temperature maintained to a minimum of 100°C unless a higher temperature is required by AWS D1.5 Table 12.3 for the material thickness. The preheat temperature shall be measured 75 mm from the point of welding.

(6) Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld, and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to re-welding.

(7) Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of tabs shall replicate the joint detail being welded and shall be a minimum of 100mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

(8) Methods of Weldment Repair

Repair procedures for damaged base metal and unsatisfactory weldments shall be prepared by an experienced welding engineer registered as a Professional Engineer and submitted to the Department for review and written acceptance prior to repair work commencing.

(9) Arc Strikes

Arc strikes will not be permitted. In the event of an isolated accidental arc strike, the Contractor shall have a repair procedure prepared by an experienced welding engineer registered as a Professional Engineer. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. The procedure shall include MPI and hardness testing of the affected area. The hardness of the repaired area shall be as specified in Section 300.5.8.4.4 (12) (Hardness Tests).

(10) Plug and Slot Welds

Plug welds or slot welds shall not be permitted.

300.5.12.5.6 Fabrication

Fabrication including all repairs shall be performed in a fully enclosed area which is adequately heated. The shop temperature shall be at least 10 degrees Celsius. Field welding is not permitted.

(1) Pre-fabrication Meeting

A pre-fabrication meeting is required prior to commencement of fabrication of sign structures/high mast poles. The meeting will be held at fabricator's plant and the Contractor shall ensure the Field Review Engineer, plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Field Review Engineer will conduct this meeting after the shop drawings and welding procedures have been reviewed. The Contractor shall provide two weeks' notice to the Department prior to the meeting.

(2) Cutting of Plate

All plate material for main members and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed.

Corners of plates and structural sections shall be ground to a 1mm chamfer.

(3) Additional Requirements

- (a) Each column, arm, extension, clamp and bracket shall be fabricated from one piece of sheet steel with a maximum of two longitudinal seam welds unless accepted otherwise. Laminating of plates shall not be allowed.
- (b) Intermediate circumferential butt welds will not be allowed, however horizontal members greater than 12 m span may have a bolted splice.
- (c) Columns, arms, extensions and clamps shall be brake press formed or roll formed. The brake press knife shall have a radius suitable for the thickness of the material and nature of the bend. The minimum bend radius for all cold formed sections shall be 100mm.
- (d) All plate and structural sections shall be free of notches and gouges.
- (e) The depth or projection of any imperfections on the inner or outer surfaces shall not exceed 15% of wall thickness. Any depth or projection up to 33% of wall thickness may be repaired by welding. Any excessive projecting weld metal shall be removed.
- (f) The diameter of bolt holes in base plates shall be sized in accordance with clause 10.18.4.2(a) of the Bridge Design Code. Further, the nominal diameter of all other bolt holes shall be 2mm greater than the nominal bolt size.
- (g) Punching of full size holes will not be permitted. The holes shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.
- (h) Hand holes with cover plates are required on the top and bottom of columns of illuminated sign structures.
- (i) Hand hole (when required) shall be stiffened by providing a reinforcing rim with semi-circular ends. The rim shall be welded to the member with a full penetration groove weld supplemented with an all around fillet weld.
- (j) Only low stress stamps shall be used for identification marks. The stamps and specific location shall be shown on the shop drawings.
- (k) Stiffeners are not allowed on column to base plate and member to flange plate connections.
- (l) Pole section joints for high mast poles shall be slip fitted connections and shall not interfere with the raising and lowering of the luminaire assembly. The pole sections shall be uniquely match-marked with low stress stamps to ensure that sections for each pole are assembled in the correct orientation.

- (m) The luminaire lowering device shall operate with the pole in place. Hinged poles or lowering devices that do not meet this criteria shall not be used.

(4) Dimensional Tolerances

All fabrication shall meet the tolerances described below:

(a) Straightness

The tolerance in straightness of any item shall not exceed the overall length divided by 300 from the surface at any point. This shall be measured with a straight line joining the surface at both ends. The difference between the straight line and the surface shall then be measured to determine the straightness.

(b) Twisting

The twist in the overall length of any column, arm, or extension shall not exceed 7°.

(c) Length

The specified length of any item shall be within 0 to 60 mm or -0 to +5% (whichever is less) with the exception of sign bridge spans which shall be within 5 mm of the specified dimensions in the unloaded condition. The tolerance for height shall be -0 to +60 mm.

(d) Across the Flat Dimensions

i) Regular Polygonal Cross-sections: The average of all across the flats dimensions from a given cross section shall be within 1% of the specified dimension. In addition, the ratio of the maximum to minimum across the flats dimensions shall be less than or equal to 1.05.

ii) Irregular Polygonal Cross-sections: The across the flats of the minor and major axis shall be within 2% of the specified dimensions and the sum of the minor and major axis across the flats must be within 1% of the specified dimensions.

(e) Tolerance for Flatness of Base Plates and Flange Plates

Surfaces of column base plates shall be flat to within 3 mm tolerance in 305 mm, and to within 5 mm tolerance overall. Faying surfaces of flange plates shall be flat to within 2 mm tolerance overall.

(f) Arm Rise

Arm rises apply to unloaded structure in the standing position.

The following tolerances for high mast poles are in addition to the tolerances noted above:

- (a) Maximum sweep of the pole mast on its overall length measured from a chord joining the extremities and the centreline of the mast shall not exceed 0.2% of its overall length.
- (b) Maximum deviation from straight of the shaft wall on any 3m length of pole mast shall not exceed 5mm.
- (c) Offset between the centreline of the top section of the pole and the centreline of the bottom section of the pole shall not exceed 150mm.
- (d) Offset between the centreline of the base plate and the centre of the pole mast at the base shall not exceed 5mm.
- (e) The tolerance of each flat for all pole sections shall be ± 3 mm for proper nesting.

(5) Pre-Assembly

After welding and fabrication but prior to galvanizing, the Contractor shall pre-assemble all structures including high mast poles complete with sign clamps to check the fit and geometry. Pre-assembled structures shall be inspected by the independent welding inspector.

The structures shall then be disassembled for galvanizing.

(6) Galvanizing

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners with additions and exceptions as described in this Section 300.5.12 (Sign Structures). The Contractor shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing. Lumps, globules or heavy deposits of zinc will not be permitted. All threaded holes or threaded couplings shall be retapped after galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be prepared by a Professional Engineer. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A 780, Method A3 Metallizing. However repair for areas not exceeding 100 mm² may be done in accordance with ASTM Method A1 "Repair Using Zinc-Based Alloy". The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association ("AHDGA") publication "Wet Storage Stain". Any evidence of wet storage stain shall be removed to the satisfaction of the Department.

(7) Base Plate Corrosion Protection

The bottom face of each base plate shall be protected by a medium grey colour barrier, to prevent contact between the zinc and the grout. The galvanized surface must be roughened prior to application of barrier coating. The surface preparation of the galvanized surface and the dry film thickness ("DFT") of the coating shall be in accordance with the coating manufacturer's recommendations. The Contractor shall test the adhesion of fully cured coating as per ASTM D3359. The method selected for testing (Method A or B) shall depend on the dry film thickness of the coating. The coating manufacturer's product data sheets shall be obtained prior to the application of the coating. The adhesion test result shall meet a minimum of "4B" classification, i.e. a maximum allowable flaking of 5%.

300.5.12.5.7 Testing and Inspection

(1) Access

The Contractor shall provide full facilities for the auditing of material and workmanship. Free access shall be allowed to the Department to all parts of the works. When required by the Department, the Contractor shall provide needed manpower for assistance in inspection duties.

(2) Independent Inspection, Testing and Reporting by the Contractor

The Contractor shall provide quality control throughout the course of fabrication. All test records made by the fabricating shop in the course of normal quality control shall be open to the Department for inspection.

Independent Inspectors Qualification

As part of Contractor's quality control, the Contractor shall retain independent inspectors. The

independent inspectors shall be employed by a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor or its subcontractors. The independent inspectors shall have direct communication with the Department. The independent inspectors shall include independent welding inspectors and independent NDT inspectors.

Independent Welding Inspectors

- a) The welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have at least two years of sign structures/high mast pole structures related fabrication inspection experience in Canada accepted by the Department.
- b) For out-of-country fabrication, the welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have at least five years of sign structures/high mast pole structures related fabrication inspection experience in Canada accepted by the Department.
- c) For field welding or repairs the welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition the inspector shall have at least two years of sign structures/high mast pole structures related fabrication inspection experience in Canada accepted by the Department.

Independent NDT Inspectors

- d) The non-destructive testing shall be done by a company certified to CSA W178.1. All NDT procedures developed by the company shall be submitted to the Department for review. The NDT inspectors shall have the following qualifications:
 - o Radiographic Testing (R/T), Ultrasonic Testing (U/T) and Magnetic Particle Inspection (MPI) inspectors shall be certified to Level II of CGSB in the appropriate category.

Duties and Responsibilities of Welding Inspector

- e) For fabrication within Canada, the welding inspector shall be in the fabrication plant and performing inspection duties for at least 25% of the fabrication time required for the sign structures and high mast poles.
- f) For fabrication outside of Canada, the welding inspector shall be in the fabrication plant and performing inspection duties for 100% of the fabrication time required for the sign structures and high mast poles.
- g) The welding inspector shall be present 100% of the time during any field welding or repairs.
- As a minimum, the welding inspector shall perform the following duties, and ensure all the requirements of the Detailed Designs and the Technical Requirements are met:
 - o Attend a pre-fabrication meeting and any subsequent meetings;
 - o Develop inspection forms to be reviewed by the Department;
 - o Verify plant certification;
 - o Identity of parent material, review of MTRs and traceability of material;

- Review of Product Data Sheets;
- Review welders' certificates;
- Review welding supervisor's certification;
- Review of welding consumables as well as storage and moisture control;
- Review of material quality, surface and internal defects and discontinuities on cut edges;
- Check for the use of most recent approved shop drawings;
- Confirm use of only Department reviewed and CWB approved welding procedures;
- Verify joint preparation such as shape, dimensions and fit-up;
- Verify current calibration of the equipment;
- Review of welding parameters such as welding current, arc voltage and travel speed;
- Confirm appropriate use of run-off-tabs;
- Check applicable preheat and interpass temperatures are being observed (post heat if required);
- Check cleaning between weld passes and layers;
- Check correct back gouging is performed;
- Visual inspection of all welds: check size and shape and ensure all welds meet the acceptance criteria;
- Witness or perform dimensional checks of weldments, ensure all tolerances are met and report tolerance measurements;
- Review certification of NDT inspectors;
- Check and ensure all NDT is done as per the Technical Requirements;
- Check all witness points. All testing and repairs specific to witness point must be completed prior to commencement of next stage of fabrication;
- Witness shop trial assembly;
- Report and write non-conformances;
- Witness all repairs are done according to the accepted procedures;
- Inspect and measure galvanizing thickness and check base plate corrosion protection; and
- Submission of weekly inspection reports to the Department.

Non-destructive Methods of Examination

The methods of non-destructive examination shall be in accordance with the following standards:

- Radiography - AWS D1.5;
- Ultrasonic - AWS D1.5; and
- Magnetic Particle - ASTM E-709.

Ultrasonic and Radiographic Testing:

The Contractor shall arrange to have all full penetration welds inspected either by ultrasonic testing or radiographic inspection methods. Partial penetration seam welds shall be inspected by ultrasonic testing. The frequency of partial penetration weld inspections shall be three random locations per weld and the length of weld for ultrasonic inspection at each location shall be 200 mm. Calibration blocks for each thickness shall be prepared for ultrasonic testing to establish sensitivity levels and acceptance criteria. The Non-Destructive Testing shall be done by a

company certified to CAN/CSA W178.1. Ultrasonic Testing procedure shall be prepared by a CGSB Level III U/T inspector and stamped by a Professional Engineer. Ultrasonic and radiographic testing technicians shall be certified to Level II of CGSB.

Magnetic Particle Inspection:

The Contractor shall arrange to have 25% of all fillet welds inspected by magnetic particle testing.

Independent Inspection Reports:

Weekly inspection reports reviewed by the Field Review Engineer shall be submitted electronically to the Department and shall include:

- Lead material; such as the Department's bridge file number, structure name/number, report number, report date, inspector's name, applicable codes and standards;
- Documents acquired during week; such as MTRs, Product Data Sheets, welders' certificates, NDT reports;
- Inspection summary of the week highlighting problems occurred and resolution;
- Traceability of material;
- Inspection forms;
- Photographs;
- Tolerance measurements; and
- NCRs generated and witnessed repairs.

Final Independent Inspection Report (Not including Sub-structure)

A final report prepared by the independent welding inspector reviewed by the Field Review Engineer shall be electronically submitted to the Department within four weeks after the fabrication of each structure. It shall include:

- Signed and stamped certificate by the Field Review Engineer;
- Final shop drawings;
- Installation/erection procedures;
- Company certification;
- Welding procedures;
- Welders' certificates specific to the structure/components;
- Equipment calibration certificates;
- MTRs with material traceability and Product Data Sheets;
- Records of material testing performed during course of fabrication (if any);
- Heat treatment records (if any);
- Weekly inspection reports;
- NDT Reports which shall include:
 - Ultrasonic test reports;
 - Radiographic reports and film; and
 - MPI test reports;
- Coating application and testing, and thickness measurements;
- Shop and field tolerance measurements;

- Bolt pre-tensioning reports;
- Non-Conformance Reports and any site instructions or design changes; and
- The Field Review Engineer shall review the work and associated documentation and provide a certificate that the fabricated materials have been built according to the Detailed Designs and Technical Requirements.

(3) Testing by the Department

The Department may perform visual, radiographic, ultrasonic, magnetic particle and any other testing that may be required at its own expense.

The Contractor shall be responsible for all wages, travel, boarding and lodging costs for the Department's representative to attend pre-fabrication meetings and subsequent monthly visits to the plants when the fabrication of sign structures and high mast poles is done outside Canada.

Witness Points

To ensure that each stage of inspection is performed in an orderly manner, during the fabrication, inspection stations will be set up at specific witness points. Sub-assemblies of the work will then be checked by the Contractor and the independent welding inspector, and deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication.

Typical witness points for a sign structure or high mast poles are:

- Material identification and traceability.
- Fitting and complete joint penetration weld testing of backing bar.
- Completion of all welding prior to shop assembly.
- NDT completed.
- Pre-assembly.
- Galvanizing and base plate corrosion protection.
- NCR disposition.
- Clearance to ship.

(4) Sign Structures and High Mast Poles Fabricated Out-of-Country

The sign structures and high mast poles when fabricated out-of-country, shall be re-inspected after their arrival into Canada. All steel components shall be brought in a CSA W47.1, Division II certified shop for inspection.

The Contractor shall arrange for inspection by qualified personnel. The inspection requirements are as follows:

- Inspection shall take place inside an enclosed shop. The shop shall be maintained at a minimum temperature of 10 degrees C;
- The qualification of welding and NDT inspectors shall be as per Section 300.5.12.5.7(2) (Independent Inspection, Testing and Reporting by the Contractor);
- The welding inspector shall inspect:
 - Verification of components to ensure that they were undamaged during transportation;
 - All welds;

- All fabricated components;
- Dimensional checks and tolerance measurements of all the components; and
- Sign structures and high mast poles shall be pre-assembled for inspection as per Section 300.5.12.5.6(5) (Pre-Assembly); and
- The Ultrasonic Testing, Radiographic Testing, and Magnetic Particle Inspection, shall be done as per Section 300.5.12.5.7(2) (Independent Inspection, Testing and Reporting by the Contractor).

The visual and NDT reports shall be submitted to the Department within one week of inspection. Non-conforming components shall not be released from the Canadian shop until the proposed remedial action has been reviewed and accepted by the Department and all re-inspection is complete.

300.5.12.5.8 Identification Tag

The Contractor shall supply and install an identification tag on each high mast pole and one column of each sign structure at 2.4 m above base plate. The column shall be drilled and tapped for 2-10 mm diameter attachment bolts. The identification tag shall be fabricated as per Standard Drawing S-1682-04 (Sign Structure Steel Identification Plaque).

300.5.12.6 Erection

All product damaged in shipping shall be replaced.

The Contractor shall not erect the structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement.

All components shall be handled with care to prevent stress to the components through bending or twisting. The use of steel chains as slings shall not be permitted. Any damage to the components through overstress, scratching or denting shall be repaired or replaced.

The Contractor shall be responsible for any additional supports to maintain stability until the anchor rod nuts are fully tightened.

After the top temporary template for the anchor rod assembly and clamping nuts are completely removed, the structure shall be set accurately on galvanized shims on top of the concrete foundation. The shim plates must be located so that a minimum of 75 mm grout coverage is provided from shims to grout edge. The method of forming or pouring the grout shall be documented. Base plates shall be grouted with Sika 212 flowable grout or a Department pre-approved equivalent. Dry-pack methods of constructing grout pads will not be allowed. The top of the finished grout elevation shall not be higher than the underside of the column base plate.

Hand hole bolts shall be coated with anti-seize lubricant.

(1) High-Tensile-Strength Bolted Connections

Bolted parts shall fit solidly together when assembled. Contact surfaces shall be free of dirt, grease, burrs, pits and other defects that would prevent solid seating of the parts. Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.

(2) Bolt Tension

All structural bolts shall be tightened by using turn-of-nut method to provide bolt tension

specified in Table 1 set out at the end of this Section 300.5.12.6 (Erection). There shall first be enough bolts brought to a “snug tight” condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. After all bolts have been taken to the snug tight condition, the Contractor shall match mark the outer face of each nut and protruding end of bolt to have a common reference line to determine the relative rotation. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified below, with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

Amount of rotation of nut relative to bolt, regardless of which is turned:

- 1/3 turn where bolt length is 4 bolt diameters or less;
- 1/2 turn where bolt length is over 4 bolt diameters and not exceeding 8 bolt diameters; and
- 2/3 turn where bolt length exceeds 8 bolt diameters.

Notes

- tolerance 1/6 turn (60°) over, nothing under; and
- length of bolt measured from underside of head.

Table 1 - BOLT TENSION

Specified Bolt Size (A325M Bolts)	Minimum Bolt Tension		Commonly Supplied Equivalent Imperial Size (A325 Bolts)	Minimum Bolt Tension	
	Kilonewtons	pounds-force		Kilonewtons	pounds-force
M16X2	94	21,180	5/8	85	19,200
M20X2.5	147	33,050	3/4	126	28,400
M22X2.5	181	40,700	7/8	175	39,250
M24X3	212	47,660	1	227	51,500
--	--	--	1 1/8	251	56,450
M30X3.5	337	75,760	1 1/4	319	71,700
--	--	--	1 3/8	380	85,450
M36X4	490	110,160	1 1/2	463	104,000

300.5.12.7 Foundation

Where detailed and specified, concrete work shall be constructed as shown on the Detailed Designs and in accordance with the relevant sections of Section 300.5 (Bridge Structures):

Section 300.5.7 - Cast-In-Place Concrete

Section 300.5.13 - Piling

Section 300.5.14 - Reinforcing Steel

(1) Material

Reinforcing steel and concrete shall comply with Sections 300.5.2.7 (Durability) and 300.5.2.8 (Materials).

(2) Anchor Rod Installation

Anchor rods shall be installed true and plumb in one complete assembly. The assembly shall be accurately positioned and secured to prevent movement or displacement during concreting procedures. No welding of any component is allowed.

The top anchor nuts shall have bevelled washers if necessary to ensure full contact with the top of the column base plate. Anchor rod nuts shall be tightened an additional 1/3 turn of the nut past the snug-tight condition after the grout has attained sufficient strength. No nuts shall be allowed under the base plate. All voids including the slots and annular space around anchor rods in the base plate shall be filled with an approved corrosion inhibiting paste.

(3) Grout Pockets and Grout Pads

The Contractor shall fill the grout pockets and construct the grout pads using Sika 212 flowable grout or a Department pre-approved equivalent. Filling of grout pockets and construction of grout pads shall be done by workers competent in this work. The grout pocket shall be 25 mm deep and the total grout thickness shall not be less than 75 mm.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the manufacturer's recommendations.

Dry-pack methods of constructing grout pads shall not be allowed.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout. A set of compressive strength cubes shall be taken to represent each days production or 0.25 m³, whichever is more frequent. Upon request all test results shall be provided to the Department within seven days. The average minimum compressive strength of three cubes at 28 days shall be a 30 MPa measured in accordance with CSA A23.2-1B. A type 1C sealer shall be supplied and applied to the exposed grout pad surfaces in accordance with Section 300.5.7.17 (Type 1c Sealer).

(4) Protection of Sign Structures and High Mast Poles

The Contractor shall erect the sign structure in a manner that addresses all safety issues including the interim period between erection grouting and final tightening of anchor rod nuts. After erection of the sign/high mast pole structures, the Contractor shall place grout pockets and pads and tighten anchor rod nuts as soon as possible after grout has achieved sufficient strength. However the Contractor shall provide adequate safe traffic accommodation until tightening and grouting is complete.

(5) Grouting in Cold Weather

When the daily minimum air temperature, or the temperature of the sign structure or substructure concrete, in the immediate area of the grouting is, or is expected to be, below 5 degrees Celsius during the placing and curing period, the following provisions for cold weather grouting shall be implemented:

- (a) Before grouting, an adequate enclosure and preheat shall be provided to raise the temperature of the sign structure/high mast pole and substructure concrete to at least 15 degrees Celsius.
- (b) Temperature of the grout during placing shall be between 10 degrees Celsius and 25 degrees Celsius.
- (c) The grout pads shall be enclosed and kept at 15°C to 25°C for a minimum of five days. The enclosure shall meet the requirements of Section 300.5.7.13 (Concreting in Cold Weather).

(6) Clean-Up

All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

(7) Contractor Inspection

The Contractor shall provide safe and adequate access meeting *Occupational Health and Safety Act* (Alberta) requirements to all working areas, including all necessary scaffolding to enable the Department to carry out its inspection.

The Contractor shall visually check 100% tightening of the bolts and anchor rod nuts by observing match-marking. In addition, the Contractor shall check 10% of all the bolts by “Calibrated Wrench Tightening”. The wrenches shall be calibrated at least once each working day in a device capable of indicating actual bolt tension. From the bolts to be installed a minimum of three typical bolts of each diameter and length shall be tested.

300.5.12.8 Sign Panels

The Contractor shall supply and install overhead sign panels as shown on the plans and in accordance with the requirements specified herein.

300.5.12.8.1 Shop Drawings

The Contractor shall provide the Department shop drawings showing the number, spacing and locations of the aluminium T-section required for each sign panel(s), assembly and mounting details. These drawings shall also detail the required method of attaching the sign panels to the sign support arms.

Fabrication shall not commence prior to the review of the shop drawings.

300.5.12.8.2 Materials

Extruded aluminum panels shall be manufactured in accordance with Section 300.4.2.11 (Permanent Highway Signs, Posts and Bases) except as noted herein.

300.5.12.8.2.1 Sheeting Materials

Reflective sheeting materials used on all overhead sign and cantilever sign structures shall be in

accordance with Section 300.4.2.11 (Permanent Highway Signs, Posts and Bases).

300.5.12.8.2.2 Backing

Each panel shall be fabricated from a number of rows of extruded aluminum sections bolted together. Each row of a panel shall be fabricated from a single piece of extruded aluminum up to a maximum length of 6 metres. Sign panels with a length in excess of 6 m can be split into multiple sections with a vertical joint that runs the vertical distance of the panel. The location of the vertical joint shall be chosen to minimize the number of letters/symbols split between the two sections. The number of sections for a panel shall be minimized.

A 1.0 cm wide x 2.5 cm long slotting shall be located on both edges of the extruded aluminum panels. The slotting shall be centered on the identification groove running longitudinally with the first slot centered 76 mm from the end of the section. The slotting shall be spaced on 152 mm centres for the entire length of the section.

300.5.12.8.2.3 Extruded Aluminum Preparation

The extruded aluminum panels shall be clean of dust, dirt and/or grease. The method used for cleaning must not damage the anodized finish of the extruded aluminum panels or prevent the adhesion of the sheeting material to the extruded aluminum sections.

The ends of the extruded aluminum sections shall be checked to ensure that they are cut square to ensure flush joints between both panels and sections of a panel. The maximum allowable gap between two adjacent sections or panels shall be 5 mm. All excess material found along the slots and edges of the panels shall be removed.

The joint between two sections of a single panel shall be connected together with a T-stiffener when installed on the sign support structure. Care should be taken in choosing the vertical joint location to avoid conflicts between the joint T-stiffeners and the T-stiffeners used to attach the sign panels to the sign support structure.

Adjacent sign panels shall not be connected together by a joint T-stiffener or the T-stiffener used to attach the sign panel to the sign support structure.

300.5.12.8.2.4 Application of Sheeting Materials

The sheeting material (lettering, symbols, borders, background, etc.) shall be applied to the extruded aluminum sections as required by the sheeting manufacturer and as shown on the Detailed Designs. The horizontal line of lettering/copy across a joint between panels, or sections of a sign panel, shall be less than 8 mm.

Each panel, as shown on the Detailed Designs, shall be fabricated as an individual piece to facilitate future modifications. Large individual panels may be fabricated in multiple pieces as noted herein.

For sign panels where the background sheeting material is green and/or yellow, the sheeting is to be wrapped securely around the top and bottom horizontal edges of each extruded aluminum sub panel section. The outer edges of sheeting are to be neatly trimmed flush with the vertical edges of the sign panel.

300.5.12.8.3 Construction

Signs shall be shipped, stored and installed in a manner to prevent damage to the sign panels. Any damaged signs shall be repaired or replaced.

The Contractor shall erect the sign panels onto the sign structures as shown on the plans to ensure that the signs are located correctly over the indicated lanes and that the correct vertical clearance is maintained.

The Contractor shall provide the T-stiffeners, J-clips, bolts, flat washers, nylon insert lock nuts, slip arresting bolts and all of the necessary hardware to securely assemble the sign and connect the sign panels to the sign structure as detailed on Alberta Transportation drawing TCS-A4-335A and shown on the shop drawings.

Individual extruded aluminum sign sub panels shall be fastened together using stainless steel 10 mm diameter x 25 mm long bolts, nylon insert lock nuts, and with a washer under both the bolt head and the nut. The last slot of each joint between sections shall be bolted.

The bolting of the joint between the extruded aluminum sections shall be staggered between the rows of slots, except for the last slots at either end of the section or panel.

Sign panels shall be attached to the T-stiffeners using J-clip assemblies. The J-clip assembly consists of a J-clip bolt whose square head fits into the channels that run along either edge of an extruded aluminum section, a J-clip, a washer and a nylon insert lock nut. J-clip assemblies shall be placed where the edge/joint of the extruded aluminum sections meets a T-stiffener. The J-clip assemblies shall alternate sides of the T-stiffeners.

19 mm diameter x 38 mm long stainless steel slip arresting bolts shall be provided with each sign as follows:

Number of Standard Height Sub Panels In Sign	Overall Maximum Sign Height (mm)	Number of Slip Arresting Bolts Per Each End of Each Sign
< 9	2745	2
10-13	3965	4
14-17	5185	6

Stainless steel slip arresting bolts and nuts shall meet the requirements of Type 316 ASTM F593H and Type 316 ASTM F594H respectively with a minimum yield strength of 310 MPa and a minimum tensile strength of 585 MPa. A stainless steel washer shall be provided under the nut side of the bolt. Slip arresting bolts shall have nuts tightened to a torque of 181 Nm.

All joiner bolts and J-clip nuts must be tightened to a torque to 26.5 Nm within a tolerance of ±0.5 Nm.

The face of the sign panels shall be cleaned.

300.5.13 PILING

300.5.13.1 General

This Section 300.5.13 (Piling) is for the supply and installation of plain and galvanized steel H-piles and pipe piles, and cast-in-place concrete piles. It includes driven piles, drilled cast-in-place concrete piles, and drilled cast-in-place concrete/steel pipe composite piles.

As part of Contractor's quality control, the Contractor shall retain independent inspectors. The independent inspectors shall be employed by a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor and its subcontractors. The inspectors shall have direct communication with the Department. The independent inspectors shall include independent welding inspectors and independent NDT inspectors.

300.5.13.2 Submittals

The following information shall be submitted to the Department by a date that is reasonable having regard to the design and construction process and in any event no later than 21 days after request by the Department, acting reasonably:

- Mill test reports for piling;
- Pile driving equipment and procedures to be used for the installation of driven piles;
- Pile drilling equipment and procedures to be used for the installation of drilled piles;
- Non-destructive testing results for steel pile splices;
- Welding procedures including welding procedure datasheets for all welds (7 days prior to welding);
- Independent welding inspector's certification (7 days prior to welding);
- Welders' certification (7 days prior to welding);
- Independent NDT inspectors' certification (7 days prior to welding);
- Repair procedure for damaged galvanizing prepared by a Professional Engineer; and
- Coating inspection, visual weld inspection and ultrasonic testing reports (within 21 days of completion of piling operations for each structure).

300.5.13.3 Reference Drawings

- Standard Drawing S-1414-87 (Standard Pipe Pile Splice)
- Standard Drawing S-1415-87 (Standard H-Pile Splice)
- Standard Drawing S-1479 (Standard Closed Pipe Pile End Plate)

300.5.13.4 Materials

300.5.13.4.1 Steel "H" Piling

Steel "H" piling shall meet the requirements of Specification CSA G40.21M Grade 350W or ASTM A36. Where piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill test reports shall be provided to the Department prior to pile installation. All welds shall be visually inspected by an independent welding inspector certified to Level III of

CSA W178.2.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test report. The mill test report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the specified Technical Requirements.

Steel H piles shall be galvanized by the hot dip method when required in accordance with the *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.

Splice plates shall be fabricated to the dimensions shown on Standard Drawing S-1415-87 (Standard H-Pile Splice).

300.5.13.4.2 Steel Pipe Piling

Steel pipe piling shall meet the requirements of Specification ASTM 252 Grade 2, except that hydrostatic testing is not required. Although piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill test reports shall be provided to the Department prior to pile installation. Some out-of-roundness of the pipe is acceptable provided an acceptable splice can be completed. All welds shall be visually inspected by an independent welding inspector certified to Level III of CSA W178.2.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test report. The mill test report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the specified Technical Requirements.

Steel pipe piles shall be galvanized by the hot dip method when required in accordance with the *ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*.

Splice backup rings and closed pipe pile end plates shall be fabricated as shown on Standard Drawing S-1414-87 (Standard Pipe Pile Splice) and Standard Drawing S-1479 (Standard Closed Pipe Pile End Plate).

300.5.13.4.3 Timber Piling

The use of timber piling will not be permitted.

300.5.13.4.4 Pile Concrete

Concrete shall meet the requirements of Pile Concrete as specified in Section 300.5.7 (Cast-In-Place Concrete).

300.5.13.4.5 Reinforcing Steel

Steel reinforcement incorporated in the pile concrete shall comply with Sections 300.5.2.7 (Durability), 300.5.2.8 (Materials) and Section 300.5.14 (Reinforcing Steel).

300.5.13.5 Handling

Piling shall be handled, hauled and stored in a manner that avoids damage to the piling materials. Loading and unloading shall be by crane, loader or other appropriate hoisting equipment.

Care shall be taken in order to prevent damaging the galvanized surface on galvanized piling. Fabric slings, wood blocking or other approved methods shall be used to support and separate galvanized piling when handling, hauling or storing. Where repair of damaged galvanizing is required, the repair shall be by metallizing in conformance with ASTM A780, Method A3, to a thickness of 180 μm .

300.5.13.6 Driven Piles

300.5.13.6.1 Equipment and Driving Methods

Acceptable driving equipment includes diesel hammers, hydraulic hammers, vibratory hammers, and driving frames. Drop hammers shall not be used under any circumstances.

Pile driving equipment shall be sized such that piles can be driven with reasonable effort to the specified ultimate bearing capacity without damaging the pile. Acceptance of pile driving equipment shall be based on the WEAP analysis and/or PDA testing. The Contractor shall submit details of the proposed pile driving equipment to the geotechnical Design Engineer and the Department a minimum of 14 days prior to the commencement of pile installation. The information provided shall include the following:

- Hammer Data: hammer type, manufacturer, model number, serial number, maximum rated energy and range in operating energy, stroke at maximum rated energy and range of operating stroke, ram weight, modifications;
- Striker Plate Data: weight, diameter, thickness, composition;
- Hammer Cushion Data: manufacturer(s), area, thickness per plate, number of plates, total thickness, and composition;
- Helmet Data: weight, composition; and
- Pile Cushion Data: material, area, thickness per sheet, number of sheets, total thickness of cushion

The initial pile driving termination criteria shall be established based on the results of WEAP analyses. During the early stages of construction, the driving termination criteria for each structure or foundation element shall be recalibrated and updated, if necessary, based on the results of PDA testing as described in Section 300.5.13.8.2 (High Strain Dynamic Load Testing - Pile Driving Analysis (PDA Testing)).

The driving of piles with driving extensions shall be avoided if practicable. When driving extensions are used, one pile from each group of 10 shall be a long pile driven without extensions, and shall be used as a test pile to determine the average bearing capacity of the group. For the special types of piling, driving heads, mandrels, or other devices in accordance with the manufacturer's recommendations shall be provided so that the pile may be driven without damage and without unnecessary trimming.

For monitoring pile installation, the Contractor shall paint markings on each pile at 0.25 m intervals with a label at each 1.0 m interval starting from the toe of the pile.

Steel “H” piles shall be driven in the orientation shown on the Detailed Designs. The Contractor shall ensure that the piles are in proper alignment by using installation driving frames and fixed leads.

Piles shall not be out of the position shown on the Detailed Designs by more than 150 mm after driving, except for fully integral abutments the foundation piles shall not be out of position by more than 50 mm. In addition, for fully integral abutments, the variation in position between the pile casing centre and the pile centre shall not be more than 25 mm.

Piles shall be not driven with a variation of more than 20 mm per metre from the vertical or from the batter as shown on the Detailed Designs. Piles in exposed bents shall not be out of position by more than 50 mm at the ground line or more than 25 mm at the point of concrete embedment in the pile cap.

In the event that the specified tolerances are not met, the Contractor shall make immediate changes to his pile driving procedures. Piles out of tolerance shall be corrected by the Contractor in a manner accepted in writing by the Department.

The Contractor shall collect and maintain complete records of pile driving activities for all piles from start to finish of driving including but not limited to:

- Pile location and orientation;
- Driving dates;
- Start and stop times;
- Initial and final pile cushion thickness;
- Pile cushion replacement depths;
- Hammer performance/number of blows per minute;
- Fuel settings and fuel setting changes;
- Pile splice locations;
- Obstruction depths and obstruction removal procedures; and
- Tip elevation and cutoff elevation.

300.5.13.6.2 Pile Capacity

Piles shall all be driven to the tip elevations shown on the Detailed Designs, or lower, to achieve the required stability and capacity. Pile capacities shall be determined by the methods given in Section 300.5.13.8 (Pile Capacity Testing).

Where no representative pile load tests are carried out and driven piles are designed based on the use of semi-empirical methods, supported by a site-specific comprehensive geotechnical investigation with soil parameters determined by laboratory testing, field testing and local experience, and with appropriate levels of construction monitoring and verification, the ultimate bearing capacity may be adjusted for Limit State Design by a geotechnical resistance factor of 0.4.

After pile driving operations have commenced, the geotechnical Design Engineer may revise the required pile tip elevations, if necessary, using the pile driving data.

300.5.13.6.3 Steel Piles

Steel piles shall consist of structural steel shapes or pipes of the section shown on the Detailed Designs or otherwise specified. Full length piles shall be provided wherever possible to avoid field splicing.

When pipe piles are to be driven closed-ended, one section of pipe for each pile shall be supplied with a welded pipe pile end plate in accordance with Standard Drawing S-1479 (Standard Closed Pipe Pile End Plate) in Appendix B.

When pipe piles are to be driven open-ended and the interiors cleaned out, a suitable auger shall be used to remove the required material. All loose material and all material adhering to the interior walls of the piles shall be removed.

After installation, closed ended or open ended pipe piles shall be filled with pile concrete.

The total energy developed by the hammer shall be sufficient to achieve the required capacity or tip elevation, but in no case shall the total energy developed be less than 35 kJ per blow.

The head shall be cut squarely and a driving cap or follower shall be provided to hold the axis of the pile in line with the axis of the hammer. The follower shall be of adequate dimensions to allow driving the pile without trimming or reducing the cross-section of the pile. When damage or buckling is evident at the driving end of the pile, in order to obtain the desired bearing capacity or penetration of the pile, the driving end of the piling shall be reinforced, or, other suitable equipment or procedures provided to prevent such damage.

Piles shall be cut off level at the required elevation. If capping is required, the connection shall be made according to details shown on the Detailed Designs.

Temporary caps shall be supplied and secured on all open pipe piles or drilled holes.

300.5.13.6.3.1 Steel Pile Splices

Steel pile splices shall be in accordance with Standard Drawing S-1415-87 (Standard H-Pile Splice) and Standard Drawing S-1414-87 (Standard Pipe Pile Splice) with the exception that Item 1 for both “Requirements and Procedure for Splicing H-Piles” and “Requirements and Procedure for Splicing Pipe Piles” is replaced with “All field welding shall be in accordance with Section 300.5.8.4.1(12) of Schedule 18”. When splicing pipe piles, appropriate methods and techniques shall be used to match out-of-round piling. Exposed pile splices are not permitted.

Where the upper portions of piling are specified to be galvanized, excess piling shall be removed from the ungalvanized portion of the piling to ensure that the galvanized portion extends to the elevation shown on the Detailed Designs. Splicing within the galvanized portion of the pile is not permitted.

The independent welding inspector shall be at the site performing inspection duties at least 50% of time during field welding.

The Contractor shall have an independent NDT inspector complete inspection for a minimum of 20% of all full penetration compression splice welds for all piles at each bridge component. Ultrasonic testing shall also be completed for welds in which visual inspection indicates the presence of a potential defect. Additional testing may be required for the full penetration compression splice welds to ensure the integrity of the structure. The Contractor shall test 100% of the full penetration tension splice welds. The ultrasonic testing shall be completed by a

company certified to CAN/CSA W178.1. Ultrasonic testing inspectors shall be certified to Level II by the Canadian General Standards Board (“CGSB”). Welds shall be repaired if full penetration has not been achieved.

The Contractor shall arrange to have an independent welding inspector certified to Level II or Level III of CSA 178.2 to perform coating inspection, weld inspection and submit final independent inspection reports to the Department within 21 days of completion of piling operations for each structure. The final independent inspection report shall include:

- Signed and stamped certificate by the Field Review Engineer;
- Independent NDT ultrasonic testing company certification;
- Independent NDT ultrasonic inspector certification;
- Signed certificate by the Independent welding inspector;
- Welding procedures;
- Welders’ certificates;
- Equipment calibration certificates;
- Mill test reports;
- NDT Ultrasonic test reports;
- Coating application, testing and thickness measurements; and
- Non-Conformance Reports and any site instructions or design changes.

300.5.13.6.4 Defective Piles

The method used to drive piles shall not result in deformation of the steel, or crushing and spalling of the concrete. Piles damaged by driving, or driven out of the specified location, orientation or driven below the cut-off elevation, shall be corrected by one of the following methods as determined by the Design Engineer and accepted in writing by the Department:

- (a) The piles shall be withdrawn and replaced by new and, if necessary, longer piles, or
- (b) Replacement piles shall be driven adjacent to defective or low piles, or
- (c) The piles shall be spliced or a sufficient portion of the footing extended to properly embed the piles.

Piles heaved by the driving of adjacent piles or by any other cause shall be re-driven to the specified termination criteria. A record of pile heave and re-drive shall be recorded for review by the Department.

In case the required penetration and capacity are not achieved, the Contractor shall provide a hammer of greater energy.

300.5.13.7 Drilled Cast-in-place Concrete Piles

300.5.13.7.1 General

In addition to drilled cast-in-place concrete piles this Section 300.5.13.7 (Drilled Cast-in-place Concrete Piles) shall include drilled cast-in-place concrete/steel pipe composite bearing piles. The work shall include drilling and belling the holes, as required, supplying and placing the steel pipe and reinforcing steel, and supplying, placing, protecting and curing the concrete.

Where no representative pile load tests are carried out and cast-in-place piles are designed based

on the use of semi-empirical methods, supported by a site-specific comprehensive geotechnical investigation with soil parameters determined by laboratory testing, field testing and local experience, and with appropriate levels of construction monitoring and verification, the ultimate bearing capacity may be adjusted for Limit State Design by a geotechnical resistance factor of 0.4.

300.5.13.7.2 Equipment and Drilling Methods

Due to the nature of the work, the Contractor and/or his subcontractors shall have adequate equipment and a proven record of competence in this work.

Only powered screw rotary type augers will be acceptable for drilling. Continuous flight auger (“CFA”) equipment is not permitted.

300.5.13.7.3 Drilling Pile Holes

Drilled pile holes shall be stabilized and sealed by means of temporary casings or other methods to prevent the possible collapse of the pile holes or ingress of water. Every attempt necessary shall be made to obtain dry pile holes prior to placing the pile concrete. To assist in the Contractor’s attempts to achieve a dry hole he shall, at a minimum, have available for use the equipment and casings of appropriate size and lengths, bailing buckets, final cleanout buckets and water pumps. The sides and bottom of a “dry” pile hole shall remain stable with no sloughing or excessive seepage, and no more than 25 mm of standing water shall be present at the tip at the time of concrete placement.

Temporary casing, if used in drilling operations, shall be removed from the hole as pile concrete is being poured. The bottom of the casing shall be maintained below the top of the concrete during withdrawal and pouring operations. Separation of the concrete during withdrawal operations shall be avoided by hammering or otherwise vibrating the casing.

Pile hole elevations shown on the Detailed Designs of the bottoms of the pile holes shall be considered approximate only, and further drilling may be required as necessary to achieve satisfactory capacity of the piles.

Where bellling of the piles is specified, bellling shall proceed only after the pile hole has been drilled to the specified elevation.

The walls and bottoms of the pile holes shall be cleaned to remove all loose and extraneous material. The presence of any gas shall be determined and appropriate means and equipment shall be employed to ensure a safe work site. Pile reinforcement and pile concrete shall not be placed until the pile hole is deemed acceptable by the geotechnical Design Engineer. The elapsed time between the completion of the pile hole and concrete placement shall not exceed two hours.

The installation of further piling shall not proceed if for any reason, the quality of the adjacent piling is compromised due to the effects of vibration or other reasons.

The Contractor shall collect and maintain complete records of pile drilling activities for all piles from start to finish including but not limited to:

- Pile location and orientation;
- Pile diameter;
- Drilling dates;
- Start and stop times;

- Soil description along shaft and at tip;
- Casing(s) and depths cased;
- Seepage encountered during drilling;
- Seepage accumulation at tip elevation;
- Reinforcing steel cage placement information; and
- Concrete pour placement information.

300.5.13.7.4 Open Drilled Holes

All open drilled holes on the site shall be covered until the time they are filled with concrete or otherwise properly backfilled with lean concrete, sand or soil cuttings. The covers shall be of adequate strength and securely fitted so that machinery and workmen are protected against cave-in and surface water is prevented from running into the pile hole.

300.5.13.7.5 Reinforcement

Steel reinforcement shall be fabricated in the sizes and to the dimensions shown on the Detailed Designs and shall be placed, centred and braced in the pile hole as detailed. Reinforcing steel shall be in accordance with Sections 300.5.2.7 (Durability), 300.5.2.8 (Materials) and Section 300.5.14 (Reinforcing Steel).

Particular care shall be taken in locating projecting reinforcing steel, to a tolerance not exceeding 10 mm in any direction. Concrete placement shall not proceed until tolerances are achieved.

Adequate "shoes" or spacers shall be firmly anchored to the reinforcement to ensure the reinforcement is kept horizontally centred with required side cover in the pile hole during concrete placement. Shoes or bar supports shall be used to ensure vertical height requirements are achieved for specified cover at the top and bottom of the pile.

300.5.13.7.6 Concrete Placement

When the reinforcement has been acceptably placed, concrete shall be immediately deposited in the pile hole. The concrete shall be "Pile Concrete" and the provisions of Section 300.5.7 (Cast-In-Place Concrete) shall apply.

Suitable forms shall be used to maintain the specified dimensions of concrete piles above ground level.

Pile concrete placed under water shall be completed and validated by "Crosshole Sonic Logging ("CSL") in accordance with 300.5.7.10.3 (Concrete Placed Under Water).

300.5.13.7.7 Cold Weather Conditions

When the ground against which pile concrete is placed is below -5°C , the pile hole shall be oversized by 100 mm. Immediately after placing and finishing the pile concrete, the top exposed surface shall be protected with insulated tarps or other means to adequately cure the concrete for seven days. If the top of the pile extends above the ground surface it shall be protected in accordance with Section 300.5.7.13 (Concreting in Cold Weather).

300.5.13.7.8 Pile Tolerance

Piles shall not be out of the horizontal position shown on the Detailed Designs by more than 50 mm. Piles shall not be out of the vertical or batter position shown on the Detailed Designs by

more than 2 mm per metre.

In the event that the specified tolerances are not met, the Contractor shall make immediate changes to his piling procedures. Piles out of tolerance shall be corrected by the Contractor in a manner accepted in writing by the Department.

300.5.13.8 Pile Capacity Testing

300.5.13.8.1 Static Load Testing

When specified, the load carrying capacity of piles shall be determined by static load tests. Static load tests shall consist of the application of a test load on a suitable platform supported by the pile, or through the use of adjacent reaction piles, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. The tests shall be in general conformance with ASTM D1143 for piles subjected to axial compressive loads and ASTM D3689 for piles subjected to axial tensile loads. Osterberg tests may be used in place of static load tests.

Where sufficient static load testing has been done to satisfy Limit State Design, Load and Resistance Factor Design (“**LRFD**”), or reliability-based design statistical requirements, a geotechnical resistance factor of 0.6 may be used in pile design.

At least one pile for each group of 100 similar piles in similar soil conditions shall be tested. The frequency of testing shall be increased to account for changing soil conditions, pile sections and types, and construction methods.

The results of load tests shall be presented in a report conforming to the requirements of ASTM D1143 for piles subjected to axial compressive loads and ASTM D3689 for piles subjected to axial tensile loads. As a minimum, the report shall include the following:

- Site plan showing locations of test pile and nearest test holes;
- Test hole logs and summary of subsurface conditions;
- Type and dimensions of test and anchor piles;
- Test pile material including basic specifications;
- Pile installation details;
- Final pile top and tip elevations;
- Ground surface elevation;
- Date and type of load test;
- Temperature and weather conditions during the test;
- Description of instrumentation used to monitor pile performance during testing including their locations;
- Description of test setup and testing procedures;
- Tabulation of time, load, and displacement readings;
- Interpretation and analyses of test results including failure load and the criterion used to estimate it, shaft friction, and end bearing resistance (as applicable);
- Pile load-movement curve; and
- Pile time-load and time-movement curves.

300.5.13.8.2 High Strain Dynamic Load Testing - Pile Driving Analysis (PDA Testing)

High Strain Dynamic Load Testing can be used as an alternate or supplemental test method to static load test for the determination of the load carrying capacity of pile foundations. PDA Testing can also be used as part of the quality control program during pile installation, whereby the theoretical driving termination criteria is calibrated based on hammer performance data gathered during the PDA Testing.

The test method involves installing accelerometers and strain gauges on the pile head, then impacting the pile head using a pile driving hammer over a very short period of time (3-4 milliseconds). The impact imparted on the pile shall be sufficient to fully mobilize the pile skin friction and end bearing resistances, and shall result in a net permanent set per blow between 3 mm and 8 mm upon impact from the pile hammer.

The PDA test may be conducted on either driven or cast-in-place piles. For driven piles, PDA testing may be conducted at the end of initial driving (“**EOID**”) such that the end bearing and skin friction resistances can be determined upon initial installation of the piles. Alternatively, the PDA testing may be conducted during re-strike (“**RST**”) to determine the bearing parameters after the driving induced pore water pressures have dissipated. Where time dependent changes in the soil conditions are anticipated, such as pile setup or relaxation, a sample of piles tested at the EOID shall be retested during RST to assess the change in the load carrying capacity of the piles. The re-strikes shall be conducted no sooner than one week after initial driving, or longer as directed by the Contractor’s geotechnical Design Engineer.

For cast-in-place piles, the PDA test shall not be conducted within one week after the installation of the pile.

The hammer energy used during PDA testing shall be such that the required ultimate pile capacity can be mobilized in a single blow without additional data interpretation. Under no circumstances shall the superposition of base and shaft capacities from different strikes, re-strikes or any combination thereof be permitted in the interpretation of test results.

Where the PDA testing is being used to determine the capacity of the pile for design purposes, a signal matching analysis using appropriate software such as the Case Pile Wave Equation Program (“**CAPWAP**”) shall be carried out.

PDA Testing shall be carried out in accordance with ASTM D4945. In addition, at least two strain gauges on a driven pile and four strain gauges on a cast-in-place pile shall be installed. All accelerometers and strain gauges shall be calibrated and inspected to ensure proper attachment to the pile. All instruments shall be installed a minimum of 2 pile diameters below the top of pile.

PDA testing shall be carried out on a minimum of 10% of the piles, including tests at each substructure element associated with the New Infrastructure and where soil conditions are expected to vary. The piles selected for testing shall be representative of other piles in the same structure. Where driven piles exhibit lower driving resistances and/or shorter penetrations than normal, or where cast-in-place piles experience extraneous soil, ground water, and/or installation conditions, additional tests over and above minimum number of tests specified above shall be required. Further, additional tests shall accompany changes in piling equipment, procedure and pile requirements.

It is permissible to initially drive piles to a capacity below the required ultimate capacity and rely

on pile setup to produce the required capacity. Where pile setup is relied upon to achieve the required pile load capacity, a minimum of 10% of the piles shall be tested at the EOID. A minimum of one third of piles tested at the EOID shall be tested again during RST to confirm the magnitude of setup.

In the situation where one pile in a pile group does not meet capacity requirements, additional tests shall be done to confirm that this pile is an isolated case. In such case, it may be permissible to rely on group effects to compensate for the lower pile capacity. The Contractor's geotechnical Design Engineer shall have the final say in this situation.

Where sufficient PDA testing has been done to satisfy Limit State Design, LRFD or reliability-based design statistical requirements, the geotechnical resistance factor for design of pile foundations may be taken as 0.5.

PDA testing shall be summarized in a daily test report including, driving stresses, transferred energy and estimated pile capacity within 24 hours of testing. A final test report shall be submitted to the Department within seven days of testing. The final test report shall be prepared in accordance with the requirements of ASTM D4945. As a minimum, it shall include the following:

- Pile and driving system information;
- Pile installation data;
- PDA testing equipment and procedure;
- Energy imparted;
- Maximum driving stresses;
- Hammer blow rate;
- Driving resistance (hammer blows per 250 mm);
- Signal matching parameters including quake and damping factors, and match quality number; and
- Shaft friction, end bearing and total pile capacity.

The test results shall be used to calibrate and if necessary update the initial driving termination criteria, modify the driving procedures or equipment (if required), and pile acceptance. No work shall be done on the foundation or substructure elements (cut-off, welding, pile caps, abutments, etc.) prior to this testing report being reviewed and accepted by the Field Review Engineer and the Department.

300.5.14 REINFORCING STEEL

300.5.14.1 General

This Section 300.5.14 (Reinforcing Steel) is for the supply, fabrication, handling and placing of carbon steel reinforcing bars, epoxy coated steel reinforcing bars, corrosion resistant steel reinforcing bars (“CRR”), and stainless steel reinforcing bars. All steel reinforcing bars shall be supplied and installed in the lengths and shapes shown on the Detailed Designs. No substitution of bars or changes to bar details will be permitted without prior written acceptance of the Department.

300.5.14.2 Material Types

300.5.14.2.1 Carbon Steel Reinforcing Bars

Carbon steel reinforcing bars shall be Grade 400, meeting the requirements of CSA Standard G30.18M.

300.5.14.2.2 Epoxy Coated Steel Reinforcing Bars

Carbon steel reinforcing bars meeting the requirements of Section 300.5.14.2.2 shall be used in the production of epoxy coated steel reinforcing bars.

Epoxy coated steel reinforcing bars shall be coated by a manufacturer certified under the Concrete Reinforcing Steel Institute (“CRSI”) Voluntary Certification program for Fusion-Bonded Epoxy Coating Applicator plants. Proof of certification shall be submitted to the Field Review Engineer prior to delivery of the material.

Epoxy coated steel reinforcing bars shall be prepared and coated in accordance with the requirements of Ontario Provincial Standard Specification OPSS 1442, Material Specification for Epoxy Coated Steel Reinforcement for Concrete, and the requirements contained herein.

The film thickness of the epoxy coating, after curing, shall be 175 µm to 300 µm (7 to 12 mils). The epoxy coating material shall conform to the requirements of OPSS 1443, Material Specification for Organic Coatings for Steel Reinforcement.

300.5.14.2.3 Corrosion Resistant Steel Reinforcing Bars

Corrosion resistant steel reinforcing bars shall consist of either low carbon/chromium steel reinforcing bars or stainless steel reinforcing bars.

Low carbon/chromium steel reinforcing bars shall meet the requirements of ASTM A1035. The alloy type shall be CS and the minimum yield strength based on the 0.2% offset method shall be equal to 690 MPa.

Stainless steel reinforcing bars, if used, shall meet the requirements of Section 300.5.14.2.4 (Stainless Reinforcing Steel Bars).

Unless otherwise specified, only one type of CRR shall be supplied for use throughout the New Infrastructure.

300.5.14.2.4 Stainless Steel Reinforcing Bars

Stainless steel reinforcing bars shall be of the following designations as defined by the Unified Numbering System (“UNS”):

- S31653
- S31603
- S31803
- S32304

Stainless steel reinforcing bars shall meet the requirements of ASTM A276 and ASTM A955/A955M (including Annex 1.2 or 1.3). The minimum yield strength shall be 420 MPa.

Austenitic grades shall meet the requirements of with ASTM A262, Practice E. Duplex grades shall meet the requirements of ASTM A1084, Method C by demonstrating no presence of detrimental phases.

Stainless steel reinforcing bars shall be shotblasted and then pickled to remove all mill scale and surface oxidation.

Unless otherwise specified, only one type of stainless steel reinforcing bars shall be supplied for use throughout the New Infrastructure.

300.5.14.2.5 Deformed Welded Wire Reinforcement

Deformed welded wire reinforcement shall be provided in accordance with ASTM A1064, Grade 70 ($f_y = 485$ MPa). Deformed welded wire reinforcement shall be able to attain a minimum elongation of 4% at ultimate strength. Testing for elongation shall be in accordance with the Tension Test specified in ASTM A1064 with the following modifications:

- The minimum test gage length shall be 100mm;
- 100% of the tests shall be across the welds; and
- The extensometer shall not be removed until 4% elongation has been attained.

300.5.14.2.6 Material Production

Steel reinforcing bars shall be produced and tested in accordance with the applicable standard(s).

Mill test reports shall be legible and provided in English for each heat and the Contractor shall maintain a tracking system and records for all reinforcing steel fabricated and installed. Mill test reports at a minimum shall include: heat number, date, location of production, compliance with production standards, chemical analysis, mechanical properties, and pickling process details (if applicable). Mill test reports shall be authenticated by the manufacturer.

Mill test reports and an outline of the tracking system shall be submitted to the Department for review and written acceptance prior to the placement of any reinforcing steel.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test report. The mill test report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the specified Technical Requirements.

The yield strength shall be determined using the offset method (0.2 %).

300.5.14.3 Fabrication

All bars requiring bends shall be cold bent at the fabrication facility. Heating of bars to facilitate bending will not be permitted.

Bars shall be cut by shearing or with fluid-cooled saws. Torch cutting will not be permitted. Bars showing evidence of torch cutting will be rejected.

Unless otherwise specified, all hooks and bends shall be fabricated using the pin diameters and dimensions as recommended in the Reinforcing Steel Institute of Canada (“**RSIC**”), *Manual of Standard Practice*. Bars shall conform accurately to the dimensions shown on the drawings and be within the fabricating tolerances detailed in the RSIC, *Manual of Standard Practice*.

Fabrication of epoxy coated steel reinforcing bars after application of the coating shall be in accordance with the requirements of Ontario Provincial Standard Specification OPSS 1442.

Fabrication of stainless steel reinforcing bars shall be carried out such that the bar surfaces are not contaminated with deposits of iron and other non-stainless steels, or suffer damage due to straightening or bending.

Steel reinforcing bars shall be fabricated without laminations or burrs.

300.5.14.4 Shipping, Handling and Storage

Steel reinforcing bars shall be covered and protected at all times during transportation.

Steel reinforcing bars of differing material types shall be stored separately. Bar tags identifying the material type shall be clearly visible and shall be maintained in-place until installation of the material.

The Contractor shall store all steel reinforcing bars on platforms, skids, or other suitable means of support able to keep the material above the ground surface while protecting it from mechanical damage or deterioration.

Special care shall be taken when handling epoxy-coated steel reinforcing bars to prevent damage to the epoxy coating. Epoxy-coated reinforcing bars shall not be dropped or dragged, and shall be lifted with non-metallic slings. Protective measures shall be implemented to prevent bar-to-bar abrasion and excessive sagging of bundles.

On site storage of epoxy-coated steel reinforcing bars shall not exceed 120 days, and exposure to daylight shall not exceed 30 days. If the daylight exposure time is expected to exceed 30 days, the Contractor shall protect steel reinforcing bars by covering with opaque polyethylene sheeting or equivalent protective material acceptable to the Department.

On-site storage of all other types of steel reinforcing bars shall not exceed 120 days unless protected with polyethylene sheeting or equivalent protective material acceptable to the Department.

The Contractor shall take all precautions necessary to prevent damage to the material during handling operations. Bundles shall be handled with spreaders and non-metallic slings. Damaged materials shall be replaced by the Contractor at its expense.

300.5.14.5 Additional Requirements for Fabrication, Shipping, Handling, and Storage of Stainless Steel Reinforcing Bars

Fabrication facilities shall be exclusive to the fabrication of stainless steel reinforcing bars or in a facility that provides a permanent fixed physical barrier which fully isolates fabrication processes.

Fabrication shall occur only on equipment dedicated solely to fabrication of stainless steel reinforcing bars. All machinery points that come into contact with stainless steel reinforcing bars shall consist of hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. All racking shall be protected with hardened steel to a minimum of 35 Rockwell, stainless steel, nylon or wood.

Methods of handling stainless steel reinforcing bars shall ensure that no carbon steel contamination occurs. Lifting shall be completed with nylon strapping dedicated to stainless steel reinforcing bars. Fork trucks used in the handling of coil or straight stainless steel reinforcing bars shall have their forks covered with hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. Stainless steel reinforcing bar bundles shall be tied with plastic strapping or stainless steel tie wire and not with carbon steel or epoxy coated carbon steel strapping.

Polyethylene wrap shall be used to fully cover all bars and bundles for shipping. Stainless steel reinforcing bars shall also be tarped at all times during shipping with tarps dedicated for stainless steel reinforcing bars.

300.5.14.6 Placing and Fastening

Steel reinforcing bars incorporated into the work shall be free from loose rust, scale, dirt, paint, oil, concrete, concrete paste or other foreign materials.

Steel reinforcing bars shall be accurately placed in the positions shown on the Detailed Designs, and shall be securely tied and chaired before placing the concrete. Bars shall be tied at all intersections, except where the bar spacing is less than 250 mm in each directions; alternate intersections may be tied at these locations. Specified distances from forms shall be maintained by supports, spacers or other means acceptable to the Department.

Bar cover shall be as specified on the Detailed Designs and within tolerances specified in Section 300.5.2.7 (Durability). Supports used to prevent bars from contact with forms or for separation between layers of bars shall be of adequate strength, shape and dimension, and acceptable for use by the Department. Supports shall be either plastic or precast concrete. Where additional reinforcing support bars are proposed by the Contractor they shall be of the same material type and grade used in the work. Supports and spacers fabricated from alternate material types may be used upon advance written acceptance of the Department.

Plastic bolster slab supports shall be Aztec Strong Back Slab/Beam Bolster - PSBB manufactured by Dayton Superior or an equivalent accepted by the Department. Bolster slab supports shall be staggered and configured to facilitate full concrete consolidation.

Precast concrete supports shall be used for all exposed faces of curbs, medians and barriers. Precast concrete supports shall be Total Bond Concrete Supports manufactured by Con Sys Inc. or an equivalent accepted by the Department. Precast concrete supports shall have the compressive strength, rapid chloride permeability, and air content meeting the Technical Requirements for the class of concrete being placed.

Tie wire shall be manufactured from the same material type as the steel reinforcing bars being tied. Plastic coated tie wire may be used where low carbon/chromium steel reinforcing bars is being placed. Where stainless steel reinforcing bars are being placed, tie-wire shall be stainless steel of any grade listed in Section 300.5.14.2.4 (Stainless Steel Reinforcing Bars).

Welding of reinforcing steel shall not be permitted.

Field bending of low carbon/chromium steel reinforcing bars is not permitted. Field bending of all other steel reinforcing bar types, regardless of circumstance, will not be permitted unless specified on the Detailed Designs.

Field cutting of epoxy coated steel reinforcing bars shall be carried out only where the Contractor has received written acceptance to do so from the Department. Cuts shall be made by shearing or saw cutting only. The epoxy coating on sheared or saw cut ends shall be patched in accordance with the Technical Requirements.

Conduits shall not be secured directly to design reinforcing or attached to embedded miscellaneous metals, and shall be positioned to maintain at least 25mm clearance to these items. Utility ducts/conduits within curbs and barriers shall be run in neat vertical and horizontal alignments positioned as shown on the Detailed Design drawings with all connections glued securely and supported at regular intervals so that no separation or displacement will occur during concreting operations. All utility ducts shall be continuous and free and clear of obstructions, and shown to be so by passing a spherical object of the appropriate size through the entire length prior to encasement within concrete.

300.5.14.7 Splicing

Splicing of bars, unless shown on the Detailed Designs and accepted by the Department is prohibited.

Splices, where permitted, shall be staggered. For lapped splices, bars shall be placed in contact and wired together while maintaining the minimum required clear distance to other bars, and the required minimum distance to the surface of the concrete.

300.5.14.8 Repair of Epoxy Coated Reinforcing Steel

The Contractor shall be responsible for the repair of all damage to epoxy coating up to the time the reinforcing steel is acceptably incorporated into the concrete. Where field cutting of the epoxy coated steel reinforcing bars was accepted by the Department, cutting shall be either shearing or saw cutting.

Repair of damaged coating and sheared or sawed ends shall be carried out using a two component epoxy coating patching material approved for use by the reinforcing steel manufacturer.

Surface preparation and material application shall be completed in accordance with the patching material manufacturer's written recommendations; the following requirements; and acceptable to the Department. The areas to be repaired shall be cleaned by removing all surface contaminants and damaged coating before applying the patching material. Where rust is present, it shall be completely removed immediately prior to application of the patching material. The patching material shall be overlapped onto the original coating for a minimum distance of 25 mm or as recommended by the patching material manufacturer. The dry film thickness of the patched areas shall be between 175 μm and 300 μm .

300.5.14.9 Repair of Stainless Steel Reinforcing Bars

Individual stainless steel reinforcing bars exhibiting any of the following defects shall be repaired or replaced by the Contractor at its expense:

- Any location of contamination from grinding or cutting slag;
- Any location of iron contamination greater than 100 mm in length;
- More than 10 discrete points* of iron contamination on bar deformations within any 1000 mm of bar length;
- More than 20 discrete points* of iron contamination on bar deformations per bar; or
- More than 5 discrete points* of iron contamination that are not located on bar deformations per bar.

* A discrete point is defined as an area of contamination less than or equal to 5 square millimetres. If any area of contamination is larger than 5 square millimetres, the area shall be divided by 5 to determine the number of discrete points.

When determined by the Department, bars exhibiting staining shall have the contaminants identified by energy dispersive x-ray analysis (“**EDXA**”). Contaminant identification shall be carried out by the Contractor at its expense. Methods proposed for the repair of stainless reinforcing steel bars shall require the Department’s acceptance prior to implementation. Staining emanating from locations of iron contamination shall be cleaned prior to placement with soap, water, or austenitic wire brush as required. Stainless reinforcing steel bars exhibiting signs of mechanical damage shall be replaced.

300.5.15 BRIDGE DECK WATERPROOFING AND ASPHALT CONCRETE PAVEMENT

300.5.15.1 General

This Section 300.5.15 (Bridge Deck Waterproofing System and Asphalt Concrete Pavement) is for the supply and installation of deck waterproofing and asphalt concrete pavement (“**ACP**”).

Bridge deck waterproofing shall be carried out in accordance with the following Technical Requirements, as shown on the Detailed Designs and Standard Drawing S-1838-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 1) and S-1839-15 (Deck Waterproofing System With 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement – Sheet 2).

300.5.15.2 Intentionally Deleted

300.5.15.3 Bridge Deck Waterproofing

300.5.15.3.1 General

The materials supplied shall be able to withstand the heat generated during the waterproofing processes without affecting the performance of the material.

300.5.15.3.2 Submittals

The Contractor shall on an annual basis and prior to the commencement of waterproofing installation provide the Department with documentation confirming material compliance.

300.5.15.3.3 Sampling and Testing

When requested by the Department, the Contractor shall carry out, at its expense, additional

material testing to confirm compliance with the Technical Requirements.

If requested by the Department, the Contractor, shall provide, at its expense, sufficient additional quantities of asphalt membrane, rubber membrane, membrane reinforcing fabric and/or protection board from the materials being used on the New Infrastructure to carry out additional material testing.

300.5.15.3.4 Materials

Tack Coat

The tack coat shall be a primer type meeting the requirements of CAN/CGSB-37-GP-9MA.

Asphalt Membrane

Asphalt membrane materials shall be supplied in cakes that are sealed and labelled by the manufacturer.

Material for asphalt membrane shall be hot applied rubberized asphalt meeting the requirements of the *Ontario Provincial Standard Specification OPSS 1213*.

Rubber Membrane

Rubber membrane shall consist of 1.2 mm thick butyl and ethylene propylene diene monomer (“EPDM”) rubber. The membrane shall meet the requirements of CAN/CGSB 37.52M.

Membrane Reinforcing Fabric

Membrane reinforcing fabric shall consist of spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points. The membrane shall be supplied in minimum widths of 300 mm.

Wick Drain

Wick drain shall be composite polypropylene with a total thickness of 3.6 mm, supplied in 100 mm widths. The puncture strength shall be a minimum of 45 N measured in accordance with ASTM D4833.

Waterproofing Protection Board

Waterproofing protection board shall consist of durable panels designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt membrane.

The waterproofing protection board shall meet the requirements of the *Ontario Provincial Standard Specification OPSS 1215* for protection board.

300.5.15.4 Equipment

An approved heating and mixing kettle shall be used to heat the hot applied rubberized asphalt membrane. The kettle shall be a double boiler oil transfer type with a built-in agitator and shall be equipped with permanently installed dial type thermometers with an accuracy of ± 2 degrees Celsius to measure the temperature of the melted compound and the oil. A separate calibrated thermometer with an accuracy of ± 2 degrees Celsius to verify the material temperature shall be available on site.

The unit shall be capable of keeping the contents continuously agitated, free flowing and lump free until the material is drawn for application.

300.5.15.5 Installation

300.5.15.5.1 General

The Contractor shall provide the Department with 48 hours advance notice prior to commencing any waterproofing operations.

Waterproofing operations shall only be carried out when the air and concrete surface temperatures are 5 °C or higher.

The Contractor shall carry out the operations involved in waterproofing in sequential order, and in such a manner that there are no delays between individual operations except those necessary to meet the requirements of these Technical Requirements.

Placement of the first asphalt concrete placement lift shall commence within 7 days of waterproofing installation unless permitted otherwise in advance and in writing by the Department.

300.5.15.5.2 Traffic Restrictions

Once surface preparation operations have commenced the Contractor shall restrict all traffic other than the construction equipment directly associated with waterproofing and bridge paving operations from traveling over the prepared areas.

These restrictions shall remain in place until such time that the ACP has been placed and cooled to ambient temperature.

300.5.15.5.3 Intentionally Deleted

300.5.15.5.4 Surface Preparation

300.5.15.5.4.1 Grout Tubes

Grout tubes shall be cut flush with the concrete deck surface prior to surface preparation. If grout tubes project above the concrete after surface preparation, they shall be re-cut flush with the concrete deck surface. A 450 mm by 450 mm piece of membrane reinforcing fabric, centered on the tube, shall be installed as described in Section 300.5.15.5.6 (Waterproofing of Joints and Cracks).

300.5.15.5.4.2 New Bridge Construction

Concrete surfaces to receive waterproofing shall be cured a minimum of 14 days and then allowed to dry a minimum of 3 days prior to waterproofing installation.

The concrete surfaces shall be completely dry prior to commencing waterproofing operations. Drying of the concrete surfaces by use of torch or other means, in the opinion of the Department that may be harmful, will not be permitted.

Once the concrete surfaces are completely dry, they shall be prepared for waterproofing installation by sandblasting or shotblasting to expose sound, laitance free concrete for the entire installation area. All dirt and debris shall be removed and disposed of leaving a prepared surface satisfactory for tack coating.

300.5.15.5.5 Tack Coating

Tack coat shall be applied wherever waterproofing membrane is required. Tack coating and waterproofing installation shall not commence until the deck has been inspected and accepted by the Field Review Engineer for surface preparation work.

Immediately prior to the application of the tack coat, the concrete surface shall be blown clean with oil and water free compressed air to remove all dust and other foreign material. The tack coat shall be cut back with an equal volume of gasoline type solvent or an alternative cut back asphalt product compatible with the asphalt membrane.

The tack coat application shall be such that the tack material will be absorbed into the concrete, resulting in a surface that is dull and black in appearance. Excess application of tack coat, indicated by a shiny black surface, shall be avoided. Tack coat material shall be applied at an approximate rate of 0.25 L/m².

Waterproofing equipment or material shall not be permitted on the tack coat until it has fully cured and is completely tack free.

300.5.15.5.6 Waterproofing of Joints and Cracks

The Contractor shall pay particular attention to waterproofing installation over construction joints, lift hook pockets, grout tubes, patches and cracks.

After tack coat application and prior to application of the primary hot asphalt membrane, a coat of hot asphalt membrane 3 mm to 4 mm thick and wide enough to extend 200 mm on either side of each joint or crack shall be applied in accordance with Section 300.5.15.5.7 (Application of Asphalt Membrane). A strip of membrane reinforcing fabric material wide enough to extend 150 mm on either side of the construction joint, lift hook pocket, grout tubes, patch or crack shall be applied while the asphalt membrane is still hot and tacky. The membrane reinforcing fabric shall then be covered with an additional layer of waterproofing 2 mm to 3 mm thick. Membrane reinforcing fabric shall be overlapped for a minimum of 100 mm when multiple strips are used.

For areas along curbs, barrier walls, and deck drains, the hot asphalt membrane shall be applied to the height of the top of the hot mix ACP surface course and 150 mm onto the deck. Rubber membrane shall be applied into the first coat of asphalt membrane while it is still hot and tacky. The rubber membrane shall extend 50 mm up the vertical face and 100 mm onto the deck surface. Rubber membrane shall be overlapped for a minimum of 100 mm where multiple strips are used. A second coat of asphalt membrane shall then be applied to fully cover the rubber membrane.

300.5.15.5.7 Application of Asphalt Membrane

Cakes of asphalt membrane shall be melted in the heating and mixing kettle to a temperature not exceeding that recommended by the membrane manufacturer.

The asphalt membrane shall not be applied until the tack coat has cured completely.

The application temperature of asphalt membrane shall be within the range recommended by the manufacturer. The membrane shall be applied in a uniform film having a minimum thickness of 4 mm and a maximum thickness of 6 mm.

Application of the asphalt membrane shall be carried out in a continuous manner to the extent practicable. Where joints are unavoidable, they shall be overlapped by a minimum of 150 mm.

The membrane shall be applied over all waterproofed joints and cracks, and shall extend up the face of curbs, barrier walls, and deck drains, to the height of the top of the design hot mix asphalt surface course.

The Contractor shall conduct its operations in such a manner that plugging of deck drains and/or drainage tubes does not occur. Plugged deck drains or drainage tubes shall be cleaned out.

300.5.15.5.8 Wick Drain Installation

Wick drains shall be installed along the full lengths of the gutters, and shall be installed when the asphalt membrane is still hot and tacky. Special attention shall be given to waterproofing and wick drain modifications at deck drain pipe locations. Tack coat shall not be applied to wick drains.

300.5.15.5.9 Protection Board Installation

The Contractor shall ensure that the asphalt membrane thickness meets the specified requirements prior to placing the protection board. Protection boards shall be laid on the asphalt membrane while the membrane is still hot, with the length of the board running transversely on the deck. The protection boards shall be placed with edges overlapping a minimum 12 mm and a maximum of 25 mm, both longitudinally and transversely. The protection board edge shall be within 5 mm of all wick drains, vertical faces of drains, and vertical faces of expansion joints.

Protection board shall be lapped to produce a shingling effect in both the longitudinal and transverse directions. Protection boards shall be placed such that the longitudinal (direction of traffic flow) joints are staggered a minimum of 150 mm. Boards shall be rolled using a linoleum or lawn type roller while the membrane is still warm to ensure good contact with the membrane. Holes shall be cut through the protection board to allow water to drain freely through the drainage tubes. At locations where the edges of the protection board have curled-up, the curled-up edges shall be cemented down using hot membrane material.

Protection boards that are warped, distorted or damaged in any way, whether by manufacture, storage, handling or exposure to the elements shall be replaced with new material.

300.5.15.6 Intentionally Deleted

300.5.15.7 Intentionally Deleted

300.5.15.8 Asphalt Concrete Pavement (ACP)

300.5.15.8.1 General

Equipment and methods used for asphalt concrete pavement on bridge deck waterproofing membranes shall be adequate to produce and place the material as specified.

300.5.15.8.2 Paver

Pavers shall be self-propelled and operated to maintain required levels, cross-falls and joint matching. Bridges that have more than two travel lanes and are longer than 30 m in length shall be paved with two or more pavers in echelon.

300.5.15.8.3 Compaction Equipment

Sufficient self-propelled equipment shall be provided to obtain the required degree of

compaction of the ACP mixture. The compaction capability of the equipment used shall equal or exceed the placing rate of the spreading operations and shall be capable of obtaining the required compaction before the temperature of the mat falls below specified levels. Compaction equipment shall be of a suitable size, weight and type, such that displacement of the mat and/or disruption of underlying materials does not occur.

The compaction equipment shall be in proper mechanical condition and shall be operated such that uniform and complete compaction is obtained throughout the entire width, depth and length of the pavement being constructed. Rollers shall be configured to ensure uniform and complete compaction up to the face of barriers, curbs and medians. Rollers provided shall leave a smooth, properly finished surface, true to grade and cross-section without ruts or other irregularities. All compaction equipment shall be equipped with methods of wetting the tires or drums to prevent adhesion or pickup of the asphalt mixture.

The Contractor shall provide a minimum of one rubber tired roller and one smooth steel drum type roller. The rollers shall have a minimum 10 tonne mass. Vibrators on vibratory rollers shall not be activated. Specialized equipment may be required to achieve adequate compaction and smoothness in tight corners at expansion assemblies and deck joints.

300.5.15.9 Placement of Asphalt Concrete Pavement

300.5.15.9.1 Protection of Adjacent Bridge Components

The Contractor shall protect all bridge components to prevent splatter or staining from asphaltic materials.

300.5.15.9.2 Tack Coat

Asphalt tack coat shall be applied to the existing protection board and between lifts of asphalt concrete pavement.

Tack coat shall not be applied to wick drains.

The surface to be tacked shall be dry and free of loose or deleterious material when the tack is applied.

The asphalt tack coat shall be applied in a uniform manner at an application rate of 0.5 ℓ/m² and suitable asphalt temperature. Air temperature at the time of application shall be 5 degrees Celsius or higher.

The tack coat shall be protected from traffic or other damage. Areas on which the tack has been damaged by traffic shall be re-tacked.

300.5.15.9.3 Spreading and Compaction

300.5.15.9.3.1 General

The mixture shall be placed only upon a dry, frost free substrate on which the tack coat has cured and when the ambient air temperature is 5°C or higher. Prior to the delivery of the mixture on the work, the base shall be cleaned of all loose or foreign material. The mixture shall be spread and compacted during daylight hours only, unless artificial lighting acceptable to the Department is provided.

During spreading and compaction operations, care shall be taken at all times to ensure that:

- Asphalt mixture is not wasted over the side or onto the adjacent surface mat;
- Damage is not done to the waterproofing membrane, curbs, barriers, medians, concrete paving lips, manholes, drains or medians; and
- Damage is not done to guide posts, guardrails, signs, power conduits or any other roadside installations.

300.5.15.9.3.2 Spreading

ACP shall be placed and compacted in two nominal 40 mm lifts.

ACP shall be spread at a temperature sufficient for the specified compaction and finishing at the final placement area.

The first lift of the ACP shall be spread by the asphalt paver in the direction of the protection board laps (downhill). In the event that paving cannot be carried out in the direction of the protection board laps, the Contractor shall submit a procedure for review, identifying measures that will be taken to ensure that the protection board and waterproofing membrane will not be damaged during paving. To avoid damaging the waterproofing membrane, the paver shall not push the delivery trucks, all equipment shall perform all turning movements off the bridge deck, and the asphalt mixture shall not be dumped onto the protection board ahead of the paver.

The longitudinal and transverse edges of each lane shall be straight in alignment, uniform, and of the same thickness as the adjoining pavement lift. Adequate measures for the protection of the exposed edges shall be maintained throughout the work.

In the placing of successive lifts, the individual mixture spreads shall be aligned in a manner such that the longitudinal joints in successive lifts do not coincide. Unless otherwise directed, the lateral distance between the longitudinal joints in the successive lifts shall be not less than 0.30 m. The longitudinal joint of the final lift of asphalt concrete pavement shall not be located within the wheel path areas.

All longitudinal and transverse joints shall be of the vertical butt joint type, made in a careful manner, well bonded and sealed, and shall be finished to provide a continuous, smooth profile across the joints.

300.5.15.9.3.3 Compaction

To avoid displacement of the mixture, lifts shall be compacted only after the spread asphalt mixture is within the following temperature ranges:

ASPHALT GRADE	COMPACTION TEMPERATURE RANGE (degrees Celsius)	
	FIRST LIFT	SECOND LIFT
PG58-28	95 degrees Celsius - 105 degrees Celsius	128 degrees Celsius - 138 degrees Celsius

The first lift shall be placed, finished and compacted for the full width, and then allowed to cool down to 50 degrees Celsius or colder prior to commencing the second lift.

The compaction process shall be monitored by the Contractor using a Control Strip Method. Control Strips shall be established on each mat placed.

The Control Strip lift shall be compacted using at least the following equipment:

- (a) One steel roller weighing not less than 10 tonnes; and
- (b) One self-propelled pneumatic rollers, ballasted to its maximum capacity, weighing not less than 10 tonnes.

Once the mix has been spread by the paver and the initial pass of the breakdown roller has been done, moisture and density measurements for determining the Control Density will commence at five locations within the Control Strip area, and will continue following repeated passes of the compaction equipment until the apparent maximum density is attained. These measurements will be taken using nuclear testing equipment.

The first lift of pavement shall be compacted to a minimum average density of 95% of Marshall Density, with no individual density less than 93%. The second lift of pavement shall be compacted to a minimum average density of 97% of Marshall Density, with no individual density less than 95%.

When required by the Department, the Contractor shall take and test cores of pavement.

Percent compaction will be expressed in percent of Marshall Standard Density. The Marshall Standard Density used for determining pavement compaction shall be as follows:

- (a) Marshall Densities determined on field sampled mix, or if not available then; and
- (b) Marshall Design Density as reported in the accepted mix design.

Coring shall be done using methods which will not damage the rubberized asphalt membrane or protection board. Core holes shall be completely de-watered and dried. A generous application of liquid asphalt shall be applied to the bottom and sides of the core hole and allowed to cure. Asphalt mix shall then be tamped in lifts into the core hole until flush with the surface of the surrounding pavement.

In order to maintain the crown of the bridge deck and approaches, the Contractor shall avoid operating the compaction equipment on or across the crown. Compaction procedures and equipment shall be such that displacement of the mixture does not occur. Roller wheels shall be kept slightly moistened by water or oil to prevent picking up the mixture, but an excess of either water or oil will not be permitted.

300.5.15.9.3.4 Surface Defects

ACP shall be smooth, true to established cross-section and grade, compacted and free from ruts, humps, depressions, or other irregularities. Any ridges, indentations or other surface defects shall be eliminated by roller or other means acceptable to the Department.

The finished surface of any lift shall have a uniform closed texture and be free of visible signs of poor workmanship. Any obvious defects such as, but not limited to the following, shall be promptly repaired in a manner acceptable to the Department.

- Areas of excess or insufficient asphalt;
- Improper matching of longitudinal and transverse joints;
- Roller or tire marks;
- Cracking or tearing; or

- Sampling locations not properly reinstated.

300.5.15.9.3.5 Smoothness

Except across the crown, the surface shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the deck anywhere below the straight edge.

300.5.15.9.3.6 Segregation of Bridge Asphalt Concrete Pavement

Pavement segregation shall be classified in accordance with section 3.50.4.7.2 “Classifying Pavement Segregation” of the Alberta Transportation Standard Specifications for Highway Construction and the Department’s manual for “Paving Guidelines and Segregation Rating Manual” shall be used as reference in classifying the severity of segregation.

During paving operations, the Contractor shall make every effort to achieve a finished surface that has a uniform closed texture and is free of segregated areas. At the end of paving every day, the Contractor shall perform an inspection of the paving to identify any instances of pavement segregation. If segregation is evident, the Contractor shall take immediate corrective action to the paving process to prevent any further occurrence of segregation. When slight segregation is identified in the bottom lift, the Contractor shall identify and correct the cause of the segregation to prevent similar segregation at the top lift.

The Contractor shall repair all areas of segregation as follows:

- (a) When any moderate or severe segregation or centre of paver streak is identified in the bottom lift, the entire lift shall be carefully removed and replaced. Any damage to the bridge deck waterproofing shall be repaired prior to subsequent paving operations.
- (b) When any moderate or severe segregation or centre of paver streak is identified in the top lift, the entire lift shall be removed and replaced.
- (c) When slight segregation is identified in the top lift and the total area of slight segregation does not exceed 0.5% of the total paved area, the areas identified shall be repaired with a slurry patch.
- (d) When slight segregation is identified in the top lift and the total area of slight segregation exceeds 0.5% of the total paved area, the entire lift shall be removed and replaced.

300.5.16 DECK SYSTEMS USING PRECAST CONCRETE PARTIAL DEPTH DECK PANELS

300.5.16.1 General

This Section 300.5.16 (Deck Systems Using Precast Concrete Partial Depth Deck Panels) is for the fabrication and construction of deck systems using precast concrete partial depth deck panels.

Unless otherwise noted in this Section 300.5.16, all the requirements of Section 300.5.2 (Design Criteria) shall apply to the design of deck systems using precast concrete partial depth deck panels.

Unless otherwise noted in this Section 300.5.16, all the requirements of Section 300.5.9 (Precast

Concrete Units and Post-Tensioning) shall apply to the supply, manufacture, delivery and erection of precast concrete partial depth deck panels.

Unless otherwise noted in this Section 300.5.16, all the requirements of Section 300.5.7 (Cast-in-place Concrete) shall apply to the construction of deck systems using precast concrete partial depth deck panels.

300.5.16.2 Intentionally Deleted

300.5.16.3 Manufacture

The panels shall be cast flat.

All edges of the panel shall have a minimum 20x20 mm chamfer, except the transverse joint which shall have a 55x55 mm chamfer along the top edges.

Panel identification tags cast into the surface of the panels are not permitted. Panel identification methods shall be acceptable to the Department.

300.5.16.3.1 Stressing Strand

All strands shall be cut flush with the precast panel edges, and the ends of the strands shall be sealed with Sikadur-31 or an approved equivalent.

300.5.16.3.2 Surface Finish

The top surface of panels shall be clean, free of laitance, and roughened to 3 mm amplitude with spacing not greater than 15 mm with grooves parallel to strands. Formed chamfer surfaces that will be in contact with cast-in-place concrete shall be sandblasted to remove all laitance and uniformly expose aggregate particles.

300.5.16.3.3 Tolerances for Panels

Precast concrete deck panels shall meet the following tolerances:

- a) Panel lengths: ± 5 mm (as measured perpendicular to the girder lines);
- b) Panel widths: ± 10 mm (as measured parallel to the girder lines);
- c) The maximum difference in plan view diagonal dimensions (squareness) of rectangular panels shall not be greater than 3.5 mm per meter of diagonal length;
- d) Thickness of panel: + 5 mm, - 3 mm;
- e) Strands shall be located at the centroid of the panel with a vertical tolerance of + 0 mm, - 3 mm, measured from the soffit and a horizontal tolerance of ± 10 mm;
- f) Deviation from straightness of panel edges along the transverse joint between adjacent panels shall not exceed 1.5 mm per metre length;
- g) Vertical bowing of panels out of plane, after casting and immediately prior to erection, in the direction of measurement, shall not be greater than the panel length/360 or the panel width/360, whichever is less, and in no case shall it exceed 10 mm maximum; and

- h) Warping of panels shall not be greater than 5 mm per metre of distance from the nearest adjacent corner.

Tolerance measurement results shall be provided to the Department forthwith, upon request. Panels not meeting any of the tolerances listed above shall be rejected.

300.5.16.3.4 Defects and Deficiencies Causing Rejection

A panel having any one of the following defects or deficiencies shall be rejected:

- a) Panels with honeycombing or spalls when the depth exceeds 15 mm or when the area of defect exceeds 25 mm x 25 mm;
- b) Panels with any voids or spalls in the bottom of the panel;
- c) Panels with any crack located parallel to or over the strands or reinforcing steel;
- d) Panels with any crack at the edges and / or with cracks at the bottom; and
- e) Panels with cracks that are deeper than 25 mm and/or wider than 0.1 mm.

300.5.16.4 Erection and Construction

The precast panels shall be erected on the girders with temporary supports. The precast panels shall be erected so that the transverse joints between adjacent panels are never greater than 5 mm. All transverse joints shall be sealed with Sikaflex 15LM or an approved equivalent to prevent mortar leakage.

The Contractor shall survey all girders at locations corresponding with those detailed on the camber diagram and determine girder haunch dimensions required to achieve design grades. The Field Review Engineer shall perform an additional and independent haunch dimensional check to confirm deck thickness and grades prior to deck reinforcing steel placement. In the event that actual girder camber values vary significantly from the estimated values indicated on the Detailed Design drawings, the Contractor may raise or lower the grades when accepted by the Design Engineer and the Department.

All precast deck panel system formwork drawings shall be prepared and sealed by a Professional Engineer, and inspected prior to placing concrete to confirm conformance with the Detailed Design. The Contractor shall design and install support brackets such that no damage to girder flanges and webs will result. Where brackets bear against girder webs, the Contractor shall protect the contact surface with timber or neoprene softeners. No drilling of additional holes, or any other modifications including field welding, shall be made to the superstructure elements. Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. Formwork for deck overhangs, curbs, sidewalks and parapets shall be fabricated so that the lines and grades shown on the Detailed Design are achieved, with adjustments made where necessary to compensate for variances in girder dimensions, positioning, alignment and sweep. All lifting hooks and deck panel levelling bolts shall be cut flush with the top of the deck panel after the profile, deck concrete thickness and girder haunch dimensions have been completed, checked and accepted by the Design Engineer, and before reinforcing steel bar

placement.

The haunches shall be formed to be flush with the edge of the girder flanges. Formwork shall be sealed against girder flanges such that concrete paste leakage does not occur. All haunch forming material, including sealants, shall be completely removed after casting the deck to fully expose the haunch concrete.

No portion of any hardware associated with deck formwork, including deck overhang formwork, shall be visible after removal of all formwork. For precast concrete girder superstructures, anchors for the exterior deck overhang formwork may be cast into the girder top flange above the web. For steel girder superstructures, anchors for exterior deck overhang formwork may be shop attached to the girder top flanges. Field welding or drilling of the girders or precast panels is not permitted.

Prior to the placement of deck reinforcing steel and prior to the placement of deck concrete, the surfaces of partial depth precast panels, girder flanges, and all formwork shall be thoroughly cleaned with high pressure water. Cleaning shall be completed in a controlled and progressive manner from the high to low ends of the deck pour area in both transverse and longitudinal directions. Appropriate wash water drains shall be incorporated into haunch and bulkhead formwork. All surfaces shall be free of dirt, debris or foreign materials. All hardened concrete surfaces to receive deck concrete shall be brought to and kept in a saturated surface dry condition, free of standing water, a minimum of two hours prior to concrete placement.

The deck and haunch concrete shall be cast monolithically in a two stage process to ensure full consolidation of concrete in the haunch area.

The first stage shall include placement of concrete in the haunch area and over the girder top flange in continuous strips. The depth of the first stage pour shall be above the bottom surface of the precast panel, but shall not exceed the top surface of the precast panel, and shall not extend in front of the second stage pour by more than 6 m. Placement and consolidation of concrete in the first stage shall be completed in such a manner that entrapped air on the vertical and horizontal formed surfaces of the haunch is minimized.

The second stage shall include placement of the remaining deck concrete. Concrete placement shall occur in a timely manner as to not result in any cold joint between the first and second stages. If cold joints are produced the entire deck section shall be removed and replaced including but not limited to the cast-in-place HPC concrete, steel reinforcing bars and precast deck panels.

Voids, cavities, or areas of honeycombing found in the haunch concrete meeting the following parameters shall be repaired by the Contractor:

- a) Any defects with depth greater than or equal to 20 mm;
- b) Defects greater than or equal to 25 mm high or 25 mm wide x 10 mm deep;
- c) 10 or more defects between 20 mm wide or 20 mm high x 15 mm deep per lineal metre;
or
- d) 30 or more defects between 10 mm wide or 10 mm high x 15 mm deep per lineal meter.

Proposed repair procedures shall be submitted for review and written acceptance by the Department.

300.5.17 HEAVY ROCK RIPRAP

300.5.17.1 Rock Material

Heavy rock riprap shall be hard, durable and angular in shape, resistant to weathering and water action, free from overburden, spoil, shale or shale seams and organic material, and shall meet the gradation requirements for the class specified. No sandstone is permitted. The minimum dimension of any single rock shall be not less than one third of its maximum dimension. The minimum acceptable unit weight of the rock is 2.5 t/m³.

The Contractor shall provide evidence of the acceptability of the riprap material. Reliable performance records of proposed material, other than fieldstone, will be considered evidence of acceptability. Angular fieldstone shall be considered to have a reliable performance record, and will be accepted if it meets the gradation requirements.

Sampling and testing are required for Class 2 and Class 3 rock riprap for which no performance records are available. Sampling and testing are not required for Class 1 rock riprap and field stone. Tests are based on the Durability Index and Durability Absorption Ratio as developed by the State of California, Department of Transportation. The Contractor shall submit representative samples of the proposed material to an independent certified testing laboratory, and test reports shall be stamped by a Professional Engineer. The independent testing laboratory shall be a legal entity not carrying out any design or construction for the Project and that is at arm’s length from and completely independent of the Contractor and its subcontractors. A representative sample of not less than 70 kg is required for each type and source of rock to be tested, and shall contain a number of pieces ranging up to 25 kg mass. Additional testing shall be carried out in the event of material difference between supplied material and the tested sample.

The material provided for each class specified shall have a gradation that conforms to the following:

		CLASS			
		1M	1	2	3
Nominal Mass (kg)		7	40	200	700
Nominal Diameter (mm)		175	300	500	800
None greater than:	kg	40	130	700	1800
	or mm	300	450	800	1100
20% to 50% greater than	kg	10	70	300	1100
	or mm	200	350	600	900
50% to 80% greater than	kg	7	40	200	700
	or mm	175	300	500	800
100% greater than:	kg	3	10	40	200

	or mm	125	200	300	500
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Percentages quoted are by mass.

Sizes quoted are equivalent spherical diameters, and are for guidance only.

Rock riprap shall meet the following minimum requirements for specific gravity, absorption and durability:

Method of Test	Requirements
California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregate (California Test 206)	Minimum Specific Gravity = 2.60 Maximum Absorption = 2.0 percent
California Department of Transportation Method of Test for Durability Index (California Test 229)	Minimum Durability Index = 52 (unless DAR* > 23)

* Durability Absorption Ratio (DAR) = Durability Index / (Absorption % + 1%)

300.5.17.2 Geotextile Filter Fabric

Where geotextile filter fabric is specified, the slope shall be graded to provide a smooth, uniform surface. All stumps, large rock, brush or other debris that could damage the fabric shall be removed. All holes and depressions shall be filled so that the fabric does not bridge them. Loose or unstable soils shall be replaced.

Non-woven geotextile filter fabric shall be used under all riprap in accordance with the following table of minimum average roll value properties (MARV's) for each specific Class of riprap:

Non-Woven Geotextile Filter Fabric		
Specifications and Physical Properties		
Property	Class 1M, 1 and 2	Class 3
Grab Strength (ASTM D4632)	650 N	875 N
Elongation (Failure) (ASTM D4632)	50%	50%
CBR Puncture Strength (ASTM D6241)	275N	550 N
Trapezoidal Tear (ASTM D4533)	250 N	350 N
Minimum Fabric Lap to be 300 mm		

The non-woven geotextile filter fabric shall meet the Technical Requirements and physical properties as listed above.

The fabric shall be laid parallel to the slope direction. It shall be placed in a loose fashion,

however folds and wrinkles shall be avoided. Adjacent strips of fabric shall be overlapped a minimum of 300 mm, except where placed underwater, the minimum lap width shall be 1 m. Overlaps shall be pinned using 6 mm diameter steel pins fitted with washers and spaced at 1 m intervals along the overlaps.

The top edge of the filter fabric shall be anchored by digging a 300 mm deep trench, inserting the top edge of the fabric and backfilling with compacted soil.

Care shall be taken to prevent puncturing or tearing the geotextile. Any damage shall be repaired by use of patches that extend at least 1 m beyond the perimeter of the tear or puncture.

The fabric shall be covered by rock riprap within sufficient time so that ultraviolet damage does not occur; in no case shall this time exceed seven days for ultraviolet material and 14 days for ultraviolet protected and low ultraviolet susceptible polymer geotextiles.

Riprap placement shall commence at the base of the blanket area and proceed up the slope. The height of drop of riprap shall be limited to 1.0 m or less, and the riprap shall not be allowed to roll down the slope. Heavy equipment will not be permitted to operate directly on the geotextile.

300.5.17.3 Placing of Rock

The rock shall be handled, dumped or placed into position to conform to the specified gradation and to the cross section shown on the Detailed Designs. The finished surface shall be reasonably uniform, free from bumps or depressions, and with no excessively large cavities below or individual stones projecting above the general surface.

300.5.17.4 Inspection of Rock

Control of gradation will be by visual inspection. The Contractor shall provide a minimum of two samples of rock, of the minimum sample size specified below. These samples shall be proven to acceptably conform to the required gradation by direct weighing of all the individual pieces with suitable scales; the mass of each piece in the sample shall be painted on the piece. These samples, located as required by the Field Review Engineer at the construction site and at the source or quarry site, may be incorporated in the finished riprap when they are no longer required for reference purposes. The samples shall be used for frequent reference in judging the gradation of the riprap being loaded at the source and placed at the site. The minimum sample size in area shall be as follows:

Class	Minimum Sample Size
1M	1 m x 1 m
1	2 m x 2 m
2	3 m x 3 m
3	4 m x 4 m

The Contractor shall provide whatever facilities are required to assist the Field Review Engineer or the Department in auditing gradation.

If, during the delivery of the material to the site, a particular load is found to be made up of pieces predominantly one size, or to be lacking in pieces of one size, it shall be dumped in a suitable location outside the area to be protected. Additional material as required to make up the

deficient sizes shall be added to this load such that the combination can then be placed to ensure uniformity.

300.5.18 BRIDGE BEARINGS

300.5.18.1 General

This Section 300.5.18 (Bridge Bearings) is for the supply, fabrication, delivery and installation of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings. The laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings shall be designed in accordance with the Detailed Designs, applicable codes and the Technical Requirements. Design details of elastomeric bearings shall also be in accordance with Standard Drawing S-1761-08 (Typical Expansion Bearing Details) in Appendix B.

300.5.18.2 Submissions

The following information shall be submitted to the Department by a date that is reasonable having regard to the design and construction process and in any event no later than 21 days after request by the Department, acting reasonably:

- Identification of bearing supplier;
- Plant certification;
- Certification of welding supervisor;
- Welders' certification;
- Independent welding inspector's certification;
- Independent NDT inspector's certification;
- Layout installation drawings;
- Welding procedures including welding procedure data sheets for all welds;
- Repair procedures for the following items prepared by a Professional Engineer:
 - Damaged base metal;
 - Unsatisfactory weldments and accidental arc strikes;
 - Damaged galvanizing;
- Shop drawings including layout drawing reviewed by the Design Engineer (seven days prior to fabrication);
- Mill test reports for all material;
- Product data sheets for all material;
- Inspection forms and reporting details. It shall include visual inspection and NDT of all components, dimensional checks and traceability of material;
- Independent welding and NDT reports for weld inspection;
- Bearings Destructive Testing and Non-Destructive Testing reports;
- Elastomer test reports;
- Methods and materials for setting anchor rods and constructing bearing pads;
and
- Methods of forming and pouring grout.

300.5.18.3 Supply and Fabrication

300.5.18.3.1 Standards

Fabrication of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings shall conform to:

- The American Association of State Highway and Transport Officials (“**AASHTO**”) LRFD Bridge Construction Specifications;
- AASHTO’s Standard Specifications for Transportation Materials and Methods of Sampling and Testing M251-06 Standard Specification for Plain and Laminated Elastomeric Bridge Bearings; and
- The American Welding Society (“**AWS**”) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN3-Z234.1-79 shall be used as the basis of conversion.

300.5.18.3.2 Qualification

The Fabricator for the steel components shall be fully approved by the Canadian Welding Bureau (“**CWB**”) as per CSA Standard W47.1 in Divisions 1 or 2.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Department.

300.5.18.3.3 Engineering Data

300.5.18.3.3.1 Welding Procedures

Welding procedures including welding procedure datasheets approved by the Canadian Welding Bureau required for the fabrication and field installation of bearings shall be submitted for each type of weld. The welding procedures shall be submitted to the Department for review before welding proceeds.

300.5.18.3.3.2 Shop Drawings

Shop drawing requirements shall be as per Section 300.5.8.3.3(2) (Shop Drawings). In addition, the following requirements shall be met:

The shop drawings shall clearly indicate all material properties, dimensions, connection attachments, fasteners and accessories, the bearing identification, and the load capacity at the serviceability and ultimate limit states as follows:

- (a) Maximum vertical permanent and total load.
- (b) Maximum lateral load and corresponding vertical load.
- (c) Maximum rotational capacity about any horizontal axis and about the vertical axis at the centre of the bearing.

Shop drawings reviewed by the Design Engineer shall be submitted to the Department seven days prior to fabrication in accordance with Schedule 5 (Design and Plan Certification Process and Review Procedure). When bearings for more than one bridge are included, individual shop and erection drawings shall be submitted for each bridge.

300.5.18.3.3.3 Mill Test Reports and Product Data Sheets

Mill test reports (“**MTR**”) and product data sheets shall be submitted to the Department for all materials prior to shipping of the finished bearings from the facility of manufacture. If material cannot be identified by mill test reports, coupons shall be taken and tested in a Canadian certified laboratory noted below and these test reports shall be made available to the Department. Mill test reports and product data sheets shall be legible and in English.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the material tested and the mill test report verified by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test report shall be stamped with the name of the Canadian laboratory and the signature of an authorized officer. It shall state that the material is in conformance with the Technical Requirements.

300.5.18.3.3.4 Material Traceability

A list of all material shall be provided for each structure showing the component designation from the shop drawings and the associated mill test report heat numbers.

300.5.18.3.4 Materials

All materials shall be new and unused, with no reclaimed material incorporated in the finished bearing.

300.5.18.3.4.1 Steel

The steel laminates within steel reinforced elastomeric bearings shall be rolled mild steel with minimum yield strength of 230 MPa. The steel for base plate, keeper bars, pintles and shims shall conform to the requirements of CSA G40.21 Grade 300W. The steel for sole plate, rocker plate and top bearing plate shall be as per Section 300.5.2.16.

300.5.18.3.4.2 Stainless Steel

Stainless steel sheets shall conform to the requirements of the American Iron and Steel Institute (“**AISI**”) Type 304, no. 8 mirror (0.2 µm) finish. The chemical and mechanical properties conform to the requirements of ASTM A 240M.

300.5.18.3.4.3 Brass

Brass sealing rings for confined elastomer bearings shall be according to ASTM B36M, half-hard.

300.5.18.3.4.4 Elastomer

Cured elastomeric compounds shall be low temperature Grade 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06. It shall have 60 durometer hardness shore A for elastomeric bearing pads (laminated and plain) and 50 durometer hardness shore A for pot bearings (elastomeric disc).

Cured elastomeric compounds for fully integral abutments and piers shall be low temperature

Grade 3, 4, or 5 and meet the minimum requirements listed in Table 1 of AASHTO M251-06. It shall have 50 durometer hardness shore A. The hardness shall be checked and the results included with the test report.

300.5.18.3.4.5 PTFE

PTFE shall be unfilled, 100% virgin polymer. It shall conform to Section 18.8.2.5 – Unfilled PTFE Sheet of the 2009 AASHTO LRFD Bridge Construction Specifications including all interim revisions.

Material used as the mating surface for guides for lateral restraint may be one of the following:

- a) Unfilled PTFE.
- b) PTFE filled with up to 15% by mass of glass fibres.

300.5.18.3.4.6 Lubricant

Lubricant shall be silicone grease, effective to -40 °C, and shall comply with U.S. Department of Defense MIL-S-8660C.

300.5.18.3.4.7 Adhesives

Adhesive for bonding PTFE to metal shall be an epoxy resin producing a bond with a minimum peel strength of 4 N/mm, when tested according to ASTM D 429, Method B. Adhesives shall not degrade in the service environment.

300.5.18.3.4.8 Base Plate Corrosion Protection

Bearing base plate corrosion protection shall be as per Section 300.5.8.4.3(4).

300.5.18.3.4.9 Anchor rods and Connecting Bolts

For anchor rods and connecting bolts, the following material properties shall be used:

DESCRIPTION	GRADES
Galvanized mild steel anchor rods in contact with galvanized bearing plates.	Galvanized CSA G40.21M Grade 300W or ASTM A307
Galvanized high strength anchor rods in contact with galvanized bearing plates	Galvanized ASTM A193 GRADE B7 (Fy=725 MPa, Fu=860 MPa). Note galvanizing of high strength steel requires special procedures; refer to Standard Drawing S-1642-00 (TL-4 Double Tube Type Bridgerail – Bridgerail Details).
Bolts connecting galvanized or weathering steel sole plate to bearing components.	Galvanized 22 mm diameter A325M Galvanized nuts A563M Galvanized hardened washers F436M

300.5.18.3.5 Welding

300.5.18.3.5.1 Filler Metals

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas processes are not considered as conforming to low hydrogen practice. These methods will not be permitted. However metal core welding (“**MCAW**”) and shielded metal arc welding (“**SMAW**”) processes utilizing low hydrogen electrodes with AWS designation of H4 will be allowed. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to base metal.

Field application of metal core arc welding shall not be used.

300.5.18.3.5.2 Cleaning Prior to Welding

Weld areas shall be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

300.5.18.3.5.3 Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to re-welding.

300.5.18.3.5.4 Methods of Weldment Repair

Repair procedures for damaged base metal and unsatisfactory weldments shall be prepared by an experienced welding engineer registered as a Professional Engineer and submitted for review and written acceptance by the Department prior to repair work commencing.

300.5.18.3.5.5 Arc Strikes

Arc strikes will not be permitted. In the event of an isolated accidental arc strikes, the Contractor shall have a repair procedure prepared by an experienced welding engineer registered as a Professional Engineer and submitted to the Department for review and written acceptance. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. These areas may be examined by the Department to ensure complete removal of the metal in the affected area. The procedure shall include MPI and hardness testing of the affected area. The hardness of the repaired area shall be as specified in Section 300.5.8.4.4(12) (Hardness Tests).

300.5.18.3.5.6 Plug and Slot Welds

Plug welds or slot welds will not be permitted.

300.5.18.3.6 Fabrication

Fabrication shall be performed in a fully enclosed area which is adequately heated. The temperature shall be at least 10°C.

Pre-fabrication Meeting

A pre-fabrication meeting is required prior to commencement of fabrication of bridge bearings. The meeting will be held at fabricator's plant and the Contractor shall ensure the Field Review Engineer, plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The Field Review Engineer will conduct this meeting after the shop drawings and welding procedures have been reviewed. The Contractor shall provide two weeks' notice to the Department prior to the meeting.

(a) Plain Bearings

Plain bearing pads shall be moulded individually, cut from moulded strips or slabs of the required thickness, or extruded and cut to length.

(b) Laminated Bearings

Laminated bearings shall be moulded under pressure as a single unit and heated in moulds that have a smooth surface finish.

Steel laminates shall have a uniform 3.2 mm thickness without any sharp edges. The bond between the elastomer and the metal laminates shall be such that when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and metal laminate. The top 10 mm galvanized laminate for sliding bearings shall have a 2.5 mm recess. The recessed surface shall be machined to the same requirements of a metal to metal contact surface as per Section 300.5.18.3.6.1 (Machining).

(c) Pot Bearings

Stainless steel sheets in contact with PTFE shall be continuously welded around the perimeter to a backing plate to prevent ingress of moisture. The weld shall be clean, uniform, without overlaps, and located outside the area in contact with PTFE.

The threaded portion of the bolts shall be coated with silicone grease prior to installation.

Virgin or glass filled PTFE elements shall be recessed in a rigid backing material and shall be bonded over the entire area with an adhesive. The rigid backing material shall be grit blasted prior to applying the adhesive.

The PTFE elements used as mating surfaces for guides for lateral restraint shall extend to within 10 mm from the ends of the backing plates.

(d) Steel Rocker Bearings

The curved surface of steel rocker bearing shall be machined as per Section 300.5.18.3.6.1 (Machining).

300.5.18.3.6.1 Machining

Machining shall be done after welding. Any metal to metal contact surfaces shall be machined.

For pot bearings, the pots and pistons shall be machined from solid metal plate or castings. There shall be no openings or discontinuities in the metal surfaces in contact with the confined elastomer or PTFE.

The surface finish of metal plate in contact with any metal plate or confined elastomer in pot bearings shall be machined to a surface finish of 6.4 μm and a flatness tolerance of 0.001 x bearing dimension.

300.5.18.3.6.2 Identification

Each bearing shall be marked with the fabricator's name, date of manufacture and unique identification number. The characters shall be not less than 10 mm in height.

300.5.18.3.6.3 Coating

Metal components described in the Detailed Designs, except weathering steel (CSA G40.21 350 A and 350 AT) and stainless steel, shall be hot dip galvanized after fabrication in accordance with ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

For pot bearings, the pot and piston plates, except surfaces in contact with elastomer, shall be metalized as per ASTM A780, Method A3. The thickness of metalizing shall not be less than 180 microns.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted to the Department for written acceptance prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and re-galvanizing.

Repair shall be in compliance with ASTM A780, Method A3 Metallizing. However repair for areas not exceeding 100 mm² may be done in accordance with ASTM Method A1 "Repair Using Zinc-Based Alloy". The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing. The Field Review Engineer will determine the acceptability of repaired areas.

Galvanized sole plates, slider plates, and rocker plates bolted to the bottom flanges of weathering steel girders shall use galvanized A325 bolts. The bolt layout, size and configuration shall be as detailed on the Detailed Designs. Girder bottom flanges at all bearing connections shall be prime coated all around (bottom, top and edges) to 100 mm beyond the sole plate or the jacking stiffener whichever is greater with an approved organic zinc epoxy primer having a certified Class B slip coefficient in accordance with the "Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as described in Appendix A of the Research Council on Structural Connections "Specification for Structural Joints Using High-Strength Bolts". The coating supplier shall provide a certificate of the batch supplied stating compliance with these Technical Requirements for the coating proposed to the Department for review and written acceptance. The galvanized top surface of the bearings plates shall be hand wire brushed to a Class A slip coefficient surface condition. Slip coefficients surface conditions shall meet the requirements of the Bridge Design Code Table 10.9.

300.5.18.3.6.4 Tolerances

Plain and laminated elastomeric bearing tolerances shall be as per AASHTO Standard M251-06.

Pot bearing tolerances shall be as follows:

- (a) The deviation from flatness of PTFE surfaces shall not exceed:
 - i) 0.2 mm, when the diameter or diagonal is equal to or less than 800.

- ii) 0.00025 of the diameter or diagonal, when the diameter or diagonal is greater than 800 mm.
- (b) The deviation from flatness of stainless steel in contact with PTFE for plane surfaces and from the theoretical surface for spherical surfaces shall not exceed:
 - i) 0.0003 LH mm for a rectangular PTFE element.
 - ii) 0.0006 RH mm for a circular PTFE element.

where:

L = the greater plan dimension for a rectangular bearing,
R = the radius of a circular bearing, and,
H = the free height of PTFE element

- (c) For confined elastomer bearings, the tolerance of fit between the piston and the pot shall be + 0.75 to + 1.25 mm. The inside diameter of the pot cylinder shall be the same as the nominal diameter of the elastomer and shall be machined to a tolerance of:
 - i) 0 to + 0.125 mm for diameters up to and including 500 mm.
 - ii) 0 to + 0.175 mm for diameters over 500 mm.
- (d) The plan dimensions of the recess for PTFE shall be the same as the nominal plan dimensions of the PTFE and shall be machined to a tolerance of 0 to + 0.2% of the diameter or diagonal.
 - i) Overall bearing plan dimension ± 3 mm
 - ii) Overall bearing height ± 3 mm
 - iii) Machined surface dimensions ± 0.4 mm
- (e) Elastomeric components shall meet the following tolerances:
Diameter: 0.0 to -1.5 mm for diameters ≤ 500 mm
 0.0 to -2.0 mm for diameters > 500 mm

Thickness 0.0 to + 1.0 mm
- (f) Brass rings shall meet the following tolerances:
 - i) Difference between internal diameter of brass ring and diameter of recess in the moulded elastomer shall be 0 to + 0.5 mm.
 - ii) Difference between sum of thicknesses of brass rings and recess depth in the moulded elastomer 0 to + 0.25 mm.
- (g) Recessed Guide Bars shall meet the requirements of the American Standard Clearance Locational Fit Class LC3 according to ANSI B4.1.
- (h) Guides for lateral restraints shall have a 0.50 mm ± 0.25 mm gap between metal restraints surfaces and mating PTFE elements.

- (i) PTFE components shall meet the following requirements:
- i) The plan dimension of the PTFE shall be 0 to - 0.2% of diameter or diagonal difference between internal diameter of brass ring and diameter of recess in the moulded elastomer shall be 0 to + 0.5 mm.
 - ii) The thickness of the PTFE shall be within 0 to + 10.0% of the design thickness. The depth of recess of the PTFE shall be 0 to + 0.3 mm of the design depth.

300.5.18.3.7 Testing and Inspection

300.5.18.3.7.1 Testing by the Department

The Department may perform visual, magnetic particle and any other testing that may be required at its own expense.

The Contractor shall be responsible for all wages, travel, boarding and lodging costs for the Department's representative to attend pre-fabrication meetings and subsequent monthly visits to the plants when the fabrication of bearings is done outside Canada.

300.5.18.3.7.2 Independent Inspection, Testing and Reporting by the Contractor

The Contractor shall be responsible for quality control and quality assurance testing required to ensure the work meets the design parameters and the Technical Requirements. Any quality control/quality assurance testing and inspection records made by the Contractor shall be made available to the Department on request.

The Contractor shall engage an independent accredited testing company to perform testing of bearing materials and the finished bearings.

The testing shall meet the acceptance criteria outlined in the Technical Requirements. The results shall be forwarded to the Department upon request for review. The Contractor shall also submit a written affidavit from the manufacturer certifying that the materials supplied meet all the Technical Requirements.

300.5.18.3.7.3 Elastomeric Bearings

Testing of elastomeric compounds shall be completed in accordance with AASHTO M251-06 to verify the material requirements listed in Section 300.5.18.3.4.4 (Elastomer) are satisfied. Testing of the completed bearings shall be in accordance with AASHTO M251-06 Clause 8. Non-destructive testing in clauses 8.8.1 and 8.8.2 shall be done for all the bearings whereas testing in clauses 8.8.3 and 8.8.4 shall be done for the sampled bearings. A sample bearing is considered one additional bearing per lot and a minimum of two samples shall be cut and tested for shear modulus. The dimensional tolerances for each bearing shall be checked and included with the testing document. The optional testing described in section 8.9 of AASHTO M251-06 is not required.

The increment in compressive deformation of laminated bearings shall not exceed 0.05 of the effective rubber thickness, when the bearing load is increased from an initial pressure of 1.5 MPa to a pressure of 7 MPa when tested as per the requirements of Section 9.1 of the AASHTO M251-06.

300.5.18.3.7.4 Pot Bearings

Testing of elastomeric compounds shall be completed in accordance with AASHTO M251-06 to verify the material requirements listed in Section 300.5.18.3.4.4 (Elastomer) are satisfied. Testing of the finished bearings shall be completed in accordance with requirements of 18.3.4 of the 2009 AASHTO LRFD Bridge Construction Specifications including all interim revisions. The long-term deterioration test described in 18.3.4.4.3 is not required. The proof load test described in 18.3.4.4.4 shall be carried out as per the long-term proof load test requirements.

300.5.18.3.7.5 Independent Inspection, Testing and Reporting of the Weldments by the Contractor

Independent Inspector's Qualification

As part of Contractor's quality control, the Contractor shall retain independent inspectors. The independent inspectors shall be employed by a legal entity that is not carrying out any design or construction work for the Project, and that is at arm's length from and completely independent of the Contractor and its subcontractors. The independent inspectors shall have direct communication with the Department. The independent inspectors shall include independent welding inspectors and independent NDT inspectors.

Independent Welding Inspectors

- The welding inspector shall be a Level II or Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition he shall have at least one year of steel bridge related fabrication experience in Canada.
- For out-of-country fabrication, the welding inspector shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. In addition he shall have at least three years of steel bridge related fabrication inspection experience in Canada accepted by the Department.
- The welding inspector for any field welding or repairs shall be a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59.

Independent NDT Inspectors

- The non-destructive testing shall be done by a company certified to CAN/CSA W178.1. All NDT procedures developed by the company shall be submitted to the Department for review. The NDT inspectors shall have the following qualification:
 - Ultrasonic Testing (U/T) and Magnetic Particle Inspection (MPI) inspectors shall be certified to Level II of CGSB in the appropriate category.

Duties & responsibilities of welding inspector

- For fabrication within Canada, the welding inspector shall be in the fabrication plant and performing inspection duties for at least 25% of the fabrication time required for the bridge bearings.
- For fabrication outside of Canada, the welding inspector shall be in the fabrication plant and performing inspection duties for at least 50% of the

fabrication time required for the bridge bearings.

As a minimum, a welding inspector shall perform the following duties during the fabrication of bridge bearings and ensure all the requirements of the Detailed Designs and the Technical Requirements are met:

- Attend a pre-fabrication meeting and any subsequent meetings;
- Develop inspection forms to be reviewed by the Department;
- Verify plant certification;
- Identity of parent material, review of MTRs and traceability of material;
- Review of Product Data Sheets;
- Review welders' certificates;
- Review welding supervisor's certification;
- Review of welding consumables as well as storage and moisture control;
- Review of material quality, surface and internal defects and discontinuities on cut edges;
- Check for the use of most recent approved shop drawings;
- Confirm use of only Department reviewed and CWB approved welding procedures;
- Verify joint preparation such as shape, dimensions and fit-up;
- Verify current calibration of the equipment;
- Review of welding parameters such as welding current, arc voltage, travel speed;
- Check applicable preheat and interpass temperatures are being observed (post heat if required);
- Visual inspection of all welds;
- Check size, shape and ensure all welds meet the acceptance criteria;
- Check cleaning between weld passes and layers;
- Perform dimensional checks of weldments, ensure all tolerances are met;
- Check and ensure all NDT of the weldment is done as per the requirements;
- Check and ensure testing of elastomer, bearings destructive and non-destructive testing are done as per the requirements;
- Check and report all non-conformances;
- Witness all repairs are done according to the accepted procedures;
- Inspect coating application;
- Check and report galvanizing and metallizing quality and coating thicknesses; and
- Report and write and non-conformances.

Magnetic Particle Inspection Schedule

Unless otherwise noted, 25% of all fillet welds shall be inspected by magnetic particle inspection.

Final Independent Inspection Report

A final report prepared by the independent welding inspector reviewed by the Field Review Engineer shall be electronically submitted to the Department within four weeks after the

fabrication of bearings for each structure. It shall include:

- Signed and stamped certificate by the Field Review Engineer;
- A written affidavit from the manufacturer certifying that the materials supplied meet all Technical Requirements;
- Final shop drawings;
- Installation/Erection procedures;
- Company certification;
- Welding procedures;
- Independent welding inspector's certification;
- Independent NDT inspector's certification;
- Welders' certificates;
- Equipment calibration certificates;
- MTRs with material traceability and Product Data Sheets;
- Records of material testing performed during course of fabrication (if any);
- Independent visual inspection and NDT reports for the welding and weldments;
- Dimensional tolerances;
- Elastomer test reports;
- Bearings NDT Reports;
- Bearings Destructive Testing Reports;
- Coating application and thickness measurements; and
- Non-Conformance Reports and any site instructions or design changes.

Bridge Bearings Fabricated Out-of-Country

The bridge bearings when fabricated out-of-country, shall be re-inspected after their arrival into Canada. All steel components shall be brought in a CSA W47.1, Division I1 certified shop for weld inspection.

The Contractor shall arrange for inspection by qualified personnel. The inspection requirements are as follows:

- Inspection shall take place inside an enclosed shop. The shop shall be maintained at a minimum temperature of 10 degrees C.
- The qualification of welding and NDT inspectors shall be as per Section 300.5.18.3.7.5 (Independent Inspection, Testing and Reporting of the Weldments by the Contractor).
- The welding inspector shall inspect:
 - Verification of components to ensure that they were undamaged during transportation;
 - All welds;
 - All fabricated components; and
 - Dimensional checks and tolerance measurements of all the components.
- The Magnetic Particle Inspection.

The visual and NDT reports shall be submitted to the Department within one week of inspection. Non-conforming components shall not be released from the Canadian shop until the proposed

remedial action has been reviewed and accepted in writing by the Department and all re-inspection is complete.

300.5.18.3.8 Approved Pot Bearings Suppliers

The following pot bearing manufacturers have been approved for the use of their products, based on compliance with the design parameters in the Detailed Designs and the Technical Requirements.

- Glacier
- Goodco Z-Tech
- LCL-Bridge

300.5.18.4 Installation

300.5.18.4.1 General

The Contractor shall submit to the Department, for review and acceptance a detailed bearing installation procedure four weeks in advance of the scheduled start of installation. The installation procedure shall include all Detailed Design drawings and documents necessary to describe the following:

- Survey information for location and elevation of grout pads, anchor rod voids;
- Placing of anchor rods and bearings;
- Grouting of anchor rods;
- Methods of forming, placing, curing, and sealing of grout pads; and
- Enclosure and system of heating for grouting in cold weather.

300.5.18.4.2 Bearing and Anchorage

Masonry bearing base plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in their exact position.

The Contractor shall remove anchor rod void forming materials, and accurately set the anchor rods, except where the rods were cast into the concrete. Any residues on the concrete surfaces, such as oils, grease or other contaminants, shall be removed by sandblasting. Anchor rods and bearing pads shall not be grouted until girder erection of the entire superstructure is completed unless otherwise accepted in writing by the Department. All methods and materials for setting anchor rods and constructing bearing pads shall be subject to the Department's review and written acceptance. The location of the anchor rods, in relation to the slotted holes in the sole plates, shall correspond with the girder temperature at the time of grouting. Where nuts are used on top of the expansion bearing anchor rods, the nuts shall be adjusted to permit free movement.

When bearings are detailed in conjunction with grout pockets in the substructure, the bearings shall be set accurately on galvanized steel shims. The shims shall be located such that a minimum of 75 mm grout coverage is provided. When grout pockets are not detailed, the bearing shall be set on the properly finished bearing areas in exact position and shall have full and even bearing on the concrete.

When required, field welding adjacent to elastomeric pads shall be performed with care to avoid damage to the elastomer. The temperature of the steel adjacent to the elastomer should be kept

below 120°C. The distance between the weld and the elastomer should be at least 40 mm.

Top of the bearing sole plate shall be within a tolerance of ± 3 mm of the correct elevation prior to girder erection.

Sole plates shall be bolted or welded to girders in accordance with the Detailed Design. Attachment of sole plates to girders by welding shall be in the longitudinal direction along the edge of the bottom flange or shoe plate. Transverse welding shall not be permitted. Transverse ends shall be sealed with Sikaflex 1a or an approved equivalent caulking material.

Galvanizing or metallizing damaged during field operation shall be repaired by metallizing as per Section 300.5.18.3.6.3 (Coating).

300.5.18.4.3 Anchor Rod Voids and Grout Pads

The Contractor shall fill the anchor rod voids and construct the grout pads using Sika 212 flowable grout or a Department approved equivalent. Dry-pack methods of constructing grout pads will not be accepted. Filling of anchor rod voids and construction of grout pads shall be done by workers competent in this work.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout. A set of compressive strength cubes shall be taken to represent each days production or 0.25 m³, whichever is more frequent. Upon request all test results shall be provided to the Department within seven days. Prior to casting deck concrete, the average minimum compressive strength of 3 cubes at 28 days shall be a 30 MPa measured in accordance with CSA A23.2-1B. A type 1C sealer shall be supplied and applied to the exposed grout pad surfaces in accordance with Section 300.5.7.17 (Type 1c Sealer).

300.5.18.4.4 Grouting in Cold Weather

When the daily minimum air temperature or the temperature of the girders, bearings or substructure concrete in the immediate area of the grouting is, or is expected to be below 5°C during the placing and curing period, the following provisions for cold weather grouting shall be applied:

- (a) Before grouting, adequate preheat shall be provided to raise the temperature of the adjacent areas of the girders, bearings and substructure concrete to at least 15°C.
- (b) Temperature of the grout during placing shall be between 10°C and 25°C.
- (c) The grout pads shall be enclosed and kept at 15°C to 25°C for a minimum of five days. The enclosure shall meet the requirements of Section 300.5.7.13 (Concreting in Cold Weather).

**SCHEDULE 18 – SECTION 400 – DBFO AGREEMENT
EXECUTION VERSION**

**400.0 OPERATIONS - NEW INFRASTRUCTURE AND EXISTING
INFRASTRUCTURE**

**SCHEDULE 18 – SECTION 400 – DBFO AGREEMENT
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400.1 OPERATIONS - GENERAL

This Section 400.0 (Operations - New Infrastructure and Existing Infrastructure) covers the operations, maintenance and rehabilitation requirements applicable to roadways and bridge structures in the Infrastructure.

In this Section 400.0, the phrase “the PNI Operating Period or the Operating Period, as applicable” means that the requirement applies to the Priority New Infrastructure after PNI Traffic Availability but before RNI Traffic Availability during the PNI Operating Period and after RNI Traffic Availability, the requirement applies to the New Infrastructure during the Operating Period.

400.1.1 RESPONSIBILITY FOR OPERATIONS

The Contractor is responsible for the supply of all management, supervision, professional and technical services, quality control and assurance, labour, materials, utilities and equipment for performing all of the duties and obligations to operate, maintain and rehabilitate the Infrastructure, except as excluded herein.

These responsibilities include the supply and payment for electrical power for roadway lighting and signalization, and any other utilities required for the New Infrastructure. The Contractor is responsible for safe and efficient site traffic accommodation.

The operational and performance requirements described in the Technical Requirements represent the requirements that shall be met. The Contractor shall measure roadway and bridge structure conditions and assure compliance to the operational and performance requirements. Where specific operational and performance requirements are not given, the Contractor is expected to operate and maintain roadway elements and bridge structures to a standard of safety, effectiveness and operation equal to, or better than, what is currently being provided on other roadway systems of similar age and type on the Provincial highway system.

Reduction of or restrictions to allowable legal load(s), during spring time thawing conditions or at any other time, is not permitted for any roadway within the New Infrastructure, during the PNI Operating Period or the Operating Period, as applicable.

The Contractor shall display during the PNI Operating Period or the Operating Period, as applicable, the Contractor's name and phone number on eight signs located safely adjacent to the Southwest Calgary Ring Road within the Project Limits. Each sign panel shall be 4' x 8' and shall be manufactured on 3/4" plywood or extruded aluminum and the sheeting and sign supports shall be in accordance with the Department's recognized products list for non-standard signs. Lettering and symbols shall be clear and legible with minimum lettering size to be 200 mm. Reflective sheeting shall meet or exceed the minimum requirements as specified in the ASTM-D4956, Performance Requirements Type IX or Type XI Unmetalized Cube Corner Microprismatic Retroreflective Element Material. All signs are to be installed by PNI Traffic Availability or RNI Traffic Availability, as applicable.

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400.1.2 MAINTENANCE AND REHABILITATION REQUIREMENTS

The requirements to be met in the maintenance of the Infrastructure shall conform to the requirements of the Contractor's Operation and Maintenance Plan of Schedule 4 (Contractor's Managements Systems & Plans) to the DBFO Agreement. In addition, the requirements to be met in the maintenance and rehabilitation of the New Infrastructure during the PNI Operating Period or the Operating Period, as applicable, shall conform to the requirements for design and construction of the New Infrastructure, as well as those of the Contractor's Infrastructure Wholelife Management Plan (such Plan forming part of Schedule 4 (Contractor's Management Systems and Plans) to the DBFO Agreement).

As-Built Construction Reports shall be updated, as required, to reflect maintenance and rehabilitation activities that change the physical dimensions or characteristics of the Infrastructure. The maximum time for completion and the providing of the updated As-Built Construction Reports to the Department shall be two months after completion of the maintenance or rehabilitation activity. If the updated As-Built Construction Reports are not available to the Department within the specified time, a Payment Adjustment of \$4,000/month or any partial month, for every month in excess of the specified time shall apply until available.

The Contractor is responsible for reclaiming all areas of the Road Right of Way and/or stormwater management facilities that have been disturbed during the PNI Operating Period or the Operating Period, as applicable, and shall obtain any required Reclamation Certificates related to these activities within 12 months of completing the reclamation activity, and provide a copy of the same to the Department forthwith.

400.1.3 COMPLIANCE WITH PERFORMANCE REQUIREMENTS

The Infrastructure shall be maintained in conformance with any allowable tolerances as specified for individual performance requirements, subject to the following:

- If measurements indicate that the Infrastructure no longer complies with the performance requirements but falls within the permitted tolerance(s), the Contractor will have the option of correcting the Infrastructure such that it conforms to the performance requirements or foregoing the repairs and paying Payment Adjustments. The option of foregoing repairs shall not be allowed at the handback of the Infrastructure to the Department at the end of the Term.
- If measurements indicate that the Infrastructure no longer complies with the performance requirements and also exceeds any allowable tolerances, the Contractor shall repair the Infrastructure so that it conforms to the performance requirements.

For performance requirements that do not include an allowable tolerance, the Contractor shall complete such work as required to achieve full compliance to the performance requirements.

In addition to the Contractor's regular inspection and measurements, the Department may undertake reviews and measurements of the Infrastructure at any time and will advise the Contractor of non-compliance.

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Where Payment Adjustments are described relative to a kilometre section of the roadway, the kilometre will be a continuous section of a single lane. Neither the requirement nor the Payment Adjustments will be pro-rated based on a partial kilometre length, but will be calculated for the next highest full kilometre length. Crossroads and individual ramps or loops will be considered as discrete sections and treated as one kilometre regardless of the actual length. Where Payment Adjustments are described relative to a period of time or a portion thereof, the Payment Adjustment shall not be prorated but shall be applied in full even if only a portion of the specified period of time has elapsed.

400.1.3.1 Alternative Inspection and Testing Methods

New technological developments may result in alternative inspection and testing methods and techniques that are more accurate, effective or economical. Mutually agreeable alternative inspection and testing methods and techniques may be introduced. These new testing methods and techniques may also require new mutually agreeable performance requirements that are consistent with the intent of existing performance requirements.

400.1.4 APPEAL OF DEPARTMENT MEASUREMENTS

In any case where Department measurements have concluded that a deficiency exists, the Contractor may appeal the results of such measurements within 30 days. Measurements made by the Contractor, using methods and equipment of equal or better accuracy to the Department's specified methods, which indicate the appealed component is not deficient, will be the only cause accepted for allowing an appeal.

The Department and the Contractor will mutually select an independent third party to undertake the appeal measurement(s).

The appeal measurements will be arranged for and paid by the Department and the new measurements shall be binding on the Contractor and the Department and shall not be subject to the Dispute Resolution Procedure. Notwithstanding the foregoing, the Department may, at its sole discretion, elect to accept the measurements submitted by the Contractor as cause for the appeal and forego further measurements.

If the independent third party's measurements verify the deficiency, the Contractor shall be invoiced by the Department, and shall reimburse the Department, for the third party appeal measurement costs plus an additional \$5,000 per appeal.

Any Payment Adjustments supported by the independent third party's measurements shall be upheld. If the independent third party's measurement(s) verify that no deficiency exists, such Payment Adjustments shall be reversed.

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400.1.5 IMMINENT DANGER REPAIRS

In instances where the Contractor and/or the Department determines an Imminent Danger (as defined below) exists on the Infrastructure, the Contractor shall have representation within the Road Right of Way, on route to the Imminent Danger, within 30 minutes of becoming aware of, or of the time the Contractor should have been aware of, the Imminent Danger and shall immediately initiate action to protect traffic and the public from the Imminent Danger and shall continue the action until the Imminent Danger is eliminated. This action may take the form of a temporary solution, including the closing of traffic lanes, until permanent repairs are able to be undertaken or the Imminent Danger is removed. If protective action is not undertaken immediately or implemented as soon as reasonably possible given the circumstances, the Department may elect to undertake such action as it determines necessary and the Contractor shall be responsible for the actual cost of the actions which may include the cost of accommodating traffic over, through or around portions of the Infrastructure, if necessary, plus a 25% administration fee. These costs shall be deducted from Payments to be made to the Contractor. In instances where the Contractor fails to meet the above timelines and/or the Department is forced to undertake action to protect any user from an Imminent Danger, the Contractor shall also be assessed a Payment Adjustment of \$15,000/occurrence. The third occurrence in any consecutive 12 month period anywhere on the Infrastructure shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement. The Department shall provide the Contractor with timely notice after the Department has considered it necessary to take action to protect a user from an Imminent Danger situation. The responsibility for the repair of the cause of the Imminent Danger shall be governed by the DBFO Agreement and the other applicable provisions of the Technical Requirements.

For the purposes of this section, “**Imminent Danger**” refers to a safety hazard that may be encountered by any user of the Infrastructure due to a collision, condition or any other abnormal occurrence on the Infrastructure. For further clarification, an “**Imminent Danger**” may or may not correspond to a need for “emergency maintenance activities” under Section 400.2.2 (Emergency Maintenance).

400.1.6 LANE CLOSURE

Under no circumstance, except for an Excepted Lane Closure (as defined below), shall the Contractor close all lanes in either direction during the PNI Operating Period or the Operating Period, as applicable, nor implement measures to require or to seek to encourage the public to use an alternative route away from the Infrastructure.

If as a result of an Excepted Lane Closure the need arises to use signs or other measures to require the public to use an alternative route away from the Infrastructure, the Contractor may effect such measures, provided that the Contractor shall as soon as reasonably practicable advise the Department of such measures and the reasons therefor. The Contractor shall take all reasonable steps to minimize the duration of such measures.

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Within 60 days after PNI Traffic Availability, the Contractor shall submit to the Department in accordance with the Review Procedure as set out in Schedule 5 (Design and Plan Certification and Review Procedure) to the DBFO Agreement (the “**Review Procedure**”), a schedule for Lane Closures (as defined below) in respect of the Infrastructure for the first 12 month period after PNI Traffic Availability (the “**Agreement Year**”) and the next succeeding Agreement Year. No later than January 1 in each Agreement Year after the first Agreement Year the Contractor shall submit to the Department in accordance with the Review Procedure a schedule for Lane Closures in respect of the Infrastructure for the next succeeding Agreement Year. Each schedule of Lane Closures (the “**Schedule of Lane Closures**”) shall give details of the proposed lanes of Lane Closure, start and end dates for each period of Lane Closure, and the work to be carried out.

The Contractor shall inform the Department of any changes to a Schedule of Lane Closures no later than 60 days prior to the commencement of the applicable Lane Closure.

The Department may raise comments in respect of any period of Lane Closure requested in a Schedule of Lane Closures. In such event, the Department shall notify the Contractor thereof with reasons and shall indicate, in the case of an objection, an appropriate duration for such Lane Closure and in any other case a period when the unacceptable period can be re-scheduled, on the basis that each such re-scheduled period shall be as close as reasonably practicable to the requested period of Lane Closure and of equal duration or, if the Contractor has indicated another period and/or duration that would be preferable to it and that is acceptable to the Department, such other period and/or duration. The Contractor shall thereupon amend the applicable Schedule of Lane Closures accordingly and re-submit the same to the Department in accordance with the Review Procedure.

The Department's approval of Lane Closures shall not be unreasonably withheld or delayed, having regard to the factors set out in the Review Procedure.

The Contractor shall not affect any Lane Closures save:

- in accordance with the Schedule of Lane Closures to which no objection has been made under the Review Procedure; or
- in an Excepted Lane Closure.

Notwithstanding that there has been no objection to the Schedule of Lane Closures in accordance with the Review Procedure, the Department may upon 60 days prior written notice require the Contractor to re-schedule a period of Lane Closure if due to a change in circumstances such re-scheduling is necessary.

The Department may not require:

- that such period of Lane Closure be brought forward by more than 60 days from the scheduled date of commencement of such period; or
- that a period of Lane Closure be deferred by more than 60 days from the scheduled date of commencement.

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If as a result of an Excepted Lane Closure, the need arises for unscheduled maintenance or repair work requiring Lane Closures, the Contractor shall effect such Lane Closures provided that the Contractor shall as soon as reasonably practicable advise the Department of such closure and the reasons therefor and shall take all reasonable steps to minimize the duration of such Lane Closure.

All Lane Closures shall be subject to the Lane Closure Payment Adjustments except Lane Closures (the “**Excepted Lane Closure**”) arising, and without being caused by a breach by the Contractor of any of the obligations of the Contractor under the DBFO Agreement or the negligence of the Contractor or those for whom the Contractor is responsible at law, from:

- an emergency, including without limitation clean-up of a motor vehicle collision;
- an order of the police, fire department, emergency medical services, military, or other similar emergency services providers;
- Approved Special Events as defined in Section 200.3.9.2 (Special Events – Partial or Full Closure Events);
- Severe Storm Events (as defined in Section 400.3.1 (Winter Maintenance Operation Requirements – General));
- Repairs of damage to the Infrastructure caused by the Province, its agents, employees, and contractors (except the Contractor but including, without limitation, those contractors other than the Contractor engaged by the Province under sections 7.3, 7.4 or 11.8 of the DBFO Agreement) and their employees and by third parties (other than the Contractor’s agents or subcontractors or others for whom the Contractor is legally responsible) provided, if the Contractor is obligated or retained to do the repairs, all reasonable steps are being taken by the Contractor to complete the repairs in accordance with the Contractor’s obligations;
- a direction of the Department or the performing of the Province’s obligations under the DBFO Agreement;
- the express authorization for such Lane Closure set out in a permit issued by the Province pursuant to section 7(2) of the *Highways Development and Protection Regulation* (AR 326/2009, as amended);
- movement of high loads or oversized loads pursuant to section 6.4 of the DBFO Agreement and required by a permit authorizing such movement issued by the Province;
- any EI Deficiencies or EI Rehab Deficiencies (as both terms are defined in section 6.6 of the DBFO Agreement); or
- any rehabilitation work being carried out or having been carried out by or on behalf of the Department in relation to the Existing Infrastructure.

The Contractor shall provide to the Department such information (including without limitation details of proposed Lane Closures and information about its traffic safety and management measures on the Infrastructure) as may be required for purposes of any information service operated by or on behalf of the Department from time to time. Currently, the Contractor shall notify 511 Alberta of all Lane Closures using the construction activity notification a minimum of three days prior to the scheduled Lane Closure. Any changes to the timing or duration of the Lane Closure shall be reported to 511 Alberta in a timely manner.

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The Contractor shall operate a telephone service answered by a knowledgeable person of the Contractor to respond to questions from the public in relation to the Infrastructure. This telephone service shall operate 24 hours per day.

Subject to the Excepted Lane Closures, for every full or partial hour of Lane Closure (as defined below) occurrence anywhere on the Infrastructure, the Contractor shall be assessed a Payment Adjustment at the applicable lane closure rate. The length of the Lane Closure for determination of Lane Closure Payment Adjustments shall be rounded up to the next higher whole kilometre.

For planned maintenance and rehabilitation activities on roadways or bridge structures that have two lanes in each direction, the Contractor must have at least one lane open to traffic in each direction at all times.

For planned maintenance and rehabilitation activities on roadways or bridge structures that have three lanes or four lanes in each direction, the Contractor must have at least two adjacent lanes open to traffic in each direction at all times. The Department may, by prior written approval, permit an exception in the interest of safety.

The right of the Contractor to do Lane Closures and incur Lane Closure Payment Adjustments is subject always to the paramount requirements set out in the first paragraph of this Section 400.1.6 and the above two paragraphs. Lane Closure Payment Adjustments are as follows:

Type	Timing/Duration	Rate
Peak Hours* - Weekdays	0600 to 0900 and 1530 to 1800 hrs	\$520/hr/lane-km
Day – Weekdays	0900 to 1530 hrs	\$220/hr/lane-km
Day - Weekends and Statutory Holidays	0600 to 1800 hrs	\$220/hr/lane-km
Evening	1800 to 2200 hrs	\$160/hr/lane-km
Night	2200 to 0600 hrs	No Charge

** A Lane Closure for planned operational purposes may not be started during Peak Hours.*

A “**Lane Closure**” is defined as:

- Any partial or complete closure of a traffic lane; or
- Any reduction of posted speed to less than 75% of the normal posted speed prior to construction impacting any through lane, merge lane or ramp, C-D road, turn lane, crossroad, bridge structure, detour or other road forming a part of or connected to the Infrastructure.

Conclusion of Lane Closure is defined as:

- Continuous, smooth, paved intact travel surface;
- Traffic control removed and traffic fully restored; and
- Cause of closure has been removed and all safety requirements have been satisfied.

Also reference Section 400.5.1.3.7 (Traffic Accommodation).

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400.1.7 IN-SERVICE SAFETY REVIEW (NEW INFRASTRUCTURE ONLY)

On an as-needed basis, the Department will compare the reported collision rates on roadway segments and interchanges on the New Infrastructure to rates recorded on similar segments of divided highways and interchanges in Alberta.

If the collision rate on any roadway segment or interchange on the New Infrastructure exceeds the benchmark by 10% or more, the Department may elect to conduct an in-service safety review (the “**In-Service Safety Review**”). If so elected, the review will be undertaken within three months of notification of the need for such a review. The In-Service Safety Review shall be undertaken in accordance with the Transportation Association of Canada’s guidelines.

The Department will provide a copy of the In-Service Safety Review to the Contractor. The Contractor shall implement any minor operational recommendations, as requested by the Department acting reasonably, at its cost within six months of such request. The minor operational recommendations may fall into the following categories:

- Provision and installation of delineators;
- Revised snow clearing and ice control procedures;
- Bridge deck icing plan procedures;
- Revised pavement markings;
- Revised directional, regulatory and warning signing (not involving sign structures);
- Revised traffic signal timings; and
- Guardrail adjustment or extension of new guardrail not greater than 10 metres.

If the minor operational recommendations from the In-Service Safety Review are not implemented within the specified time by the Contractor, a Payment Adjustment of \$1,500/week or any partial week, for the first four weeks and \$3,000/week or any partial week, thereafter shall apply until all of the minor operational recommendations are implemented.

400.2 INSPECTION, EMERGENCY AND ROUTINE MAINTENANCE REQUIREMENTS

400.2.1 ROADWAY INSPECTIONS REQUIREMENTS

The Contractor’s Operation and Maintenance Plan (Section 100.2.9) shall include details on how roadway inspections will be carried out and shall as a minimum, meet the following requirements:

- On Business Days, inspect the roadway at a minimum frequency of every two hours between 6:30 a.m. and 6:30 p.m. and every four hours between 6:30 p.m. and 6:30 a.m.;
- On days other than Business Days, inspect the roadway at a minimum frequency of once every four hours (24 hours per day);

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- Observe road conditions, repair requirements, snow or weather issues, icing conditions on bridge decks, and sign conditions for each inspection;
- Inspect traffic signal operation in accordance with Package F in Appendix J; and
- Confirm the retroreflectivity of signs visually during dark (night time conditions) at least once every two months. Signs that are reasonably considered to be deficient shall be tested within 30 days of the visual inspection.

The Contractor shall provide sufficient resources to patrol the roadway, to observe, react to and report all circumstances or conditions affecting the travelling public or the future repair of the roadway or appurtenances. The Contractor shall investigate reports of adverse conditions from members of the public, regulatory agencies, police authorities and the Department, and perform the immediate repair of all hazardous conditions in accordance with Section 400.1.5 (Imminent Danger Repairs) and Section 400.2.2 (Emergency Maintenance).

400.2.1.1 Routine Observations

During the performance of roadway inspections, emergency maintenance, routine maintenance or at any other time the Contractor's personnel are travelling on the roadway, such personnel shall observe conditions of the roadway surface, appurtenances, and the Road Right of Way for the purpose of identifying any deficiencies and scheduling such work as required to maintain compliance to the Technical Requirements.

Items of work which would typically be identified during routine observations include but are not limited to the following:

- Damaged signs and delineators;
- Drainage problems including blockages, erosion or lack of capacity of ditches, culverts and drainage grates, particularly during spring thaw and run-off. The Contractor shall make interim repairs in these areas when possible;
- Any required cleaning, litter removal or snow removal;
- Damage to structures or appurtenances;
- Roadside or median barriers which have been damaged or moved from the original position, or any other condition that prevents, or reduces the effectiveness of the barrier from performing its intended function;
- Graffiti;
- Burned out lights on the roadway lighting systems;
- Non-functioning, malfunctioning or burned out lights on traffic control lighting systems; and
- Condition of bridge structure components, e.g. bridge rail, bridge deck and bridge deck joints.

400.2.1.2 Daily Road Reports

As part of normal winter duties or as otherwise required, the Contractor shall provide daily road reports in the Department's standard format to 511 Alberta. The Contractor shall provide road reports to 511 Alberta three times daily, once prior to 0600 hours, once between 1100 – 1200

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hours and once between 1500 – 1600 hours. These reports shall detail driving conditions on the Infrastructure and shall be updated as required, so that the travelling public is kept current with changing roadway or weather conditions. The Contractor shall provide the Department with a copy of all reports issued.

400.2.2 EMERGENCY MAINTENANCE

Any work identified which falls under the category of emergency maintenance or otherwise results in an unsafe condition shall be immediately addressed by the Contractor and, subject to the DBFO Agreement and the other applicable provisions of the Technical Requirements, at the Contractor's cost.

Emergency maintenance activities, requiring the Contractor's immediate response by having representation within the Road Right of Way, on route to the emergency, within 30 minutes of becoming aware of, or of the time the Contractor should have become aware of, include but are not limited to, the following:

- Repairing or replacing temporary or permanent critical regulatory signs (STOP and YIELD) or performing temporary repairs of signs;
- Removing from the roadway surface, roadkill and debris of a size or type that may create a hazard;
- Report all incidences of roadkill to the appropriate authorities;
- If an animal is injured, the Contractor shall contact the police and/or fish and wildlife officials, who will determine and arrange for the action required;
- In cases involving livestock, the Contractor shall remove the carcass from the roadway surface and contact the owner of the animal to dispose of the carcass. If the owner cannot be contacted, the Contractor shall remove the carcass from the Road Right of Way, dispose of the carcass at an approved site and immediately notify the Department;
- Repairing traffic signals and advanced warning devices, including without limitation:
 - Resetting signals if the lights are in flash mode;
 - Replacing burned-out bulbs;
 - When the lights are completely out of service, setting up portable STOP signs from all directions until permanent repairs occur; or
 - Establish traffic signal trouble call requirements as detailed in Package F in Appendix J;
- Responding to collisions or natural disasters, including without limitation:
 - Traffic control, including erecting detours or barricades in accordance with appropriate traffic control requirements;
 - Supply and erection of emergency signs;
 - Cleaning-up the collision or disaster site;
 - Removing from the roadway surface, any material including damaged guardrail which presents a hazard to the travelling public;
 - Applying absorbent material to minor spills at collision sites;
 - Placing "Police Emergency Ahead" signs at the scene of collisions, spills or obstructions on the roadway;
 - Providing emergency traffic control and arrowboards;

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- Reopening of the roadway within one hour of clearing the collision or natural disaster; and
- Communication with, coordinating with, and providing access for, emergency response services that may be required on the Infrastructure or be required to pass over the Infrastructure;
- Notification of and cooperation with the relevant emergency and/or regulatory authorities in the containment and clean-up of all spills, including those in ditches and ponds. The Contractor shall also notify the Department of any spills within 24 hours of any occurrence;
- Providing adequate marking of any conditions on the roadway surface or in the Road Right of Way which are a hazard to the travelling public, including:
 - Emergency repair and marking of unsafe or poor pavement conditions; and
 - Emergency repair and/or marking of unsafe or poor bridge structure conditions.

An incident requiring emergency maintenance activities may also require a response under Section 400.1.5 (Imminent Danger Repairs).

400.2.3 ROUTINE MAINTENANCE

The Contractor's routine maintenance activities shall include, but not be limited to, the following:

- Removing and disposing of incidental refuse and litter from within the Road Right of Way;
- Straightening or reinstalling sign posts;
- Shimming and tightening connections on breakaway sign posts as required;
- Straightening or reinstalling delineator posts and replacing reflective strips on guardrails and delineator posts;
- "Summerize" signals and control boxes;
- "Winterizing" signals and control boxes;
- Performing regular traffic signal maintenance twice per year at all traffic signal locations in accordance with Package F in Appendix J;
- Washing signs, delineators and reflective strips on guardrail. If soap is used, it must be biodegradable;
- Removing graffiti from all sites;
- Removing non-conforming signs from within the Road Right of Way;
- Performing annual inspections of all drainage system components, scheduling required maintenance and draining, and completing such maintenance and draining prior to freeze-up each year;
- Removing minor blockages in the drainage system on a regular basis;
- Removing, collecting and disposing of winter sand by May 15 of each year; and
- Removing, collecting and disposing of tracked dirt and all other debris from the roadway.

400.2.4 MEASURING FOR COMPLIANCE

For all roadway inspection, emergency maintenance and routine maintenance requirements, the Contractor shall undertake the work within the time periods stipulated in the Technical Requirements and in accordance with the Contractor's Operation and Maintenance Plan (Section

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100.2.9).

All traffic signal timings, after they are implemented by the Contractor, shall be subject to review by the Department. The Contractor shall make necessary adjustments to the signal timing to meet traffic signal operation requirements outlined in Packages A through F in Appendix J.

400.2.5 PAYMENT ADJUSTMENTS

If the roadway inspection, emergency maintenance and routine maintenance are not completed within the required time period on the Infrastructure, the Contractor shall be assessed the following Payment Adjustments.

In this section, “**occurrence**” refers to an occurrence anywhere on the Infrastructure.

If the Contractor fails to undertake the roadway inspections, Payment Adjustments shall be made as follows. The number of occurrences of non-conformance shall be determined for a consecutive 12 month period.

- \$3,000 for the first occurrence;
- \$6,000 for the second occurrence;
- \$12,000 for the third occurrence; and
- \$24,000 for the fourth occurrence and each occurrence thereafter.

If the Contractor fails to undertake routine maintenance in any consecutive 12 month period, Payment Adjustments shall be made as follows:

- \$6,000 for the first occurrence;
- \$12,000 for the second occurrence;
- \$24,000 for the third occurrence, and each occurrence thereafter.

If the Contractor fails to undertake emergency maintenance in any consecutive 12 month period, Payment Adjustments shall be made as follows:

- \$25,000 for the first occurrence;
- \$50,000 for the second occurrence; and
- The third occurrence shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement.

The Department shall notify the Contractor after the first and second occurrence of non-compliance with an emergency maintenance performance requirement in any consecutive 12 month period.

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400.2.6 REPORTING PROCEDURES

All actions taken related to Section 400.2.2 (Emergency Maintenance), shall be reported immediately to the Department.

The Contractor shall record conditions identified during roadway inspections, and any work performed as a result of the observations. Such information shall be reported to the Department. The report shall make a distinction between conditions that required immediate response and those that could be scheduled as future work.

The Contractor shall record and report monthly, all routine maintenance performed, including segments worked and activities performed.

These reports shall include:

- Segment(s) worked; and
- Action(s) taken.

400.3 WINTER MAINTENANCE OPERATION REQUIREMENTS

400.3.1 GENERAL

When undertaking winter maintenance operations, the Contractor shall coordinate its operations to achieve Bare Pavement (as defined below) conditions on all driving lanes and pathways or walkways. “**Bare Pavement**” is defined as the travel lanes, and walkway/pathways being free of snow, packed snow, frost and ice. Gore areas may have accumulations of loose snow up to 100 mm and shoulders may have accumulations of loose snow up to 30 mm. Drainage points shall be kept free of snow and debris.

The Winter Maintenance Standards table below defines the requirements for snow clearing and ice control for the Infrastructure:

Winter Maintenance Standards							
Class	AADT Range	Max. Time to React (hrs)	Storm Event		Severe Storm Event		Max. Time to Bare Pavement Temperature Waiver (°C)
			Max. Time to Bare Pavement (hrs)	Max. Time to Clean Up (hrs)	Max. Time to Bare Pavement (hrs)	Max. Time to Clean-Up (hrs)	
A	0 to 30 000	1.5	5	48	10	72	-10
AA	30 001 to 75 000	1.0	3	48	6	72	-15
AAA	75 001 to 125 000	1.0	3	48	6	72	-20
AAAA	125 001 and above	1.0	3	48	6	72	-25

All roadways within the Infrastructure shall have a class assigned to each segment, as shown in the table above, on the basis of AADT for that segment. The AADT for each segment shall be determined in accordance with Section 200.3.1 (Traffic Volume Payment Adjustments). Winter

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snow clearing and ice control traffic segments may change in length or class depending on the changes in traffic volume (AADT).

AADT will be determined for the following sections as indicated:

1. Calgary Ring Road within the Project Limits – traffic counter used for Traffic Volume Payment Adjustments under Section 200.3.1;
2. Glenmore Trail (east of Sarcee Trail) – historical average daily weekday traffic volume flow maps provided by the City or traffic counts performed by the City; and
3. Crossroads - historical average daily weekday traffic volume flow maps provided by the City or traffic counts performed by the City.

A “**Storm Event**” is defined as a period of time of continuous precipitation and/or condensation and/or wind causing the formation of snow and/or ice on the roadway surface and that is not a Severe Storm Event. The end of a Storm Event shall be considered the last known time of precipitation, heavy snow drifting or condensation affecting the roadway.

A “**Severe Storm Event**” is defined as:

- a. A combination of heavy snowfall over a short duration, accumulation of more than 2 cm/hr, or snowfall greater than five days duration, wetter snow, and high winds that result in visibility conditions such that snowplow operations become hazardous and such operations should reasonably cease for several hours;
- b. A snowfall event where a weather warning was issued from Environment Canada or its successor;
- c. A wind event where the wind is greater than 60 km/h for four consecutive hours; or
- d. A freezing rain or hail event where the accumulation on fixed objects is greater than 6 mm.

The end of a Severe Storm Event shall be considered the last known time of precipitation, heavy snow drifting or condensation affecting the roadway.

The Contractor shall react to a Storm Event or a Severe Storm Event within the “Max. Time to React” shown in the table above. The reaction time shall be measured from the time that the Contractor becomes aware or is notified, or should have been aware of, the start of a Storm Event or a Severe Storm Event to the time the Contractor starts to engage in snow/ice removal activities with the appropriate equipment. The Contractor may be made so aware by its own forces, media, the Department, Local Authorities or emergency services.

The Contractor shall achieve Bare Pavement within the “Max. Time to Bare Pavement” shown in the table above. The time to Bare Pavement shall be measured from the end of the Storm Event or the Severe Storm Event to Bare Payment.

The Contractor shall achieve Clean-up within the “Max. Time to Clean-up” shown in the table above. Time to complete Clean-up shall be measured from the end of the Storm Event or the Severe Storm Event to the completion of Clean-up. “**Clean-up**” is defined as banks or drifts of

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snow that are greater than 0.5 m high are removed from the roadway including at least 2 m adjacent to the shoulder from all high speed (posted 100 km/hr or greater) driving surfaces. “Clean-up” includes the restoration of sight distance on all ramps, intersections and crossroads.

Should winter snow and ice conditions dictate, the “Max. Time to Bare Pavement” requirement may be waived by the Department if the temperature after the “Max. Time to Bare Pavement” is below the indicated value in the last column of the above table. During this time of cold temperatures, the Contractor shall apply winter abrasive material and attempt to physically remove ice and packed snow from the roadway surface. At all times, abrasives will be present on all slippery surfaces within the driving lanes, to ensure safety for the travelling public. Once the temperature rises above the indicated value in the last column of the above table, the “Max. Time to Bare Pavement” requirement shall recommence, and the Contractor will have the full time to achieve Bare Pavement.

During a Severe Storm Event, the Contractor shall maintain one driving lane open in both directions (including on/off ramps).

Pathways and walkways shall be cleaned of snow within 48 hours of the end of a Storm Event or a Severe Storm Event.

The Contractor shall prepare an annual specific and updated Snow Clearing and Ice Control Operations Plan that meets the requirements of Section 400.3 (Winter Maintenance Operation Requirements). The plan must be acceptable to the Department and in place by September 15th of each year for the upcoming winter months.

The Snow Clearing and Ice Control Operations Plan must provide for the deployment of snowplows and spreader equipment capable of meeting and which does meet the following objectives:

- The Infrastructure roadways must be open to the driving public at all times, unless the Department closes the road;
- All lanes remain operational during snow conditions;
- Plowing shall commence prior to snow accumulation reaching 15 mm on any roadway;
- The deployment of snowplows and spreader units shall be calculated based on these requirements and the locations of the Contractor’s sand and salt stockpiles;
- If required to meet labour and plowing standards and/or where storm intensities are beyond the capabilities of the normal snow removing equipment complement during storms which last more than 48 hours, identify a procedure for obtaining and deploying additional resources;
- Snowplows and spreader units shall respond within the applicable response times;
- Include a contingency plan to address storm conditions which may force the closure of the roadway facility or instances where traffic prevents the deployment of the standard snowplow/equipment complement;
- Plowing coverage shall provide for the continuous integrated plowing of both shoulder and surface of the roadway facility including interchange ramps, intersections and cross-roads;
- Snowplowing on bridges shall be done to prevent snow, ice or other substances from being

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thrown onto underlying roadway, railways or canals;

- A plan for meeting the Section 400.3 (Winter Maintenance Operation Requirements), in case of a winter storm or winter driving conditions, during the non-winter months;
- Address the cover-off of equipment operators who meet their “Hours of Service” limits or tire. Provide cover-off operators and ensure all equipment remains operational and operated, for the duration of the storm and for the Clean-up (as defined in Section 400.3.1) periods;
- Provide for the provision of regular winter condition reporting to the Department and 511 Alberta or any other agency identified by the Department;
- Snowplows shall be equipped with real-time GPS units with real-time location data provided to 511 Alberta on a continuous basis; and
- Coordinate winter maintenance with the Local Authority.

The accepted Snow Clearing and Ice Control Operations Plan shall be adhered to throughout the Construction Period and the Operating Period.

400.3.2 EQUIPMENT AND MATERIALS

The Contractor’s Snow Clearing and Ice Control Operations Plan (see Sections 100.2.9 and 400.3.1) shall include periods for which the level of equipment shall be available from October 1 to April 30 and identify levels of equipment that will be available from May 1 to September 30 during non-winter months to respond to snow falls during these periods.

Specifications for plowing and sanding trucks shall, as a minimum, be in accordance with applicable law, including without limitation the *Traffic Safety Act* (Alberta) and any regulations thereunder and any replacement or successor legislation, and applicable Department standards, as identified in *Alberta Transportation Standard Specifications for Highway Maintenance*.

Sand and salt materials shall be stored in a manner identified in the EMS (Section 100.2.2). The Environment Canada - Code of Practice for the Environmental Management of Road Salts shall be used as a guideline. The Contractor shall adjust the materials storage and handling practices as necessary to address changes or developments in the environmental concerns for any of the materials used.

400.3.3 SNOW CLEARING AND ICE CONTROL OPERATIONS

The Contractor shall conduct all winter maintenance activities with the objective of achieving Bare Pavement (as defined in Section 400.3.1) conditions as quickly as possible and in all cases within the stipulated time periods. Activities shall comply with the accepted Snow Clearing and Ice Control Operations Plan (see Sections 100.2.9 and 400.3.1) and the following:

- The required complement of snowplows shall be deployed within the time limits identified;
- Emergency vehicles and equipment shall be deployed on the roadway system in the event that the standard equipment complement cannot meet Section 400.3 (Winter Maintenance Operation Requirements);

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- Snowplows and sand/salt spreader trucks shall be operated in accordance with applicable laws and regulations;
- Snow/ice equipment shall be operable and operated on a 24 hour basis, throughout the Storm Events or Severe Storm Events (both as defined in Section 400.3.1) and subsequent Clean-up (as defined in Section 400.3.1);
- All equipment shall be operated with due diligence to prevent damage to the Infrastructure, and with due regard for the safety of the travelling public; and
- Any damage to the Infrastructure as a result of snow clearing or ice control operations shall be the responsibility of the Contractor.

400.3.3.1 Measuring for Compliance

The Contractor shall monitor its performance relative to Section 400.3 (Winter Maintenance Operation Requirements) and record all response times and snow and ice accumulations in a maintenance management record which shall be provided to the Department on a monthly basis.

400.3.3.2 Non-Compliance

If the Contractor fails to comply with any of Section 400.3 (Winter Maintenance Operation Requirements), despite such a failure, the Contractor shall immediately mobilize in order to minimize snow and ice accumulations.

If non-compliance is observed, Payment Adjustments will be assessed against the Contractor.

Non-compliance is defined as any one of the following:

- The Contractor fails to deploy equipment in accordance with the accepted Snow Clearing and Ice Control Operations Plan (see Sections 100.2.9 and 400.3.1);
- The Contractor has failed to deploy additional resources in accordance with the Snow Clearing and Ice Control Operations Plan;
- The Contractor has failed to plow/remove and/or apply materials as identified in the accepted Snow Clearing and Ice Control Operations Plan;
- The Contractor failed to meet the deployment time frames;
- The Contractor fails to achieve Bare Pavement (as defined in Section 400.3.1) within the specified time frames following the end of a Storm Event or a Severe Storm Event (both as defined in Section 400.3.1); and
- The Contractor fails to supply any ice control materials.

400.3.3.3 Payment Adjustments

When the Contractor is non-compliant, Payment Adjustments shall be made as follows:

- \$15,000 for each occurrence of non-compliance during a Storm Event or a Severe Storm Event (both as defined in Section 400.3.1) (to a maximum of \$90,000 total for the Infrastructure);

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- \$30,000 for each occurrence of non-compliance during a subsequent Storm Event or a Severe Storm Event in any consecutive 12 month period (to a maximum of \$180,000 total for the Infrastructure); and
- The third occurrence of any non-compliance within a consecutive 12 month period but in a separate third Storm Event/Severe Storm Event shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement.

The number of occurrences of non-conformance shall be determined for a consecutive 12 month period.

The Department shall notify the Contractor after the first and second occurrences of non-compliance in any consecutive 12 month period. In this section, “occurrence” refers to an occurrence anywhere on the Infrastructure.

400.3.4 PREFERENTIAL BRIDGE DECK ICING

The Contractor shall implement and carry out the Preferential Bridge Deck Icing Plan (see Section 100.2.9 (Operation and Maintenance Plan)). For the purposes of the Technical Requirements, “**preferential bridge deck icing**” shall mean ice formation within the driving lanes of a bridge deck during a weather circumstance when ice formation within the driving lanes of the roadway leading to and from such bridge deck is not occurring.

400.3.4.1 Measuring for Compliance

The Contractor shall monitor its performance relative to the Preferential Bridge Deck Icing Plan and record all occurrences of preferential bridge deck icing and response times in a maintenance management record which shall be provided to the Department on a monthly basis.

400.3.4.2 Non-Compliance

The Contractor shall be in non-compliance under this Section 400.3.4.2 if preferential bridge deck icing is observed within any of the driving lanes on any of the PBD Bridges (as defined in Section 200.2.16 (Preferential Bridge Deck Icing)) and either:

- such icing has occurred as the result of the Contractor’s failure to comply with the current Preferential Bridge Deck Icing Plan; or
- upon becoming aware of such preferential bridge deck icing, the Contractor fails to immediately mobilize in order to reasonably minimize such preferential bridge deck icing; or
- preferential bridge deck icing has previously occurred on any of the PBD Bridges under the same Preferential Bridge Deck Icing Plan during a prior distinct weather circumstance occurring in the prior 12 month period.

(each a “**Preferential Bridge Deck Icing Non-Compliance Event**”).

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400.3.4.3 Payment Adjustments

When the Contractor is non-compliant pursuant to Section 400.3.4.2 (Non-Compliance), Payment Adjustments shall be made as follows:

- \$15,000 for each occurrence of a Preferential Bridge Deck Icing Non-Compliance Event during a distinct weather circumstance (to a maximum of \$90,000 total for the Infrastructure) (the “**First Set of Occurrences**”);
- \$30,000 for each occurrence of a Preferential Bridge Deck Icing Non-Compliance Event following the First Set of Occurrences during a subsequent but separate and distinct weather circumstance in any consecutive 12 month period (to a maximum of \$180,000 total for the Infrastructure) (the “**Second Set of Occurrences**”); and
- The third occurrence of any Preferential Bridge Deck Icing Non-Compliance Event within a consecutive 12 month period but during a separate and distinct weather circumstance shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement.

The number of occurrences of non-compliance shall be determined for a consecutive 12 month period.

The Department shall notify the Contractor after the First Set of Occurrences and the Second Set of Occurrences in any consecutive 12 month period. In this section, “**occurrence**” refers to an occurrence anywhere on the Infrastructure.

400.3.4.4 Plan Replacement

The Contractor shall be entitled at any time to replace the Preferential Bridge Deck Icing Plan provided such replacement plan shall be reasonably designed to prevent preferential bridge deck icing from occurring on the PBD Bridges (as defined in Section 200.2.16), including without limitation be reasonably designed to rectify any previous failures in preventing preferential bridge deck icing, and is reviewed in accordance with Schedule 5 (Design and Plan Certification and Review Procedure).

400.4 ROADWAYS

400.4.1 ROADWAY MAINTENANCE REQUIREMENTS

The Contractor shall maintain the entire pavement structure, appurtenances, and all associated works that are included as part of the Infrastructure in accordance with the performance requirements. All areas of pavement including shoulders and gores shall be maintained to similar conditions as the driving lanes. Specifically for Sections 400.4.3 (Smoothness Requirements) and 400.4.4 (Rutting Performance Requirements) as they apply to shoulders and gores, the Contractor shall confirm all shoulders and gores meet the requirements by taking measurements at reasonable and representative locations as proposed by the Contractor and approved by the Department.

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400.4.1.1 Measuring and Testing For Compliance

The Contractor shall be proactive in maintenance of the roadways and appurtenances and shall test conformance with the performance requirements at least once annually or as stipulated by the Technical Requirements. The Contractor shall schedule testing prior to August 1st of each year so that any required repairs can reasonably be completed in the same calendar year. All test results shall be provided to the Department forthwith, upon its request.

For each of the Technical Requirements, the Department may also conduct measurements for compliance and advise the Contractor of any deficiencies.

400.4.1.2 Completing Repairs

When a specific deficiency is identified and times are not defined in the following sections, the Contractor shall correct the work such that it complies with the performance requirements in accordance with the following:

- If the Contractor is aware, or should have been aware, of the deficiency prior to September 1 in any calendar year, the Contractor shall complete the repairs prior to October 31 of the same calendar year;
- If the Contractor is aware, or should have been aware, of the deficiency after September 1 in any calendar year, the Contractor shall complete the repairs prior to June 30 of the following calendar year; or
- When a deficiency with respect to Section 400.4.2.1 (Cross-Slope and Superelevation Rates) or Section 400.4.3 (Smoothness Requirements) is identified between September 1 and April 30 in any year of the PNI Operating Period or the Operating Period, as applicable, the Contractor shall correct the work such that it complies with the performance requirements by July 31 of the following calendar year.

For all deficiencies, the Contractor shall complete the repairs within these timelines. Failure to do so will result in the applicable Payment Adjustments being assessed. Notwithstanding the allowances for delaying repairs over the winter period the Contractor shall schedule testing to allow time for required repairs within the calendar year. In the event that the Contractor is aware of a deficiency after September 1 due to delays in testing, the specified Payment Adjustment will be assessed for the period until repairs are complete, including the winter period.

**400.4.2 PAVEMENT GEOMETRIC REQUIREMENTS (NEW
INFRASTRUCTURE ONLY)**

This Section 400.4.2 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

The Contractor shall maintain all roadway sections to the designed lines and grades. The following tolerances shall be met. Tolerances refer to the finished pavement surface.

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400.4.2.1 Cross-Slope and Superelevation Rates

The roadway superelevation and cross-slope rates shall be maintained to be within $\pm 0.35\%$ of the design rates immediately after construction and within $\pm 1.0\%$ of the design rates during the PNI Operating Period or the Operating Period, as applicable. References to cross-slope requirements shall also apply to superelevation on horizontal curves.

400.4.2.2 Pavement Widths

Design pavement surface width refers to the finished surface as shown on the Contractor's Designs for the standard cross section for the specific segment of roadway. The pavement surface width shall be constructed and maintained to the width defined by the standard cross section for the specific area of roadway. Any mainline pavement with a surface width less than the design width but not greater than 0.35 m less than the design width, either immediately after construction or during the PNI Operating Period or the Operating Period, as applicable, shall be subject to Payment Adjustments.

400.4.2.3 Measuring For Compliance

The Contractor shall measure the roadway superelevation and cross-slope immediately prior to PNI Traffic Availability or RNI Traffic Availability, as applicable, and after each major surface rehabilitation and whenever the surface appears to not meet the superelevation and cross-slope requirements using a laser based Class I inertial profiling device as defined by ASTM E950, or better. Measurements made using an inertial profiler device shall be averaged for 100 m segments of the roadway. Requirements for cross-slope measuring and conformance shall also apply to superelevation on horizontal curves. Notwithstanding the foregoing, the Department may elect to test or measure the roadway independently if there are concerns regarding the serviceability of the roadway.

The pavement width shall be measured following initial construction and after each rehabilitation which has an impact on roadway width, by means of conventional survey techniques at a minimum of 20 equally spaced measurements per kilometre.

For measurements made using inertial profiling devices, the limiting values will apply to each 100 m segment of the roadway and the average value determined for each consecutive one km section based on the absolute value of the difference between measured and designed cross-slope or superelevation. For width measurements an average value of the difference between measured and design width shall be determined per kilometre, or fraction thereof, shall be determined based on measurements each 50 m.

If the results of the measurements indicate that the work does not comply with the specified criteria, the work will be deemed to be deficient and the Contractor shall schedule remedial work within the specified time period indicated in Section 400.4.1.2 (Completing Repairs).

Cross-slope and superelevation measurements shall be collected for each lane on a continuous basis and reported at 50 m intervals. The measurements shall be made across the entire lane

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width utilizing an inertial profiling vehicle combining a vehicle frame referenced inertial measurement unit (“**IMU**”) with a minimum roll accuracy of 0.01° and a minimum of 10 height sensors. Continuous cross-slope and superelevation measurements shall be calculated based on the linear best fit of the measured transverse profile averaged for each 100 m lane segment of the roadway. The cross-slope and superelevation shall be collected to an accuracy of +/- 0.02 percent and reported to +/- 0.1 percent for each 100 m lane segment.

The Contractor shall conduct an on-site verification prior to the start of the measuring for compliance. The cross-slope and superelevation equipment verification will be based on direct comparison with manually measured transverse profiles at verification sites established by the Contractor. This verification is to validate the cross-slope measurements of the inertial profiling device by using direct comparisons to known roadway geometry. The Contractor is required to run the inertial profiling device over the verification site(s) three times to determine the accuracy and repeatability of the inertial profiling device. The average cross-slope and average superelevation over the 500 m site(s) derived through the automated data collection must be within 0.1 percent of the average cross-slope and superelevation derived through manual survey. The values derived from the automated data collection will be considered repeatable if the values from each run are within +/- 1 standard deviation of the mean for the three runs. All test and measurement results shall be provided to the Department forthwith.

400.4.2.4 Payment Adjustments

Payment Adjustments shall be assessed on a \$/lane-km basis for cross-slope and superelevation rate measurement. Pavement width Payment Adjustments shall be assessed on a \$/km basis for width variations. Payment Adjustments shall apply to full or partial kilometres and full or partial weeks and shall be assessed until the deficiency is corrected.

Payment Adjustments:

(a) Cross-Slope and Superelevation:

If following construction and prior to the New Infrastructure being opened for use by the public, the roadway superelevation and cross-slope rates are measured and are found not to be maintained within $\pm 0.35\%$ of the design rates then the New Infrastructure shall not be opened for use by the public and no Payment shall be paid until such time as the deficiency is corrected.

If during the PNI Operating Period or the Operating Period, as applicable, the roadway superelevation and cross-slope rates are measured and are found not to be maintained within $\pm 1.0\%$ of the design rates then the following Payment Adjustments will apply:

- \$4,500/week or any partial week, for the first four weeks the deficiency is not remedied; then
- \$13,500/week or any partial week, thereafter.

Percentages refer to a numeric deviation from the designed percentage and not to a percentage deviation. This means that if the designed percentage is 6%, the deviation referred to in the pre-

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public use scenario is > 5.65% and < 6.35 %; and the deviation referred to in the operations scenario is > 5.0% and < 7.0%.

(b) Pavement Width Less than Design Width (Mainline):

If following construction and prior to the New Infrastructure being opened for use by the public, the Mainline pavement surface width is measured and is found to be up to 0.35 m narrower than the design width then any Payment shall be reduced by an amount equal to the length of the non-conforming roadway, rounded to the next highest kilometre, multiplied by \$120,000/km.

If following construction and prior to the New Infrastructure being opened for use by the public, the Mainline pavement surface width is measured and is found to be more than 0.35 m narrower than the design width then the New Infrastructure shall not be opened for use by the public and no Payment shall be paid until such time as the deficiency is corrected.

If after final-stage paving or pavement rehabilitation, the Mainline pavement surface width is measured and is found to be up to 0.35 m narrower than the design width then there shall be a Payment Adjustment equal to the length of the non-conforming roadway, rounded to the next highest kilometre, multiplied by \$120,000/km. Payment Adjustments for the same section of non-conforming roadway will be applied once following construction and again following each paving opportunity (i.e. final-stage paving or pavement rehabilitation, including overlay and/or mill and replace).

If after pavement rehabilitation, the Mainline pavement surface is measured and is found to be more than 0.35 m narrower than the design width then the Contractor must repair the deficiency within the timeframes specified in Section 400.4.1.2 (Completing Repairs). A failure to repair such deficiencies shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement.

(c) Pavement Width Less than Design Width (C-D Roads, Ramps and Crossroads):

If following construction and prior to the New Infrastructure being opened for use by the public, the pavement surface width on C-D roads, ramps or crossroads is measured and is found to be less than the design width then the New Infrastructure shall not be opened for use by the public and no Payment shall be paid until such time as the deficiency is corrected.

If after pavement rehabilitation, the pavement surface width on C-D roads, ramps or crossroads is measured and is found to be less than the design width then the Contractor must repair the deficiency within the timeframes specified in Section 400.4.1.2 (Completing Repairs). A failure to repair such deficiencies shall be a potential Termination Event for the purposes of and having the consequences set out in section 16.8(k) of the DBFO Agreement.

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400.4.3 SMOOTHNESS REQUIREMENTS (NEW INFRASTRUCTURE ONLY)

This Section 400.4.3 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

The roadways shall be maintained with an International Roughness Index (“**IRI**”) value equal to or less than those shown in the following table:

Specified Maximum IRI Values

Design Speed (km/hr)	During PNI Operating Period/Operating Period		After Initial Construction of New Infrastructure and Immediately Before Traffic Availability	
	IRI (mm/m) (1 km average)	IRI (mm/m) (100 m average)	IRI (mm/m) (1 km average)	IRI (mm/m) (100 m average)
> 110	1.9	2.9	0.9	1.9
> 90 ≤ 110	2.0	3.0	1.0	2.0
> 70 ≤ 90	2.2	3.2	1.2	2.2
≤ 70	2.4	3.4	1.4	2.4

at all times based on a one kilometre average value for each lane. Furthermore, individual 100 m long sections shall be maintained with an IRI value less than or equal to the corresponding specified maximum IRI values.

400.4.3.1 Measuring For Compliance

Measurements shall be made by the Contractor immediately prior to PNI Traffic Availability or RNI Traffic Availability, as applicable, and then at a minimum of once every three years thereafter using a laser based Class 1 inertial profiling device as defined by ASTM E950, or better. The IRI shall be determined in accordance with ASTM E1926 and the recommended “*Best Practice Guidelines*” contained within “*Standardization of IRI Data Collection and Reporting in Canada*” as published by the Transportation Association of Canada. In addition to the “*Best Practice Guidelines*”, the IRI for each lane in each direction is to be determined, anomalous roughness events are to be identified with an event “log” during data collection, the start and end limits are to be identified, the data is to be collected during the same week from year to year, and where “should” is used in the TAC “*Best Practices Guidelines*” it means that it must be done.

The Contractor shall conduct an on-site verification prior to the start of the measuring for compliance. The profile measurement and IRI post-processing and reporting verification will be based on direct comparison with manually measured longitudinal profiles in each wheel path at verification sites established by the Department for the evaluation of inertial profiling devices on local area roadway(s). The Contractor is required to run the inertial profiling device over the specified site(s) three times to measure the accuracy and repeatability of the inertial profiling device. The average IRI values for each wheel path over the 500 m site(s) derived through the

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automated data collection must be within 10% of the IRI derived through manual survey. The values derived from the automated data collection will be considered repeatable if the values from each run are within plus or minus 5% of the mean for the three runs.

The limiting IRI values will apply to the average value determined for each consecutive one km section of each lane. All average IRI values will be collected to the nearest 0.01 mm/m and reported to the nearest 0.1 mm/m value.

If the results of the tests or measurements indicate that the work no longer complies with the specified criteria, the work will be deemed to be non-compliant and the Contractor shall undertake the necessary work to address the non-compliance. All test and measurement results shall be provided to the Department forthwith.

400.4.3.2 Payment Adjustments

If the repairs are not completed within the applicable specified time period in Section 400.4.1.2 (Completing Repairs), the Contractor shall be assessed the following Payment Adjustments. The Payment Adjustment shall apply to full or partial lane-kilometres and 100 m sections, as applicable, and will be assessed until the deficiency is corrected.

Payment Adjustments:

Deviation Above Specified Maximum IRI Values as listed in Section 400.4.3 and measured on a 1 lane-km interval:

¹Deviation Above Specified Maximum IRI Value (mm/m)	Payment Adjustment (\$/lane km)
1. After Initial Construction	
Average IRI is less than (Specified Maximum IRI)	No Payment Adjustment. Roadway may be opened.
Average IRI is equal to or greater than (Specified Maximum IRI) and less than (Specified Maximum IRI + 1.0)	Roadway may open, however repairs and Payment Adjustments to apply. \$4,500/week or any partial week, for first 4 weeks, then \$13,500/week or any partial week, thereafter
Average IRI is equal to or greater than (Specified Maximum IRI +1.0)	No Payment Adjustment. Cannot open roadway.
2. During PNI Operating Period/Operating Period	
Average IRI is greater than (Specified Maximum IRI + 0.3)	\$4,500/week or any partial week, for first 4 weeks, then \$13,500/week or any partial week, thereafter

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Note ¹ Deviation refers to the numeric difference from the specified IRI value, i.e. if the design speed was 110 kph the roadway must be maintained at an IRI of less than 2.0 mm/m. If the measured IRI during the PNI Operating Period or the Operating Period, as applicable, was greater than 2.3, then a Payment Adjustment would apply.

Deviation Above Specified Maximum IRI Value as listed in Section 400.4.3 and measured on a 100-metre lane interval.

Deviation Above Specified Maximum IRI Value (mm/m)	Payment Adjustment (\$/100 m lane section)
1. After Initial Construction	
Average IRI is equal to or less than (Specified Maximum IRI)	No Payment Adjustment. Roadway may be opened.
Average IRI is greater than (Specified Maximum IRI) and less than or equal to (Specified Maximum IRI + 1.0).	Roadway may open, however repairs and Payment Adjustments to apply. \$4,500/week or any partial week, for first 4 weeks, then \$13,500/week or any partial week, thereafter
Average IRI is greater than (Specified Maximum IRI + 1.0)	No Payment Adjustment. Cannot open roadway.
2. During PNI Operating Period/Operating Period	
Average IRI is greater than (Specified Maximum IRI + 0.3)	\$4,500/week or any partial week, for first 4 weeks, then \$13,500/week or any partial week, thereafter

Payment Adjustments for lane-km averages are based on the average of both wheel path test results and Payment Adjustments shall apply to full or partial lane-kilometres. The Payment Adjustment assessment for individual 100 m sections shall be based on the average of both wheel path test results and Payment Adjustments shall apply to each 100 m section of non-compliance.

400.4.4 RUTTING PERFORMANCE REQUIREMENTS (NEW INFRASTRUCTURE ONLY)

This Section 400.4.4 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

The roadway shall be maintained with rut depths of less than 14 mm at all times based on one km average values. For 100 m sections the rut depths shall be maintained to be less than 19 mm and for any isolated section, less than 25 m in length, the rut depths shall be maintained to less than 29 mm.

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400.4.4.1 Measuring For Compliance

Measurements shall be made by the Contractor immediately prior to PNI Traffic Availability or RNI Traffic Availability, as applicable, and then at a minimum of once every three years thereafter using a laser based Class 1 inertial profiling device as defined by ASTM E950, or better and equipped with a minimum of 10 lasers. Testing shall be performed during the same week for each test year. Rut depth measurements shall be collected for each lane on a continuous basis and reported at 50 m intervals. Rut depth measurements made with an inertial profiling device shall be averaged for each 100 m lane segment of the roadway for each wheel path of each lane. The rut depths shall be collected to an accuracy of +/- 0.5 mm and reported to +/- 1 mm for each 100 m lane segment.

The Contractor shall conduct an on-site verification prior to the start of the measuring for compliance. The wheel path rut depth measurement equipment verification will be based on direct comparison with manually measured transverse profiles at verification sites established by the Department for the evaluation of inertial profiling devices on local area roadway(s). The Contractor is required to run the inertial profiling device over the specified site(s) three times to measure the accuracy and repeatability of the inertial profiling device. The average rut depth over the 500 m site(s) derived through the automated data collection must be within +/- 3 mm of the average rut depth derived through manual survey. The values derived from the automated data collection will be considered repeatable if the values from each run are within +/- 1 standard deviation of the mean for the three runs.

Measurements of localized areas shall be carried out using a 1.8 m straight edge in accordance with ASTM E1707.

The limiting rut depth values will apply to the average value determined for each consecutive one km section for each lane. Additionally, for each lane, each individual 100 m section rut depth value shall be <19 mm and all localized areas shall be maintained to have rut depth measurements of <29 mm. Localized areas shall be determined for individual wheel path locations, all other rut measurements will be based on the average of both wheel path locations, for each lane. All average rut values shall be rounded down to the nearest mm and reported as an integer value.

If the results of the tests or measurements indicate that the work no longer complies with the specified criteria, the work will be deemed to be non-compliant and the Contractor shall undertake the necessary work to address the non-compliance. All test and measurement results shall be provided to the Department forthwith.

400.4.4.2 Payment Adjustments

If the repairs are not completed within the applicable specified time period, Section 400.4.1.2 (Completing Repairs), the Contractor shall be assessed a Payment Adjustment. The \$/lane-km value shall apply to full or partial kilometres and shall be assessed until the deficiency is corrected.

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Payment Adjustments:

Average Rut Depth (mm)(1 km average)	\$/lane-km	Average Rut Depth (mm) (100 m section)	\$/Lane 100 m Section	Rut Depth (mm) (Isolated Deficiency)	\$/Isolated Deficiency
After initial construction >4	No payment, cannot open roadway	After initial construction >4	No payment, cannot open roadway	After initial construction >4	No payment, cannot open roadway
During operations >14 - must fix within specified time period	\$4,500/week or any partial week, for first four weeks, then \$13,500/week or any partial week, thereafter	During operations >19 - must fix within specified time period	\$4,500/week or any partial week, for first four weeks, then \$13,500/week or any partial week, thereafter	During operations >29 - must fix within specified time period	\$3,000/week or any partial week, for first four weeks, then \$9,000/week or any partial week, thereafter

Payment Adjustments for lane-km averages are based on both wheel path test results. The Payment Adjustment for individual 100 m sections applies to the average of both wheel paths except that isolated sections shall be based on individual wheel paths and can result in a Payment Adjustment based on both wheel paths at the same station location. The Payment Adjustment for 100 m sections applies to each 100 m section of non-compliance.

400.4.5 SKID RESISTANCE REQUIREMENTS (NEW INFRASTRUCTURE ONLY)

This Section 400.4.5 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

ASTM E274 or alternate testing methods, as approved by the Department, shall be used to determine the skid resistance of the pavement along the New Infrastructure.

ASTM E 1960 shall be used to determine the calibrated wet friction at 60 km/h (F60) and the speed constant of wet pavement friction (SP). The resulting International Friction Index (“**IFI**”) shall be reported along with the actual skid numbers determined.

Areas of pavement which exhibit a physical appearance of polishing, flushing or bleeding and/or which exhibit a higher than average incidence of collisions shall be tested for skid resistance.

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400.4.5.1 Measuring For Compliance

After PNI Traffic Availability or RNI Traffic Availability, as applicable, areas of pavement on the New Infrastructure which exhibit a visual appearance of polishing, flushing or bleeding and/or which exhibit a higher than average incidence of collisions shall be tested for skid resistance within 30 days of the date which the Contractor first became aware, or the date which the Contractor should have been aware, of such conditions, weather permitting. All test and measurement results shall be provided to the Department forthwith.

400.4.5.2 Completing Repairs

If results of the tests or measurements indicate that the New Infrastructure no longer complies with the specified criteria, the New Infrastructure will be deficient, requiring repair. When a specific deficiency is identified, the Contractor shall correct the work such that it complies with the minimum requirements within 60 days of the deficiency being confirmed. All test and measurement results shall be provided to the Department forthwith.

400.4.5.3 Payment Adjustments

If the repairs are not completed within the applicable specified time period, the Contractor shall be assessed a Payment Adjustment. The \$/lane-km value shall apply to full or partial kilometres and will be assessed until the deficiency is corrected.

Skid Resistance	\$/Deficiency
During operations IFI<30 - must fix within specified time period	\$4,500/lane-km/week or any partial week, for first four weeks, then \$13,500/lane-km/week or any partial week.

400.4.6 GENERAL PAVEMENT MAINTENANCE REQUIREMENTS

The Contractor shall maintain all pavement sections including shoulders and gore areas on a regular basis in order to ensure that they remain in a structurally sound and safe condition and continue to provide the service for which they were intended recognizing the Contractor is not responsible for rehabilitating the Existing Infrastructure.

The Contractor shall maintain the pavement surface in a safe condition. If a pavement deficiency is a hazard to motorists, it shall be repaired immediately regardless of size. The following sections provide detailed requirements.

In respect of the Existing Infrastructure only:

- (a) the Contractor is responsible for repair according to the repair methods for localized deficiencies, localized roughness, and localized cracking for both asphalt and hydraulic cement concrete pavements as indicated in Section 100.2.9 (Operation and Maintenance

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Plan);

- (b) the Contractor is not responsible for any work at joints in the hydraulic cement concrete pavement, if any, for the Existing Infrastructure, where work such as mud jacking and grinding, is due to slab movements;
- (c) the responsibility for the cost of the repair shall be governed by the DBFO Agreement and other applicable provisions of the Technical Requirements;
- (d) the Contractor will be responsible for reporting any pavement related problems with skid resistance, roughness, cross slope, superelevation, structural or other deficiency to the Department; and
- (e) the term “**localized**” means access within one metre or less from each other.

400.4.6.1 Localized Deficiencies

Localized deficiencies within any travel lane which are > 0.1 square metre shall be repaired within 24 hours following the time when the Contractor became aware, or should have become aware, of the deficiency. Localized deficiencies which are not located within the travel lanes and/or do not exceed 0.1 square metres shall be repaired within 21 days following the time when the Contractor became aware, or should have become aware, of the deficiency. Spalling or other distress at crack locations and joints shall be treated as a localized deficiency.

400.4.6.2 Localized Roughness

All areas of the pavement shall be maintained true to lines and grades. Localized areas, such as transverse cracks or joints, shall be maintained to prevent localized roughness. Deficiencies which cause localized roughness shall be repaired. The definition of localized roughness shall be any abrupt deviation in excess of 6 mm when measured with a 1.2 m straight edge.

**400.4.6.3 Localized Cracking – Asphalt Concrete Pavements
(Existing Infrastructure Only)**

For all localized cracking in asphalt concrete pavements on the Existing Infrastructure, all transverse cracks between 2mm and 25mm in width and all longitudinal cracks between 2mm and 12 mm in width shall be routed and sealed. Routed cracks with missing sealant shall be re-sealed. Transverse cracks greater than 25mm and longitudinal cracks greater than 12mm are to be spray patched. The Contractor shall prepare and carry out a crack sealing program annually, with a completion date for the work of August 31 each year of the PNI Operating Period or the Operating Period, as applicable.

**400.4.6.4 Localized Cracking – Hydraulic Cement Concrete
Pavements (Existing Infrastructure Only)**

For all localized cracking in hydraulic cement concrete, if any, on the Existing Infrastructure, all

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random cracks between 2mm and 20mm in width shall be sawn/routed and sealed. Sawn/routed cracks with missing sealant shall be re-sealed. The Contractor shall prepare and carry out a crack sealing program annually, with a completion date for the work of August 31 each year of the PNI Operating Period or the Operating Period, as applicable.

400.4.6.5 Measuring For Compliance

The Contractor shall inspect the Infrastructure on a continual basis as part of the schedule of inspection, and shall identify deficiencies related to Section 400.4.6 (General Pavement Maintenance Requirements). All test and measurement results shall be provided to the Department forthwith.

400.4.6.6 Completing Repairs

The Contractor shall undertake any required repairs within the time lines indicated for the specific maintenance need. Where a specific timeline is not indicated, the repairs shall be undertaken within 30 days of the time the Contractor became aware, or should have become aware, of the deficiency. Maintenance repair requirements apply year-round and may be required during poor weather conditions. All test and measurement results shall be provided to the Department forthwith.

400.4.6.7 Payment Adjustments

If repairs, permanent or otherwise, are not completed within the stipulated time period, the Contractor shall be assessed Payment Adjustments at a rate of \$750/required repair for each seven day period or any partial week, until the deficiency is corrected.

For the Existing Infrastructure only, if the annual crack sealing programs are not completed by August 31st each year, the Contractor shall be assessed a Payment Adjustment of \$2,500/km or any partial km, of single direction unsealed mainline, C-D road, ramp or crossroad/month or portion thereof, until the annual programs are completed.

**400.4.7 MISCELLANEOUS - OPERATION AND PERFORMANCE
REQUIREMENTS**

This Section 400.4.7 covers the performance requirements of specific appurtenances and maintenance activities that must be performed to a specified standard by the Contractor. Notwithstanding the foregoing sentence but subject to the DBFO Agreement, all infrastructure associated with the Infrastructure shall be maintained in an adequate condition and function as designed.

Non-specified items of the Infrastructure such as, but not limited to, backslope, sideslope, or embankment movements, fencing, and pavement shoulders or gore areas shall be maintained to a level consistent with standard practice. Non-specified items shall be monitored and maintained in accordance with standard industry practice. The timing for completing repairs detailed in Section 400.4.1.2 (Completing Repairs), will apply except as specifically noted. Subject to

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specific reporting requirements specified elsewhere in this Section 400.4.7 (Miscellaneous - Operation and Performance Requirements), all test, measurement, inspection, and other results (including both pre-repair and post-repair) in this Section 400.4.7 (Miscellaneous - Operation and Performance Requirements) shall be recorded and retained by the Contractor, and such records shall be provided to the Department forthwith, upon its request.

400.4.7.1 Delineators

Delineators shall be maintained clean at all times and shall exhibit a minimum retroreflectivity of 80% of design value.

The Contractor shall maintain delineator guideposts plumb within 50 mm throughout their length.

Delineators shall be maintained within 5% of design height and shall not deviate from design locations by more than 50 mm.

Delineators shall be maintained to provide the intended delineation at all times. Delineators that are damaged, or otherwise removed, such that they are not providing the desired delineation shall be replaced.

400.4.7.1.1 Measuring For Compliance

The Contractor shall identify damaged, missing or otherwise ineffective delineators during roadway inspections. At least twice per year (once within one month prior to October 31 and once within one month prior to May 1), the Contractor shall complete a detailed inspection and, when required (i.e. vertical alignment more than 50 mm out of plumb), shall realign delineator guideposts to within 13 mm of plumb throughout their length.

400.4.7.1.2 Completing Repairs

Delineators that become soiled shall be cleaned within seven days providing weather conditions permit.

Delineators that are damaged, missing or otherwise fail to function as designed, shall be replaced within seven days.

400.4.7.1.3 Payment Adjustments

Payment Adjustments shall be assessed against the Contractor for each delineator which does not comply with the requirements of this Section 400.4.7.1 (Delineators) within the stipulated time period at a rate of \$30/delineator/day or any partial day, until made to comply.

400.4.7.2 Roadway Lighting

Roadway lighting includes all lights designed and constructed for the Infrastructure or

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subsequently added to the Infrastructure. The Contractor shall undertake the necessary maintenance to ensure that the desired illumination is provided to motorists at all times. The Contractor shall inspect the operation of the entire roadway lighting system, including the structural integrity of components, power supply, conduit, cables and equipment on a regular basis and this shall be included in the Contractor's QMS (Section 100.2.1). In addition, the following shall apply:

- Individual lights/luminaires shall be maintained to provide light output in accordance with the manufacturer's rated design parameters and lighting shall be maintained and operated to provide the level of illumination as designed;
- Poles shall be maintained plumb within 10 mm in 1 m;
- Poles and other mounting hardware shall be maintained in a clean and neat repair, with no corrosion visible;
- Concrete bases shall be maintained to be structurally adequate for the design loads;
- A regular monitoring program for evaluating the condition of all roadway lights, including the supporting infrastructure shall be conducted and deficiencies in light standards, bases, power supply or other luminaire elements reported to the Department as soon as practicable; and
- All portions of the installation and any repairs or modifications shall with respect to the Existing Infrastructure comply fully with the original designs and any applicable codes and with respect to the New Infrastructure comply fully with the Detailed Designs and construction requirements and any applicable codes.

400.4.7.2.1 Measuring for Compliance

The Contractor shall conduct a regular monitoring program for evaluating the condition of all roadway lights, including all supporting infrastructure, within the Infrastructure. The Department may inspect lights at any time and notify the Contractor of any non-compliance with the Technical Requirements.

400.4.7.2.2 Completing Repairs

The Contractor shall undertake repairs within the following guidelines, from the time that the deficiency is known, or should have been known, to the Contractor:

- Outage of 2 consecutive lamps or a single lamp shall be repaired within 96 hours.
- Outage of 3 to and including 5 consecutive lamps shall be repaired within 72 hours.
- Outage of more than 5 consecutive lamps shall be repaired within 48 hours.
- Repair or replacement of lighting infrastructure damaged by an accident shall be done within 21 days, unless consecutive lights are not operating, in which case the repairs shall be done within seven days.

An outage is defined as total failure of the lamp to light, failure of the lamp to produce the manufacturer's rated output (to such an extent that it is visually apparent when compared to other lamps), intermittent lighting caused by cycling on and off, or light is prevented from being

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properly distributed to the roadway surface.

Poles which are out of alignment more than allowed in the Technical Requirements shall be corrected within 60 days. Any condition of poles or concrete foundations that affect the structural integrity of the installed lighting system shall be repaired within 20 days except for high mast systems, which shall be repaired within five days.

When the work necessitates the replacement of lighting structures, only new materials shall be used, unless otherwise directed in advance and in writing by the Department.

400.4.7.2.3 Payment Adjustments

The Contractor shall be assessed Payment Adjustments for failing to adjust, maintain, repair/replace lamps or components of the roadway lighting system within the time stipulated in Section 400.4.7.2.2 as follows:

- Lamp repair/replacement, \$150/lamp/day or any partial day, that the lamp remains in need of repair/replacement; and
- Repair or adjustment of any pole, base or other lighting system component, \$150/component/day or any partial day, that the component needs adjustment.

400.4.7.3 Barriers and Guardrail

Barriers and guardrail shall be maintained to function as designed and to have a neat and tidy appearance at all times. The Contractor shall inspect the condition of guardrail on the Infrastructure on a daily basis and this shall be included in the Contractor's QMS (Section 100.2.1). In addition, the following shall apply:

- Guardrail that is dented, bent, twisted or otherwise misaligned shall be repaired or replaced. Barriers and guardrail shall be maintained in proper alignment, as designed, at all times. Permissible tolerances for plumb and horizontal grades shall be 20 mm from design grades. Permissible tolerances for vertical grades shall be 40 mm from design grade;
- Barriers and guardrail shall be free of obstructions, visible at all times and reflective markers shall be clean and function as designed;
- Guardrail damaged by collision shall be replaced. When guardrail is damaged resulting in an Imminent Danger (as defined in Section 400.1.5), it shall be repaired immediately to assure the continued protection of the travelling public. When immediate permanent repair is not possible, temporary repairs shall be implemented immediately incidental to the Imminent Danger. Permanent repairs shall be done using new materials and shall be installed within one week of the Imminent Danger incident to original design specifications, unless otherwise directed in advance and in writing by the Department;
- Posts which are structurally unsound, loose, out of plumb, or otherwise failing to provide the required functionality, shall be replaced;
- All components shall be securely fastened with the designed fasteners at all times;
- Concrete barrier that has concrete pieces missing shall be repaired or replaced as reasonably appropriate to perform as originally intended in a safe and effective manner;

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- Concrete barrier that has structural weakening shall be replaced so that it preserves public safety and performs as originally intended; and
- The Contractor shall conduct a daily monitoring program for evaluating the condition of all guardrails on the Infrastructure and reporting deficiencies in the guardrail installations on the Infrastructure to the Department as soon as practicable.

400.4.7.3.1 Measuring for Compliance

The Contractor shall undertake daily inspections of all barriers and guardrail sections within the Infrastructure.

400.4.7.3.2 Completing Repairs

In situations when barriers or guardrails are missing or damaged such that they do not function as intended, the Contractor shall undertake repairs or temporarily protect the area immediately. All other non-compliant sections of barrier or guardrail shall be repaired within 60 days. In instances where temporary repairs are required, such temporary repairs may not be in place for more than five days. In winter months when permanent repairs may not be possible due to freezing conditions, temporary measures may stay in-place until the ground is free of frost.

400.4.7.3.3 Payment Adjustments

Following the expiration of the specified time-frame for completing repairs, or in the case where temporary repairs have been in-place until weather permits repairs to be more reasonably undertaken, a Payment Adjustment of \$275/metre/day or any partial day, of non-compliant barrier or guardrail shall be assessed until the repairs are completed.

400.4.7.4 Grass Cutting and Landscape Maintenance

400.4.7.4.1 General

The Contractor shall maintain the vegetation in all areas of the Road Right of Way and stormwater management facilities. The Contractor shall remove and dispose of any dead vegetation and re-seed grass, if necessary, to retain the overall landscaping within the Road Right of Way and stormwater management facilities. Areas that are not covered with a uniform stand of grass shall be reseeded. An area is considered to have a non-uniform stand of grass if any bare spots measuring greater than 1 m² are present or if the ground cover is less than 80% grass.

With the exception of trees and shrubs, all vegetation within the Road Right of Way and stormwater management facilities shall not exceed 300 mm in height, except during the first year following PNI Traffic Availability or RNI Traffic Availability, as applicable, when the height of vegetation may exceed 300 mm for a maximum duration of one month in certain areas provided that:

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- The Contractor has documented and can demonstrate that soil moisture is high in such area of concern and that the use of conventional mowing equipment would likely cause rutting and/or damage to the landscaped area;
- Moisture conditions in such affected areas are assessed biweekly to determine if mowing can be successfully performed without causing damage;
- Control of noxious weeds continues; and
- The Contractor addresses any complaints regarding the vegetation height within seven days to the satisfaction of the Department acting reasonably.

Weed control shall be carried out, by the Contractor, as required to control noxious weeds including all noxious weeds identified under the *Weed Control Act* (Alberta) and Local Authority bylaws.

The Contractor shall be responsible to repair at their own cost any damage to grassed areas caused by any vehicles traveling through the Road Right of Way.

400.4.7.4.2 Weed Control

400.4.7.4.2.1 *Operating Standards, Approvals and Permits*

The Contractor shall comply with the operating standards and practices of the Industrial Vegetation Management Association of Alberta and shall have a service approval agreement from Alberta Environment. All personnel applying chemicals shall have a valid applicators license issued by Alberta Environment.

Special use approvals issued by Alberta Environment, will be required in instances where chemicals are to be sprayed within 30 m of an open body of water. In such instances, the Contractor shall advertise the proposed work in newspapers local to the area, 30 days prior to the scheduled starting date of the work.

The Contractor shall provide the Department with a copy of the newspapers containing the advertisement. The Contractor shall refer all public concerns to Alberta Environment, who will identify any work conditions in the approval. The Contractor shall be responsible for obtaining the special use approval and shall comply with the conditions specified therein.

The Contractor is liable for any damage caused to areas outside the Road Right of Way occasioned by its use of chemicals for weed control and shall promptly handle any damage claims in this regard. The Contractor shall also pay any fines/penalties assessed by the governing authority for failure to promptly comply with applicable requirements.

For the Existing Infrastructure, the Contractor shall not be responsible for watering or re-planting materials but shall be responsible for the weed control within the designated areas, including the planting areas, and shall be responsible for the removal of dead vegetation. The Contractor shall be responsible for replacing plants damaged by the Contractor or by those for whom it is legally responsible.

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400.4.7.4.2.2 *Materials*

The Contractor shall select and supply the appropriate chemical for vegetation control. Only chemicals approved by the appropriate department of the Federal Government for general industrial spraying shall be used. The Contractor shall supply any signs required to identify treated areas in public use areas.

400.4.7.4.2.3 *Procedures*

The Contractor's use of chemicals, application rates and methods shall comply with the policies, rules and regulations of Alberta Environment. The Contractor shall maintain accurate records of all applications including the type and amounts of chemicals used and the locations treated. If requested, the Contractor shall supply this information to the Department along with copies of the bills of lading and the manufacturer's recommended application rates for the chemicals used. The Contractor shall dispose of empty chemical containers only at approved disposal sites.

400.4.7.4.3 *Measuring for Compliance*

The Contractor shall undertake weekly inspections of all areas of the Road Right of Way and stormwater management facilities to assess the need for any type of landscape maintenance including grass cutting, re-seeding/re-planting, weed control and the removal of dead vegetation. The monitoring program shall comply with the program documented in the Contractor's EMS (Section 100.2.2). The Department may inspect landscaping at any time and notify the Contractor of any non-compliance to these specifications.

Alberta Environment and the Local Authority will also inspect for noxious weeds and any order or direction given to the Contractor regarding deficiencies in compliance shall be dealt with immediately.

400.4.7.4.4 *Completing Repairs*

When the Contractor fails to observe the need for maintenance, or fails to undertake maintenance within two weeks of when the Contractor is made aware or should have been aware of the need for maintenance, then the Contractor will be considered non-compliant and the specified Payment Adjustments will be applied.

400.4.7.4.5 *Payment Adjustments*

Payment Adjustments shall be assessed against the Contractor on the following basis:

- Grass or weeds in excess of the specified maximum height, \$500/hectare or any partial hectare/month or any partial month, for any portion of a hectare that fails to meet these requirements.

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400.4.7.5 Litter and Graffiti Clean Up

The Contractor shall maintain the Road Right of Way and the drainage system to be reasonably free of litter. The Road Right of Way must be free of any and all litter that may cause damage to vehicles, or otherwise result in a safety hazard for roadway users. The Contractor shall:

- Conduct an annual litter clean up, each year by June 1. Following the annual clean up no litter shall be visible within the Road Right of Way and the drainage system;
- Conduct litter clean up, to the same standard as the spring clean up, on or about July 30, and September 30 each year during the PNI Operating Period or the Operating Period, as applicable. In addition, the Contractor shall clean up any litter that measures more than 0.025 cubic metres (one cubic foot) in volume within the Road Right of Way or the drainage system within 48 hours of observing the litter;
- Immediately remove and dispose of litter, including dead animals, on the roadway that has the potential to affect traffic. Dead animals at any other location on the Road Right of Way or the drainage system shall be removed within six hours of being observed;
- Report all incidences (together with reasonable details thereof) of motor vehicles that the Contractor has reason to believe have been abandoned, are parked in contravention of law, regulation or by-law, or are otherwise left unattended in a manner that obstructs the normal movement of traffic or constitutes a present or potential hazard to persons or property, to the appropriate law enforcement authorities as soon as reasonably practical and in any event within 24 hours from the time the Contractor was aware or should have been aware of such incidences. The Contractor shall fully cooperate and properly coordinate with the appropriate law enforcement authorities in the seizure or removal of such motor vehicle;
- Report all incidences (together with reasonable details thereof) of signs or other objects placed within the TUC or the Road Right of Way by third parties;
- Remove graffiti from any location visible from the roadway within 96 hours. Graffiti that cannot be effectively removed shall be covered with appropriate materials; and
- Remove all waste or other litter generated by the Contractor's operation.

Notwithstanding the above requirements for litter clean-up the Contractor shall work with and coordinate with policing authorities and registered motor vehicle owners and their insurers to facilitate clean-up of debris resulting from accidents within the Road Right of Way.

400.4.7.5.1 Measuring for Compliance

The Contractor shall undertake daily inspections of all areas of the Road Right of Way and drainage system to assess the need for litter and graffiti clean-up.

The Contractor will be considered to be non-compliant with this Section 400.4.7.5 (Litter and Graffiti Clean Up) if any of the following occur:

- An annual spring clean-up campaign has not been conducted, or has been conducted but has not removed all visible litter from the Road Right of Way and drainage system or graffiti from the Infrastructure, by June 1st of each year;

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- The specified summer and fall clean-up operations have not been completed by August 15 and October 15 respectively, in each year;
- Litter that poses a hazard has not been removed within the specified time period;
- The Department or the Contractor identifies that the Road Right of Way and drainage system is littered and unsightly and such litter is not removed within the specified time frame;
- The Department or the Contractor identifies that the Infrastructure is covered in graffiti and such graffiti is not removed or appropriately covered within the specified time frame;
- Failure to report abandoned vehicles to the appropriate law enforcement authorities as soon as reasonably practical and in any event within 24 hours from the time the Contractor was aware or should have been aware of such incidences or failure to fully cooperate and properly coordinate with the appropriate law enforcement authorities in the seizure or removal of such motor vehicles; and
- Waste generated by the Contractor has not been removed within one week of the completion of the work associated with the waste, or if such waste is creating an unsightly or hazardous condition.

400.4.7.5.2 Completing Clean Up

When the Contractor fails to observe the need for litter or graffiti clean-up, or fails to undertake clean-up required within the specified time, then the Contractor will be considered non-compliant and the specified Payment Adjustments shall be applied.

400.4.7.5.3 Payment Adjustments

If the Contractor is determined to be non-compliant, a Payment Adjustment of \$400/day, or any partial day, shall be assessed for each and every occurrence of non-compliance. An occurrence is any single or multiple non-compliance. Payment Adjustments for litter or graffiti clean-up are cumulative but shall not exceed \$800/day. The Payment Adjustment shall be assessed for each day, or portion thereof, until the clean-up is completed.

400.4.7.6 Drainage Systems

Drainage systems shall be maintained to function as designed and to assure that environmental requirements are met at all times.

The Contractor shall undertake drainage system maintenance to ensure that the roadway surfaces and all other elements of the Infrastructure are safe and effectively drained.

The requirements of this section apply to any aspect of the Infrastructure that serves a drainage function, including, but not limited to:

- Drainage structures;
- Oil-grit separators;
- Culverts;

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- Ditches;
- Stormwater management facilities;
- Curb and gutter (drainage function);
- Manholes, inlet and outlet structures, catch basins, flumes; and
- Storm sewers.

The Contractor shall ensure that environmental requirements required by legislation or design are met at all times and shall maintain all aspects of the drainage facilities to prevent the discharge of silt or sediments into water courses.

Drainage system elements shall be maintained to assure full hydraulic and structural capacity.

Oil-grit separators shall be operated and maintained according to the manufacturer's recommendations and shall meet the City's *Stormwater Management Design Manual* (2011) criteria. An average annual total suspended solids removal rate of 85% shall be achieved for particle sizes of 50 µm and greater for each year.

Ditches, sideslopes, backslopes and any land within the Road Right of Way, the drainage system and/or parts of the TUC drained by the Infrastructure system shall be protected from erosion, including wind erosion. The Contractor shall be responsible for any damage to the Road Right of Way, the TUC, or any lands adjacent the TUC caused by a deficiency in the maintenance of the drainage system for the Infrastructure or by a deficiency in the design and construction of the drainage system for the New Infrastructure.

The Contractor shall manage the drainage system such that deficiencies are repaired immediately if erosion or sedimentation is a potential, or within one year for all other repairs.

For stormwater management facility inspection and maintenance that requires access through the TTN reserve, the Contractor shall request, through the Department, a band council resolution for permits to be issued under the *Indian Act* (Canada).

The Contractor shall test all gates, actuators, wireless modems, and control systems that are part of the spill control system of the stormwater management infrastructure related to the Elbow River stormwater ponds at intervals not exceeding one month. Any deficiencies shall be repaired immediately.

400.4.7.6.1 Measuring for Compliance

The Contractor shall complete regular inspections of the Infrastructure to assess the function of the drainage systems and to schedule maintenance and repairs. The frequency of these inspections shall be at least on an annual basis in accordance with Section 400.2.3 (Routine Maintenance) or as otherwise noted in this Section 400.4.7.6.

400.4.7.6.2 Completing Repairs

The Contractor shall plan for and complete repairs to the drainage system on an annual basis or

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as otherwise noted in this Section 400.4.7.6. Drainage deficiencies identified by the Contractor's inspection shall be corrected within two months of the date of the inspection excepting if such repairs are necessary to prevent the potential for ponding of water on the road surface or if potential for erosion or sedimentation exists or if the potential for contamination of downstream waterbodies exists, in which case repairs shall be made immediately.

400.4.7.6.3 Payment Adjustments

The ponding of water on the road surface at any time is not acceptable. For each and every case in which ponded water remains on the road surface for greater than 60 minutes, the Contractor shall be assessed a Payment Adjustment per day, or portion thereof, until the water is removed and the cause of the ponding is rectified.

For paved areas with ponds less than or equal to 4 m² the Payment Adjustment shall be \$1,500/pond/day or any partial day. For paved areas with ponds in excess of 4 m² a Payment Adjustment of \$7,500/pond/day or any partial day, shall be made.

If any gate, actuator, wireless modem or other component of the control systems that are part of the spill control system of the stormwater management infrastructure related to the Elbow River stormwater ponds is deficient in its function, or if the Contractor's monthly inspection identifies a deficiency in any gate, actuator, wireless modem or other component of the spill control system, the Contractor shall rectify the deficiency immediately or Payment Adjustments of \$5,000/day or any partial day, for each deficiency, shall be assessed until the deficiency is repaired.

If erosion of lands occurs, the Contractor shall be assessed a Payment Adjustment if it is not repaired, and the cause rectified within one week of the time of the Contractor becoming aware or should have been aware of the deficiency, of \$700/day or any partial day, until repairs are complete.

For all other drainage system deficiencies, the Contractor shall complete the necessary repairs within the stipulated time period or be assessed a Payment Adjustment of \$150/day or any partial day, for each deficiency, until the deficiency is repaired.

400.4.7.7 Curb And Gutter

Curb and gutter and any associated works shall be maintained to function as designed recognizing the Contractor is not responsible for the rehabilitation of the Existing Infrastructure. References to curb and gutter shall include curb or gutter sections which may exist separately within the New Infrastructure. The following shall apply:

- Curb and gutter shall be maintained to ensure that their function in overall drainage and driver guidance is maintained at all times;
- Curb and gutter shall be maintained to ensure no ponding of water anywhere along the length of the curb, within the gutter or on any roadway or shoulder;
- Broken or damaged concrete shall be replaced when required to restore functionality;

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- Scaling of a concrete surface shall be limited to no more than 10% of surface area in any five lineal metre section of curb and gutter;
- Cracking of concrete shall be limited to a maximum crack width of 3 mm, occurring at a maximum frequency of one crack every 2 m; and
- Curb height shall be maintained to meet the requirements of the design specifications and in no case shall be less than 150 mm.

400.4.7.7.1 Measuring for Compliance

The Contractor shall undertake inspections every six months of all curb and gutter sections within the Infrastructure for the purpose of evaluating the functionality and the condition of the concrete materials.

400.4.7.7.2 Completing Repairs

The Contractor shall complete repairs to restore the functionality of the curb and gutter sections to the level and alignment for which they were originally designed. General repairs shall be completed within 180 days of the time when the Contractor knew of, or should have known of, the deficiency. Replacements of curb and gutter for surface scaling and/or cracking which do not impair functionality shall be completed within 180 days of the time when the Contractor knew or should have known of the deficiency.

400.4.7.7.3 Payment Adjustments

Payment Adjustments for each instance where a curb and gutter section does not conform to the Technical Requirements, and is not repaired within the stipulated time period, shall be \$1,500/occurrence/day or any partial day, until rectified.

400.4.7.8 Sidewalks, Walks, Pedestrian Walks and Multi-use Trails

Sidewalks, walks, pedestrian walks and multi-use trails (“**Walkways**”) shall be maintained to function as designed. The Contractor shall undertake the necessary maintenance to ensure that any Walkways within the Infrastructure are maintained in a condition that is safe for pedestrian traffic. The following shall apply:

- Vertical displacement at joints or cracks that exceed 5 mm shall be repaired or replaced to remove the differential elevation and remove any tripping hazard;
- Concrete that is cracked in multiple locations within the same general area of Walkways or otherwise results in a discontinuity that may pose a tripping hazard or be a safety concern shall be removed and replaced;
- Concrete surfaces that exhibit scaling over more than 15% of the surface area in any 1 m² section and results in a rough surface texture shall be removed and replaced; and
- Crack widths in excess of 5 mm require repairs or replacement of the Walkways section(s) affected.

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400.4.7.8.1 Measuring for Compliance

The Contractor shall undertake monthly inspections of Walkways for evaluating the condition of all Walkways within the Infrastructure.

400.4.7.8.2 Completing Repairs

The Contractor shall complete repairs to restore the functionality of the Walkways to the level for which it was originally designed. Repairs shall be completed within 180 days of the time when the Contractor knew of, or should have known of, the deficiency.

400.4.7.8.3 Payment Adjustments

Payment Adjustments for each instance where Walkways do not conform to the Technical Requirements, shall be \$1,500/occurrence/month or any partial month, until rectified.

**400.4.7.9 Subgrade Sideslopes and Backslopes (New
Infrastructure Only)**

This Section 400.4.7.9 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

Subgrade sideslopes shall be maintained as a uniform, smooth surface or straight line from the edge of pavement to edge of sideslope. Over the PNI Operating Period or the Operating Period, as applicable, the straight line sideslope may vary from the design slope angle by no more than 1%.

Backslopes shall be maintained as a uniform, smooth surface or straight line from the ditch bottom to the top of the slope. Over the PNI Operating Period or the Operating Period, as applicable, the straight line backslope may vary from the design slope angle by no more than 2%.

Depressions or abrupt elevation changes greater than 0.05m, for a distance of 2.0 m down the sideslope shall be repaired by the Contractor. Abrupt changes in slope angle that form a depression greater than 0.1 m from the design straight line or slumping in sideslopes or backslopes shall be repaired by the Contractor.

400.4.7.9.1 Measuring for Compliance

The Contractor shall undertake weekly inspections for evaluating the condition of all subgrade sideslopes and backslopes within the New Infrastructure.

400.4.7.9.2 Completing Repairs

The Contractor shall complete repairs to restore the functionality of the sideslopes and backslopes to the level for which it was originally designed. Areas that require repair within the clear zone shall be completed within 30 days of the time when the Contractor knew of, or should

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have known of, the deficiency. Other areas requiring repair shall be completed within 180 days of the time when the Contractor knew of, or should have known of, the deficiency.

400.4.7.9.3 Payment Adjustments

Payment Adjustments for each instance when where the sideslope and backslope does not conform to the requirements herein, shall be \$1,500/occurrence/week or any partial week, for deficiencies located within the clear zone and \$1,500/occurrence/month or any partial month, for other deficiencies.

**400.4.8 TRAFFIC CONTROL DEVICES - OPERATION AND
PERFORMANCE REQUIREMENTS**

400.4.8.1 Signs

Signs shall be maintained such that they function as designed. The Contractor shall undertake the necessary maintenance to ensure that the desired message is available to motorists at all times. The following shall apply:

- Signing which does not function as designed shall be adjusted, relocated, and/or supplemented to meet the intended function. This includes ensuring signs are not obscured by other signs and do not provide conflicting messages;
- All signs shall be maintained to the physical size, materials, and lettering as designed and constructed for the original installation;
- Signs shall be kept clean and legible at all times;
- Signs shall have an acceptable level of retroreflectivity. Generally, acceptable retroreflectivity can be determined by visual examination of the sign under night-time driving conditions. Signs that exhibit reduced or blotchy retroreflectivity in excess of 25% of the sign area shall be considered to have unacceptable retroreflectivity. Sign reflectivity shall meet the requirements of ASTM D4956;
- Measurement of retroreflectivity will be determined in accordance with ASTM E1709 using a portable retroreflectometer;
- Signs shall be replaced if sign-sheeting material delaminates from the sign blank;
- Sign posts shall be maintained straight and true and shall not lean more than 25 mm in 1 m in any direction;
- Signs shall be kept level, within 25 mm in 1 m, and properly orientated for the travelling public;
- All post replacement of mounted signs shall be the same type as the original installation;
- Galvanized or painted posts shall have the coating maintained such that no corrosion is visible;
- The maintenance of breakaway bases shall be conducted to meet the requirements of the design specifications;
- Signs or billboards containing advertising or for any commercial purpose are not permitted. The Contractor is responsible for the removal of all such signs/billboards; and
- The Contractor shall remove any non-conforming signs or any unauthorized signs from the

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Road Right of Way.

400.4.8.1.1 Measuring for Compliance

The Contractor shall conduct regular inspections no less than twice per year (once between October 1 and April 30 and once between May 1 to September 30) to evaluate the condition of all signs within the Infrastructure.

400.4.8.1.2 Completing Repairs

The Contractor shall repair/replace any sign that is damaged, stolen, vandalized or which otherwise fails to meet the requirements of this Section 400.4.8 (Traffic Control Devices - Operation and Performance Requirements), within the following timelines:

- Non-critical regulatory signs shall be repaired/replaced within 48 hours;
- Standard information/directional signs shall be repaired/replaced within 14 days; and
- Non-standard information/directional signs shall be repaired/replaced within 60 calendar days.

For straightening, or otherwise maintaining signs, the work shall be conducted within 21 days, unless the deficiency is such as to affect the effectiveness of the sign.

Unauthorized signs shall be removed within one day.

These time lines apply to the time elapsed from when the Contractor knew of, or should have known of, the deficiency with respect to any specification requirement in Section 400.4.8 (Traffic Control Devices - Operation and Performance Requirements).

400.4.8.1.3 Payment Adjustments

Payment Adjustments shall be assessed against the Contractor for failing to maintain, repair/replace signs within the stipulated time as follows:

- General maintenance - \$150/sign/week for any whole or partial week the sign remains in need of maintenance;
- Repair or replacement of regulatory signs - \$1,500/sign/day, or any partial day, until rectified;
- Repair or replacement of information signs $< 1 \text{ m}^2$ or failure to remove an unauthorized sign - \$150/sign/day or any partial day, until rectified; and
- Repair or replacement of information signs $\geq 1 \text{ m}^2$ - \$400/sign/day or any partial day, until rectified.

400.4.8.2 Traffic Signals

Traffic signals shall be maintained as designed and shall be fully functional at all times. The following shall apply:

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- Signal lights, including any cross-walk lights or advance warning devices shall be maintained such that all lights function at all times;
- Electronics associated with signals shall be maintained such that all signals are functioning at all times;
- Traffic detection devices shall be maintained such that all detection devices are functioning at all times;
- Time clocks in the traffic controllers shall be maintained such that the clock time is accurate matching the Mountain Standard Times;
- Power supplies for signal installations shall be protected, maintained and serviced as required to ensure an uninterrupted power supply is available to keep the signals functioning at all times;
- Signal timing shall be coordinated with the Local Authority to provide consistency throughout the network;
- Signal poles shall be maintained straight and true and shall not lean more than 10 mm in 1 m in any direction;
- Poles, control cabinets and other signal hardware shall be maintained such that no corrosion is visible and that corrosion does not affect the structural and operational integrity of any elements; and
- All repairs shall comply with the original design requirements.

400.4.8.2.1 Measuring for Compliance

The Contractor shall conduct a regular monitoring program as outlined in Package F in Appendix J for evaluating the condition of all traffic signals within the Infrastructure.

400.4.8.2.2 Completing Repairs

The Contractor shall repair/replace any signals damaged, stolen, vandalized or which otherwise fail to meet the requirements of Section 400.4.8.2 (Traffic Signals). Signal problems are classified into the following categories:

- (1) Non-functioning traffic signal
- (2) Severe Equipment Problem
- (3) Minor Equipment Problem
- (4) Severe Operation Problem
- (5) Minor Operation Problem

The definitions of the traffic signal problems covered under the above categories, the corresponding types of responses required, as well as the required signal repair schedules (response time) are provided in Package F in Appendix J.

The time lines apply to the time elapsed from when the Contractor knew of, or should have known of, the deficiency.

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400.4.8.2.3 Payment Adjustments

Any period when the traffic signals are not fully functional, for any reason whatsoever, including power failure under the Contractor's control, shall result in a Payment Adjustment, following the expiration of the specified time period for completing the specific repair, in accordance with the following:

- First occurrence of a non-functioning signal location - \$750/hour or any partial hour, until rectified;
- First occurrence of non-functioning bulb or colour display (maximum of one at a signal location) - \$150/day or any partial day, until rectified;
- First occurrence of non-functioning bulb or colour display (2 to 4 non-functioning lights or colour displays (provided no non-functioning two bulbs or colour display of the same type affects traffic in any single direction)) - \$300/day or any partial day, until rectified;
- First occurrence of mis-aligned signal pole - \$150/day or any partial day, until rectified; and
- Each occurrence to remediate corrosion within the specified time - \$150/occurrence/month or any partial month, until rectified.

Payment Adjustments for further occurrences of non-compliance following the first occurrence shall be twice the value shown above for each and every such further occurrence. In this section, "occurrence" refers to an occurrence anywhere on the Infrastructure.

The number of occurrences of non-compliance shall be determined for a consecutive 12 month period.

400.4.8.3 Pavement Markings

Pavement markings shall be maintained such that they function as designed. Pavement markings shall be maintained to achieve the following general objectives:

- To provide positive lane delineation for the safe and orderly movement of traffic on the Infrastructure;
- To convey information to a vehicle operator without diverting the driver's attention; and
- To complement regulations or warnings by other devices such as traffic signals or signs.

All sections of roadway shall have markings with a minimum retroreflectivity of 100 mcd/lux/m². If durable markings are used, the minimum retroreflectivity for white markings shall be 125 mcd/lux/m² and the minimum retroreflectivity for yellow markings shall be 100 mcd/lux/m². The retroreflectivity shall be evaluated over segments of one kilometre or the length of the line (whichever is less) at any time between April 15 and October 15. All retroreflectivity measurements shall be made on a clean dry surface using a 30 m geometry retroreflectometer. Random measurements shall be taken throughout any one kilometre section with results averaged in order to determine any area to be repaired. All markings shall be maintained in a manner such that they are in proper repair, fully visible, complete and intact. Specifically but not exclusively, the Contractor shall ensure that:

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- Dirt or debris which obscures the markings is removed;
- Breaks in markings caused by repair work, accident or any other reason, are reinstated;
- Temporary markings for scheduled resurfacing are installed;
- Markings comply with all design requirements and the following tolerances:
 - Nominal 100 mm wide lines shall be applied to a tolerance of 100 mm to 110 mm;
 - Nominal 200 mm line widths shall be applied to a tolerance of 200 to 210 mm;
 - All direction dividing, lane dividing or continuity lines shall not exceed a maximum dimensional length deviation of +/- 100 mm for a specified 6.0 m or 3.0 m length of space; and
 - All markings shall be applied at the proper location in accordance with the designed markings and in no case shall vary from the design location by more than 100 mm;
- All non-conforming markings are obliterated from the roadway; and
- Painted pavement markings shall exhibit:
 - No excessive (more than 10%) overspray;
 - No splattering of paint;
 - Clean definitive edges;
 - No more than five tracks per km;
 - Uniform distribution of glass beads across the line; and
 - Uniform thickness.

400.4.8.3.1 Measuring for Compliance

The Contractor shall inspect the Infrastructure on a daily basis and will identify deficiencies related to general maintenance requirements. Deficient lines or markings will be measured and rounded up to the nearest full kilometre for the Payment Adjustment. Measurement of retroreflectivity of the pavement markings will be determined in accordance with ASTM Standard Test Method E1710 using a portable retroreflectometer.

400.4.8.3.2 Completing Repairs

Temporary markings following repair work, scheduled maintenance or rehabilitation shall be installed the same day as the work is performed.

Permanent markings are required to be installed within seven days of temporary markings being installed.

Incorrect or confusing markings shall be removed immediately. This may involve remedial measures pending scheduling of permanent removal.

400.4.8.3.3 Payment Adjustments

If temporary markings are not installed within the time period specified, Payment Adjustments in the amount of \$7,500 per line/markings per km or any partial km, per day or any partial day, shall be assessed until the temporary markings are installed.

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If the permanent markings to replace temporary markings are not installed to the required standard within the stipulated time period, Payment Adjustments in the amount of \$150 per line/marking per km or any partial km, per day or any partial day, shall be assessed to the Contractor until the repairs are made.

If minimum retroreflectivity as specified in Section 400.4.8.3 is not achieved, Payment Adjustments in the amount of \$150 per line/marking per km or any partial km, per week or any partial week, shall be assessed until the minimum retroreflectivity is achieved.

If non-compliant markings are not re-installed to the required standard within the stipulated time period, Payment Adjustments of \$150 per marking/day or any partial day, shall be assessed until the markings are re-installed.

If incorrect or confusing markings are not removed within seven days, Payment Adjustments in the amount of \$150/marking/day or any partial day, shall be assessed to the Contractor until the repairs are made.

**400.4.9 ROAD TRAFFIC NOISE MITIGATION (NEW
INFRASTRUCTURE ONLY)**

This Section 400.4.9 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

Requirements for road traffic noise mitigation are described in the Section 200 (Project Specifics). If the AADT exceeds 167,000 vehicles per day on the New Infrastructure, the Contractor will be relieved of the responsibility for further road traffic noise mitigation.

400.4.9.1 Measuring For Compliance

The Contractor shall have an independent, qualified noise consultant measure noise levels to confirm noise levels are in compliance with Section 200 (Project Specifics). Noise measurements will generally be made in response to public complaints but, subject to the last paragraph of Section 400.4.9.3, will not be required more than once in any 12 month period. All test and measurement results shall be provided to the Department forthwith, upon its request.

400.4.9.2 Completing Repairs

When measurements indicate noise exceeds the limiting noise level, the Contractor shall undertake remedial action to either reduce the noise levels generated or to effectively screen the areas as required to reduce noise levels. Any proposed screening devices shall require the prior written approval of the Department. The Contractor shall complete repairs required to result in compliance with the limiting noise level within 180 days of becoming aware of the non-compliance. All test and measurement results shall be provided to the Department forthwith, upon its request.

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400.4.9.3 Payment Adjustments

Subject to the second sentence of Section 400.4.9 (Road Traffic Noise Mitigation), if the Contractor fails to implement repairs to attain compliance within the stipulated time period, the Contractor shall be assessed a Payment Adjustment as set out below until repaired.

For the first 180 days, the Payment Adjustment shall be \$75,000/30 day period or any partial 30 day period, for each km of roadway or any partial km, which exceeds the noise level.

Following the 180 day period, a Payment Adjustment of \$150,000/30 day period or any partial 30 day period, for each km of roadway or any partial km, shall be assessed.

If within 360 days of the time period stipulated for completing repairs, the Contractor has not completed repairs to result in compliance, the Department may undertake the construction of sound attenuating works and deduct the costs, plus a 25% administration fee, from Payments to be made to the Contractor.

The Contractor's responsibility for noise mitigation applies to and includes Mainline AADT volumes of 167,000 vehicles per day. AADT volumes shall be determined in accordance with Section 200.3.1 (Traffic Volume Payment Adjustments).

If the Contractor fails to conduct a noise assessment using an independent, qualified noise consultant within one year of receiving a noise complaint, a Payment Adjustment of \$5,000 per month or any partial month until the noise assessment is completed will apply.

**400.4.10 TESTING CONDUCTED WITH AN INERTIAL PROFILER
(EXISTING INFRASTRUCTURE ONLY)**

Once every three years, the Contractor shall measure the smoothness (IRI), and rutting of the Existing Infrastructure roadways, except all ramps and crossroads.

Measurements with the inertial profiler shall be in accordance with the requirements of the following sections. The measurements must be obtained after June 1st and before August 1st in the years the measurements are obtained:

- Section 400.4.2 (Pavement Geometric Requirements)
- Section 400.4.3 (Smoothness Requirements); and
- Section 400.4.4 (Rutting Performance Requirements).

The data collected for the inertial profiler shall be submitted to the Department electronically in accordance with the ASCII CSV file structure formats and file naming convention used by the Department forthwith.

All data collected by the Contractor is confidential to the Department and shall be turned over to the Department and shall become the property of the Department and may be used in any manner

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the Department deems appropriate. The Contractor shall not use this data for any purpose nor shall the Contractor disseminate any information to any parties other than the Department.

400.4.10.1 Measuring for Compliance

Measurements with the inertial profiler must be collected during the same week from test year to test year. The profile measurements and IRI post-processing shall be submitted to the Department within three weeks of the collection of the field data.

400.4.10.2 Payment Adjustments

If the field measurements are not collected within the same week of the year in each testing year, the Contractor shall be assessed Payment Adjustments at a rate of \$2,500/week or any partial week, for each week in which the field measurements vary from the required week.

If the profile measurements and IRI post-processing is not submitted within the stipulated time period, the Contractor shall be assessed Payment Adjustments at a rate of \$750/week or any partial week, for each week that the information is not submitted.

400.5 BRIDGE STRUCTURES

400.5.1 OPERATIONS

400.5.1.1 General

During the Contractor's regularly scheduled inspections of the roadway and appurtenances as specified in Section 400.2 (Inspection, Emergency and Routine Maintenance Requirements), the Contractor shall pay special attention to the condition, functionality and safe operation of the bridge structures. The Contractor shall ensure that qualified personnel carry out the regularly scheduled inspections. Any deficiencies that pose an imminent danger to the travelling public shall be addressed immediately.

In addition, regular scheduled bridge inspections as outlined in Section 400.5.1.3 (Performance Compliance Inspection and Testing) shall be completed by the Contractor to measure and determine compliance of the bridge structures forming part of the Infrastructure with the bridge structure performance requirements identified in Section 400.5.3 (Performance Requirements). Appropriate preventative maintenance, repair and rehabilitation actions are expected to be required. The Contractor is expected to take appropriate action to address identified deficiencies within specified time periods to ensure the long-term durability and serviceability of the bridge structures.

400.5.1.2 Utility Accommodation

The Contractor shall accommodate utilities on the bridge structures when requested by the Department. All costs associated with the installation, maintenance and operation of the utilities shall be the responsibility of the utility owner.

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During the PNI Operating Period or the Operating Period, as applicable, the utility line may need to be removed or relocated to facilitate major maintenance, rehabilitation, replacement or closure of a bridge structure. Relocation or removal of the utility line, including all associated costs, shall be borne by the owner of the utility.

In the event that a utility line is no longer required, the utility owner shall advise the Department and the Contractor and arrange for the line to be removed and, when applicable, for the structure to be restored to the condition commensurate with that prior to the installation of the line.

400.5.1.3 Performance Compliance Inspection and Testing

400.5.1.3.1 Inspections and Testing

All bridge structures included in the Infrastructure will be considered a component of the provincial bridge structure inventory and as such shall be subject to at least the same level of inspection as are all other bridge structures on the Provincial highway system.

The Contractor shall complete bridge inspection and testing of the bridge structures to measure and determine compliance to the performance requirements. The compliance inspection and testing shall be based on the Department's existing *Bridge Inspection and Maintenance ("BIM") System*.

The BIM system consists of two levels of inspection. Level 1 inspections are routine inspections that are carried out on a regular inspection cycle and are primarily a visual inspection carried out without the use of specialized equipment for testing or for access. Level 2 inspections will also be carried out on a specified interval or on a one-time site-specific basis. Using specialized equipment and expertise, the Level 2 inspections gather detailed and quantified information and data on a particular bridge structure or bridge element.

400.5.1.3.2 Routine Level 1 Inspections

The Contractor shall complete routine Level 1 inspections in accordance with the Department's current *Bridge Inspection and Maintenance ("BIM") System* to confirm that the performance requirements in Section 400.5.3 (Performance Requirements) are being met. Only qualified and experienced bridge inspectors that have a current Class A certification under the Department's BIM system shall complete the inspections.

The routine Level 1 bridge inspections will be completed at the prescribed cycle as follows:

- Initial inspection within 30 days after the first anniversary of PNI Traffic Availability; and
- Every 21 months after the initial inspection.

The routine inspection cycle may be shortened if deemed necessary by the inspector due to condition, functionality, use of the bridge structures or any other reason.

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The Contractor shall complete each routine Level 1 inspection within the time period of one month prior to the originally scheduled date of the routine Level 1 inspection to one month following the originally scheduled date of the routine Level 1 inspection.

400.5.1.3.3 Specialized Level 2 Inspections

The Department currently carries out a number of specialized Level 2 inspections including concrete deck, copper sulphate electrode (“CSE”) or half-cell testing, chloride ion content testing, ultrasonic inspection of steel elements, scour survey, steel culvert barrel measurement, timber coring, concrete girder, paint system and vertical clearance measurement.

For the bridges forming part of the New Infrastructure using the Department’s standard deck protection system as identified in Section 300.5.2.7 (Bridge Structures – Design Criteria – Durability) the Contractor shall complete the following specialized Level 2 inspections to determine the condition of the concrete bridge decks:

- Year 15 Concrete deck inspection, CSE testing, Chloride ion content testing;
- Year 20 Concrete deck inspection, CSE testing, Chloride ion content testing; and
- Year 25 Concrete deck inspection, CSE testing, Chloride ion content testing.

For alternative deck protection systems used on bridges in the New Infrastructure the Contractor shall identify the performance criteria and the testing proposed for determining if the performance of the concrete bridge decks at Years 15, 20 and 25 meets the performance criteria.

For bridges forming part of the Existing Infrastructure, the Contractor shall complete specialized Level 2 inspections in accordance with the schedule outlined in Section 200.3.6.2 (Level 2 Bridge Deck Inspections) to determine the condition of the concrete bridge decks. The specialized Level 2 deck inspections shall consist of concrete deck inspection, CSE testing and chloride ion content testing.

Only qualified and experienced bridge inspectors that have a current Class A certification under the Department’s BIM system shall complete the inspections.

The specialized Level 2 inspection and testing, except for the submission of inspection results, shall be completed between May 15 and September 15 of the testing year specified during the PNI Operating Period or the Operating Period, as applicable.

400.5.1.3.4 Inspection and Testing Notification

The Contractor shall notify the Department a minimum of two weeks in advance of the scheduled inspection and testing date and time.

The Department reserves the right to direct the Contractor to complete all or a portion of the specified Level 2 inspections in Section 400.5.1.3.3 for the New Infrastructure and the Existing Infrastructure. The Contractor shall request clarification from the Department four weeks in advance of the scheduled Level 2 testing which of the tests specified in Section 400.5.1.3.3 shall

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be completed for each structure. The Department may elect to have a representative on site during the Contractor's scheduled inspection and testing. The Department also reserves the right to complete inspection or testing concurrently with the Contractor's scheduled inspection and testing or at any other time. In the event the Department elects to complete inspection and testing concurrently with the Contractor's scheduled inspection and testing, the Contractor shall provide the required traffic accommodation and assistance and cooperation.

The Department will use in-house or external engineering consultants to complete the inspection and testing on their behalf. Only qualified and experienced bridge inspectors that have a current Class A certification under the Department's BIM system will perform the Department's inspection and testing work.

400.5.1.3.5 Inspection Reporting

Within 30 days of the completion of a routine Level 1 bridge inspection and within 90 days of the completion of a specialized Level 2 bridge inspection and testing, the Contractor shall provide the results of the inspection and testing to the Department. In addition to the inspection and testing results, the Contractor shall submit a report identifying any components or elements in respect of the Infrastructure found to be non-compliant with the performance requirements in Section 400.5.3 (Performance Requirements). Each identified deficiency will be categorized as structural and operational or standard maintenance in accordance with the requirements of Section 400.5.2 (Bridge Maintenance and Operations) along with the specified time period for commencement or completion of repair and/or remediation actions.

400.5.1.3.6 Payment Adjustments

In the event the Contractor fails to complete the scheduled inspection and testing requirements, including the submission of inspection results to the Department, the Department shall assess the following Payment Adjustments for late submission of inspection results:

- \$15,000/bridge/month or any partial month, for routine Level 1 inspections until submitted;
- \$30,000/bridge/year or any partial year, specialized Level 2 inspections until submitted.

400.5.1.3.7 Traffic Accommodation

The Contractor is expected to perform inspections and testing during non-peak traffic periods and on dates that cause a minimum of inconvenience to the travelling public.

The bridge inspection and testing may require inspectors and workers to be on or in close proximity to the roadway, making traffic accommodation necessary. The Contractor shall provide all necessary temporary signing and traffic accommodation for the duration of the inspection and testing at its own cost.

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Lane Closure Payment Adjustments (see Section 400.1.6) shall be charged during inspection and testing carried out by the Contractor but not for testing and inspection carried out by the Department.

400.5.1.3.8 Measurement and Determination

The Department has made every effort to develop and use measurable and quantifiable performance requirements for the bridge structure elements. The BIM system minimizes the subjective nature of these evaluations through formal guidelines and extensive training and certification of inspection personnel.

400.5.2 BRIDGE MAINTENANCE AND OPERATIONS

400.5.2.1 General

For the Existing Infrastructure, the Contractor shall be required to carry out preventative maintenance actions on the bridge structures. The Department will be responsible for the repair of all structural and operational deficiencies (see description in Section 400.5.2.2) and standard maintenance deficiencies (see description in Section 400.5.2.3) in respect of the Existing Infrastructure.

For the New Infrastructure, the Contractor shall be required to maintain the bridge structures in a safe and effective operating condition at all times during the PNI Operating Period or the Operating Period, as applicable. This will require preventative maintenance, standard maintenance and periodic rehabilitation actions during the PNI Operating Period or the Operating Period, as applicable.

The quality and standard of the maintenance, repair, and rehabilitation actions shall be appropriate to ensure the design life of the bridge structures.

400.5.2.2 Structural and Operational (New Infrastructure Only)

This Section 400.5.2.2 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

Structural and operational deficiencies are deficiencies that compromise public safety and must be repaired prior to the 20 months allowed for standard maintenance repairs. An inexhaustive list of some structural and operational deficiencies are as follows:

- Repair of misalignment or cracking to steel girders caused by collision damage, overloads or other causes;
- Repair of excessive cracking, spalling or reinforcement damage to concrete girders caused by collision damage, overloads or other causes;
- Repair of potholes in the bridge deck;
- Repair of deck joint components protruding above the riding surface and causing a hazard to traffic;

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- Repair of misalignment, cracking or rupture of bridgerail or guardrail components caused by collision damage or other causes;
- Repair of culverts with deformations exceeding those allowed by the performance requirements;
- Repair of longitudinal cracked seams in culverts;
- Repair of misalignment and cracking in sign structure support components; and
- Repair of bridge approaches when the grade over the length extending over the approach slab and 3 m beyond it at both ends deviates from the line under a 6 m straight-edge by more than 45 mm, or when the approach slab deviates from the design grade by more than 1.5%.

All structural or operational deficiencies identified shall be notified to the Department forthwith. The Contractor shall commence work to rectify a structural or operational deficiency within 60 days of identification.

For some deficiencies that may not be effectively repaired or rectified during inclement weather, the Department at its sole discretion may extend the required time period for commencement of work to 180 days.

400.5.2.3 Standard Maintenance (New Infrastructure Only)

This Section 400.5.2.3 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

If the Department agrees that deficiencies do not fall within the category of structural and operational they shall be categorized as standard maintenance. These deficiencies are expected to be non-safety and non-hazard related. The Contractor shall complete work to rectify these deficiencies within 20 months of identification.

400.5.2.4 Preventative Bridge Structures Maintenance

The Contractor shall carry out a preventative bridge structures maintenance program for the Infrastructure. The program shall include annual washings of the bridge decks, sealing of all bridge decks exposed to de-icing salts and sealing of all curbs. For the Existing Infrastructure, sealing of all bridge decks shall be with an approved Type 1c sealer and sealing of all curbs with an approved Type 2a sealer; and sealing shall be carried out in accordance with the schedule outlined in Section 200.3.7 (Preventative Bridge Maintenance). For the New Infrastructure, sealing of all bridge decks, curbs and barriers shall be with an approved Type 1c sealer.

400.5.2.5 Payment Adjustments

In the event the Contractor fails to meet the specified schedule for preventative maintenance actions or satisfactory repair and remediation of identified deficiencies, the Department shall assess the following Payment Adjustments:

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400.5.2.5.1 Structural and Operational (New Infrastructure Only)

This Section 400.5.2.5.1 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

In the event the Contractor fails to commence work within 60 days of identification of a structural or operational deficiency, a Payment Adjustment of \$1,500/day or any partial day, per deficiency shall be assessed until the Contractor commences and diligently pursues completion of the work.

For deficiencies where the Department has extended the required time period for commencement of work to 180 days, a Payment Adjustment of \$1,500/day or any partial day, per deficiency if the Contractor fails to commence work within 180 days of being notified of the deficiency and shall be assessed until the Contractor commences and diligently pursues completion of the work.

400.5.2.5.2 Standard Maintenance (New Infrastructure Only)

This Section 400.5.2.5.2 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

In the event the Contractor fails to complete work within 20 months of a standard maintenance deficiency being identified, a Payment Adjustment of \$7,500/month or any partial month, per deficiency shall be assessed until the Contractor completes the work.

400.5.2.5.3 Preventative Bridge Structures Maintenance

In the event the Contractor fails to complete the scheduled preventative bridge structures maintenance (see Section 400.5.2.4 (Preventative Bridge Structures Maintenance)), with the exception of annual bridge washings within the year scheduled, a Payment Adjustment of \$7,500/bridge/month or any partial month, shall be assessed until the Contractor completes the work.

In the event the Contractor fails to complete the annual bridge washings by June 1st of the year scheduled, a Payment Adjustment of \$7,500/bridge/month or any partial month, shall be assessed until the Contractor completes the work.

400.5.2.6 Bridge Structure Maintenance and Rehabilitation Requirements (New Infrastructure Only)

This Section 400.5.2.6 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

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At least two weeks prior to commencement of any bridge structures maintenance actions, the Contractor shall submit detailed design drawings and construction specifications required for the proposed work to the Department for information and review, if applicable.

At least one month prior to commencement of bridge structures rehabilitation actions, the Contractor shall submit detailed design drawings and construction specifications for the proposed work to the Department for information and review.

**400.5.2.7 Notification Of Bridge Structure Maintenance and
Rehabilitation (New Infrastructure Only)**

This Section 400.5.2.7 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

In addition to the Contractor's scheduled maintenance and rehabilitation work included in the Operation and Maintenance Plan (as defined in Section 100.2.9), the Contractor shall notify the Department a minimum of two weeks in advance of any proposed bridge structure maintenance or rehabilitation actions. The written notification shall outline the type of work proposed, schedule for commencement and completion, hours of work and any lane closures or impacts to the travelling public.

**400.5.3 PERFORMANCE REQUIREMENTS (NEW INFRASTRUCTURE
ONLY)**

This Section 400.5.3 applies to the New Infrastructure only and does not apply to the Existing Infrastructure.

400.5.3.1 General

The individual components and elements of bridge structures shall be in adequate condition and functioning as designed during the PNI Operating Period or the Operating Period, as applicable.

No component or element shall show evidence of any loss in structural strength and shall operate safely and in a manner consistent with the Department's Bridge Inspection and Maintenance System.

Notwithstanding the performance requirements stated in Sections 400.5.3.2 (Individual Component Requirements – Bridges), 400.5.3.3 (Individual Component Requirements – Bridge Culverts) and 400.5.3.4 (Individual Component Requirements – Sign Structures) for bridges, bridge culverts and sign structures respectively, all individual components rated three or less under the Department's Bridge Inspection and Maintenance System shall be considered to be in non-conformance.

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400.5.3.2 Individual Component Requirements - Bridges

400.5.3.2.1 Approach Slab

The transition on and off the bridge structure from the roadway shall meet the following requirements:

- The grade on the approach slab shall deviate from the design grade by less than 0.5%; and
- The grade over a length extending over the approach slab and 3 m beyond it shall not deviate from the line under a 6 m straight-edge by more than 15 mm. This condition shall apply at both ends of the approach slab.

400.5.3.2.2 Wearing Surface

The wearing surface on bridge structures shall meet the rutting requirements as stated for the roadway in 400.4.4 (Rutting Performance Requirements).

The wearing surface on bridge structures shall meet the skid resistance requirements as stated for the roadway in 400.4.5 (Skid Resistance Requirements).

Asphalt concrete pavement (“**ACP**”) wearing surfaces on bridge structures shall meet the general pavement maintenance requirements as stated for the roadway in 400.4.6 (General Pavement Maintenance Requirements).

The pavement markings on bridge structures shall meet the pavement lines and message requirements as stated for the roadway in 400.4.8.3 (Pavement Markings).

400.5.3.2.3 Concrete Bridge Decks

Unless noted otherwise, the bridge deck shall not have any physical defects or chemical deterioration.

The underside of all concrete decks shall be free of stains resulting from deterioration, efflorescence and exudation.

Any cracking on the deck underside shall be limited to a maximum width of 0.3 mm.

The following performance requirements for specialized Level 2 inspections shall be met for the Department’s standard deck protection system as identified in Section 300.5.2.7 (Durability):

Year 1 of the PNI Operating Period/Operating Period

Electrical resistance between electrical ground connections shall be measured and recorded to the nearest Ohm (Ω).

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Year 15 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 90% of readings less negative than -0.300 V.

Maximum average total chloride content of 0.010, by percent weight, at the top mat of reinforcing or 100 mm depth, whichever is less.

Year 20 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 85% of readings less negative than -0.300 V.

Maximum average total chloride content of 0.015, by percent weight, at the top mat of reinforcing or 100 mm depth, whichever is less.

Year 25 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 80% of readings less negative than -0.300 V.

Maximum average total chloride content of 0.020, by percent weight, at the top mat of reinforcing or 100 mm depth, whichever is less.

Level 2 testing shall be carried out in accordance with the requirements of the Department's *Level 2 Bridge Inspection Manual*.

All test results shall be provided to the Department forthwith.

400.5.3.2.4 Curbs, Barriers, and Medians

There shall be no physical defects or chemical deterioration.

Cracking shall be limited to a maximum width of 0.3 mm occurring at a maximum frequency of one crack every 2 m over the length of the bridge structure.

There shall be no exposure of utility voids or other formed voids.

Differential movement in the horizontal or vertical direction shall be limited to 6 mm.

Joints shall be fully sealed, free of cracks and spalls, and able to accommodate required movements.

The following performance requirements for specialized Level 2 inspections shall be met:

Year 1 of the PNI Operating Period/Operating Period

Electrical resistance between electrical ground connections shall be measured and recorded to the nearest Ohm (Ω).

Year 15 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 90% of curb readings less negative than -0.300 V.

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Year 20 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 85% of curb readings less negative than -0.300 V.

Year 25 of the PNI Operating Period/Operating Period

CSE test results showing a minimum of 80% of curb readings less negative than -0.300 V.

Level 2 testing shall be carried out in accordance with the requirements of the Department's *Level 2 Bridge Inspection Manual*.

400.5.3.2.5 Bridge and Pedestrian Rails

Elements shall be free of collision damage, horizontal and vertical misalignment, improper guardrail laps, loose connections and missing nuts and bolts.

Steel components shall be free of deformation, cracks, and corrosion.

Anchor bolts shall have proper alignment and firm anchorage.

There shall be no physical defects or chemical deterioration in the grout pads.

400.5.3.2.6 Deck Joints

Deck joints shall be able to accommodate the thermal movements stated on the Detailed Designs without imposing any additional load on substructure or superstructure components. The joints shall be vertically aligned and the variation in the gap along the length of the deck joint shall not exceed 10%. There shall be no missing or loose bolts, nor damage to joint anchorages or knockout concrete.

All deck joints shall capture and manage deck drainage such that it does not come into contact with the concrete and steel surfaces of other bridge elements.

For finger joints, the fingers shall sit level, have no cracks and the trough system under the joint shall function without signs of leakage or debris accumulation. Tolerance for finger gaps shall be within those noted on Standard Drawing S-1638.

For gland type joints, there shall be no signs of leakage or holes or damage to the seal or leakage around the joint.

Steel components shall be free of deformation, cracks and corrosion.

Sidewalk deck joint cover plate slip resistant surfaces shall be effective over not less than 95% of the original slip resistant surface area.

400.5.3.2.7 Bridge Deck Drainage Systems

Build-up of gravel or debris shall not cause any ponding on the bridge deck or impede the flow

of water away from the bridge deck.

Deck drains and pipes shall not be clogged with debris.

Down spouts shall be low enough to prevent splashing of water on superstructure and substructure elements.

There shall be no ponding of water along the shoulders or in the driving lanes.

For grade separations, the location of drains shall not create ponding water or an icing hazard on the roadway below.

400.5.3.2.8 Concrete Girders

Prestressed concrete girders shall not have any physical defects or chemical deterioration or staining.

Any cracks or defect in the prestressed concrete girders shall meet the requirements of Section 300.5.9.7 (Manufacture).

There shall be no signs of damage or deterioration due to impacts or collisions.

400.5.3.2.9 Steel Girders

Steel girders shall be free of harmful corrosion, notches and cracks.

Bolted connections shall be free of deformation, warping and missing, worn, sheared or deformed fasteners.

Web stiffeners shall not have any evidence of buckling.

Girders shall not show any evidence of sags, buckling, bowing or twisting.

All welds shall be free of cracks.

There shall be no signs of damage or deterioration due to impacts or collisions.

400.5.3.2.10 Intentionally Deleted

400.5.3.2.11 Sidewalks

Sidewalk surfaces shall be smooth but have adequate traction and be free of debris.

There shall be no physical defects or chemical deterioration.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m

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of cracking per square metre of sidewalk area.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.12 Bearings

Bearings shall be operational and shall be free of all debris that may impede movement.

Expansion bearings shall be able to accommodate the thermal movements stated on the Detailed Designs without imposing any additional load on substructure or superstructure components.

Coating system on bearings shall be functioning and intact.

Component parts shall have proper alignment, proper contact surfaces and minimum resistance.

Bearing pads and plates shall be in proper position.

There shall be no physical defects or chemical deterioration in the grout pads.

Elastomeric components shall be free of cracks and splits along the edges. Minor bulging of the elastomeric components shall be limited to 10% of the component thickness.

Anchor bolts shall have proper alignment and firm anchorage.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.13 Bearing Seats and Caps

Caps shall not have any rotation or displacement. Integral abutments shall operate within design limits with no signs of distress.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

The bottoms of bearing seats shall not be exposed due to soil settlement or other reasons.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.14 Backwalls and Breastwalls

There shall not be any significant loss of material below the backwall or breastwall.

There shall be no physical defects or chemical deterioration of concrete components.

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Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.15 Wingwalls and Retaining Walls

Headslopes and retaining walls displacements shall not impact the ability of deck joints, bearings, barriers and piles/casings to operate as designed and without imposing any additional loads to bridge superstructure and substructure components.

The bottoms of wingwalls and retaining walls shall not be exposed due to soil settlement or other reasons.

Defects in precast concrete panels used for the MSE retaining wall shall meet the requirements of Section 300.5.11.4.1 (Precast Concrete Fascia Panel Production).

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre for cast-in-place components.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.16 Piers

Piers shall not have any evidence of collision damage or damage due to ice or debris.

Visible piles shall not have any evidence of bowing or misalignment due to deterioration, impact, excessive loads or unintended lateral loading.

There shall be no signs of heaving or settlement.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking of concrete components shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

Steel components shall be free of corrosion, notches, cracks, sheared bolts and cracked welds.

400.5.3.2.17 Nose Plates

There shall be no missing plate sections or loose connections.

There shall not be loss of section due to corrosion.

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Nose plates with significant impact damage shall be repaired or replaced.

400.5.3.2.18 Concrete Finishes

Concrete finishes in visible areas shall not be stained, chipped or peeling.

400.5.3.2.19 Slope Protection for River Crossing

Any settlement of the headslope fill in the vicinity of the abutment shall be limited to 150 mm.

Slope or scour rock riprap protection shall be of the required gradation and quality as specified in the Detailed Designs.

Average rock size and thickness of the rock layer shall be as specified in the Detailed Designs.

For concrete slope protection, gaps between the abutment and the slab shall be limited to 100 mm.

There shall be no crushing of concrete around the pier or bulging at the toe.

There shall be no physical defects or chemical deterioration.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre of the slope protection area.

400.5.3.2.20 Slope Protection for Grade Separation

Any settlement of the headslope fill in the vicinity of the abutment shall be limited to 150 mm.

For concrete slope protection, gaps between the abutment and the slab shall be limited to 100 mm.

There shall be no crushing of concrete around the pier or bulging at the toe.

There shall be no physical defects or chemical deterioration.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre of the slope protection area.

Drainage shall not penetrate below the slab and there shall be no presence of voids below the slab.

400.5.3.2.21 River Training Works

Average rock size, gradation and thickness of the rock layer shall be as specified in the Detailed Designs.

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There shall not be significant scour or erosion around or under the training works.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.2.2 Other Bridge Structure Elements

Other bridge structure elements not listed in these requirements shall be in adequate condition and functioning as designed throughout the PNI Operating Period or the Operating Period, as applicable.

400.5.3.3 Individual Component Requirements – Bridge Culverts

400.5.3.3.1 Embankments

Embankments shall not show any signs of instability such as slumping, excessive settlement, or cracking.

Embankments shall not show any signs of erosion such as gulying or erosion or scour along the toe of the sideslope.

The slope of the embankment shall be as specified in the Detailed Designs.

400.5.3.3.2 Headwalls and Collars

Headwalls and collars shall not have excessive settlement or rotation and must be securely connected to the barrel or bevel section.

Headwalls and collars shall not show any signs of piping, scour or erosion.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

Steel components shall not have excessive corrosion, loss of section or loose connections.

400.5.3.3.3 Wingwalls

Any gap or void between the wingwall and the barrel section shall be limited to a maximum of 75 mm. There shall not be any loss of fill material.

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Wingwalls shall have proper vertical alignment and be securely connected to the headwall, if applicable.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

Steel components shall not have excessive corrosion, loss of section or loose connections.

400.5.3.3.4 Cutoff Walls

Cutoff walls shall be securely connected to the culvert invert.

There shall be no signs of undermining, piping or uplift.

400.5.3.3.5 Bevel Ends

For flexible culverts, any deformation (dimensional change) is limited to within 7% of the design or as-constructed dimensions.

For rigid culverts, any deformation (dimensional change) is limited to within 1% of the design or as-constructed dimensions unless specifically indicated otherwise in the Detailed Designs.

There shall be no physical defects or chemical deterioration of concrete culverts.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.3.6 Roofs

For flexible culverts, any deformation (dimensional change) is limited to within 7% of the design or as-constructed dimensions.

For rigid culverts, any deformation (dimensional change) is limited to within 1% of the design or as-constructed dimensions unless specifically indicated otherwise in the Detailed Designs.

There shall be no physical defects or chemical deterioration of concrete culverts.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.3.7 Sidewalls

For flexible culverts, any deformation (dimensional change) is limited to within 7% of the design or as-constructed dimensions.

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For rigid culverts, any deformation (dimensional change) is limited to within 1% of the design or as-constructed dimensions unless specifically indicated otherwise in the Detailed Designs.

There shall be no physical defects or chemical deterioration of concrete culverts.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.3.8 Floors

For flexible culverts, any heaving (dimensional change) is limited to within 7% of the design or as-constructed dimensions.

For rigid culverts, any deformation (dimensional change) is limited to within 1% of the design or as-constructed dimensions unless specifically indicated otherwise in the Detailed Designs.

There shall be no physical defects or chemical deterioration of concrete culverts. Any abrasion shall be limited to light scaling over a maximum surface area of 10%.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.3.9 Circumferential Seams

Circumferential seams shall not be misaligned between adjoining sections.

There shall be no evidence of infiltration of backfill material caused by improper connections or separation of adjoining sections.

Circumferential seams shall not have any cracks.

400.5.3.3.10 Longitudinal Seams

Longitudinal seams shall not have any cracks.

Longitudinal seams shall not have any signs of bolt tipping, distortion, cusping, improper nesting or signs of corrosion.

400.5.3.3.11 Coatings

Steel culvert material may have some superficial rust but no pitting or loss of section.

400.5.3.3.12 Fish Passage Enhancement Features

Concrete, steel or rock boulders used for baffles or other fish enhancement features shall be

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located as specified in the Detailed Designs.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

Steel material may have some superficial rust but no pitting or loss of section.

400.5.3.3.13 Waterway Adequacy

There shall be no reduction in the culvert opening of more than 35% due to debris accumulation, gravel or siltation.

400.5.3.3.14 Slope Protection

Slope or scour protection shall be of the required gradation and quality, as specified in the Detailed Designs.

Average rock size, gradation and thickness of the rock layer shall be as specified in the Detailed Designs.

400.5.3.3.15 River Training Works

Average rock size, gradation and thickness of the rock layer shall be as specified in the Detailed Designs.

There shall not be significant scour or erosion around or under the training works.

There shall be no physical defects or chemical deterioration of concrete components.

Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.3.16 Other Bridge Culvert Structure Elements

Other bridge culvert structure elements not listed in these requirements shall be in adequate condition and functioning as designed throughout the PNI Operating Period or the Operating Period, as applicable.

400.5.3.4 Individual Component Requirements - Sign Structures

400.5.3.4.1 Pedestal

There shall be no physical defects or chemical deterioration of concrete components.

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Any cracking shall be limited to a maximum width of 0.3 mm and a linear measurement of 1 m of cracking per square metre.

400.5.3.4.2 Column

Columns shall be properly aligned with no bends, bows or kinks.

Steel components shall be free of corrosion, notches, cracks, sheared or loose bolts and cracked welds.

400.5.3.4.3 Connections/Bearings

There shall be no missing anchor nuts and all nuts shall be fully torqued.

Anchor bolts shall have proper alignment and firm anchorage.

There shall be no physical defects or chemical deterioration in the grout pads.

All concrete in the area of the connections shall be sound.

Welds and connections shall be free of cracks and defects.

400.5.3.4.4 Superstructure Elements

The superstructure is defined as that portion of the sign structure that is attached to the support columns and spans between the columns.

Steel elements shall not show any evidence of sags, buckling, bowing or twisting.

Bolted connections shall be free of deformation, warping, and missing, loose, worn, sheared or deformed fasteners.

Steel elements shall be free of corrosion, notches and cracks.

All welds shall be free of cracks.

400.5.3.4.5 Coatings

Coatings shall be intact and effective in preventing corrosion and loss of section.

There shall be no rusting, scaling, peeling, blistering, discolouration or other defects.

400.5.3.4.6 Other Sign Structure Elements

Other sign structure elements not listed in these requirements shall be in adequate condition and

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functioning as designed throughout the PNI Operating Period or the Operating Period, as applicable.

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500.0 HANDBACK REQUIREMENTS

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500.1 ROADWAY HANDBACK REQUIREMENTS - NEW INFRASTRUCTURE

At the end of the Term, when the Department assumes responsibility for the New Infrastructure, the roadway shall meet or exceed the following requirements:

500.1.1 CONDITION OF PAVEMENT

The pavements shall meet or exceed the following requirements:

- Cross-slope and superelevation <0.5% deviation from design rate. Percentages refer to a numeric deviation from the designed percentage and not to a percentage deviation. This means that if the designed percentage is 2% the deviation referred to is >1.5% and <2.5%;
- Pavement surface width shall not be less than design width (*Subject to the Payment Adjustment provisions in Section 400.4.2 (Pavement Geometric Requirements).*)

PAVEMENT SMOOTHNESS		
Design Speed (kph)	IRI (mm/m) 1 km Average	IRI (mm/m) (100 m Section)
>110	1.9	2.9
>90 ≤110	2.0	3.0
>70 ≤90	2.2	3.2
≤70	2.4	3.4

- 1 km average rutting shall be < 10 mm;
- 100 m section average rutting shall be < 15 mm;
- Isolated area rutting shall be < 25 mm;
- Minimum skid number (skid resistance) = 30; and
- Pavement Smoothness IRI Values shall be less than or equal to the numbers in the above table.

All testing and measuring for compliance shall be completed by the Contractor according to the requirements outlined in Section 400.4 within the same calendar year as when the end of the Term occurs. All compliance testing and monitoring results shall be supplied to the Department by September 1 of the year in which the end of the Term falls or two months prior to the end of Term, whichever occurs first.

Notwithstanding the foregoing, the Department may elect to test or measure the roadway independently if there are concerns regarding the serviceability of the roadway.

500.1.2 PAVEMENT SURFACE CONDITION

The pavement surface, including lanes and shoulders, shall be free of any evidence of structural

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weakness, pitting, potholes, ravelling, segregation, scaling, delamination, localized roughness and all other deficiencies. All cracks and joints shall be sealed with a sealant acceptable to the Department. The pavement surface shall be free and clear of dirt, sand and other debris.

500.1.3 STRUCTURAL REQUIREMENTS

At the time the Department assumes responsibility of the roadway, the structural capacity of each and every lane of the roadway shall be such that a rehabilitation design for 10 years of traffic loading starting as of the date the Department assumes responsibility for the roadway will conform to the following:

- For roadways requiring long-life pavements as described in Section 300.4.1.8, the rehabilitation design will not require any structural strengthening or overlays; and
- For all other roadways, the rehabilitation design will require no more than a 50 mm asphalt concrete overlay or equivalent treatment for the pavement type.

The 10 year traffic loading will be determined based on traffic estimates at the time, but in no case will it exceed 10 million equivalent single axle loads for any lane of any section of roadway.

Pavement strength testing to determine the structural capacity and the rehabilitation needed for the requirement above will be completed by an independent consultant retained and paid for by the Department and acceptable to both the Department and the Contractor. The Contractor shall be responsible for providing all traffic accommodation to allow pavement strength testing or other testing (either destructive or non-destructive), as required.

500.1.4 CONDITION OF ALL SIGNS

All signs on the New Infrastructure must be in-place and functioning as designed and shall meet or exceed the following:

- Have an acceptable level of retroreflectivity. No signs shall exhibit reduced or blotchy retroreflectivity in excess of 25% of the sign area;
- Regulatory signs shall have a minimum retroreflectivity of 250 cd/lux/m² at an observation angle of 0.2° and a light entry angle of -4°;
- Information signs shall have a minimum retroreflectivity of 170 cd/lux/m² at an observation angle of 0.2° and a light entry angle of -4°;
- Signs shall exhibit no sign-sheeting material delaminations from the sign blank;
- Sign posts shall be maintained straight and true and shall not lean more than 25 mm in 1 m in any direction;
- Signs shall be kept level, within 25 mm in 1 m, and properly orientated for the travelling public;
- Galvanized or painted posts shall have no visible corrosion; and
- All posts of mounted signs are of the same type.

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500.1.5 CONDITION OF GUARDRAIL

All guardrail on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All guardrails shall be within 6 mm maximum for plumb and grade;
- All posts are sound and vertical; and
- All components shall be securely fastened with the designed fasteners.

500.1.6 CONDITION OF BARRIERS

All barriers on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All missing pieces and/or areas of structural weakening must be replaced.

500.1.7 CONDITION OF LIGHTING

All lighting systems and related components on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- Poles shall be plumb within 10 mm in 1 m;
- Poles and other mounting hardware shall be clean and neat, with no structural corrosion and all visible corrosion areas are to be re-galvanized by methods approved by the Department;
- Concrete bases shall be structurally adequate for the design loads; and
- Each individual light/luminaire shall be operational, provide light output in accordance with the manufacturer's rated design parameters, and overall illumination in accordance with the Detailed Designs.

The Contractor shall cooperate with the Department to coordinate the transfer of supply of electrical power at the end of the Operating Period.

500.1.8 CONDITION OF TRAFFIC SIGNALS

All signal systems on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All signal lights, including any crosswalk lights or advance warning devices, shall be fully functional;
- Traffic detection devices shall be fully functional;
- Time clocks in the traffic controllers shall be accurate matching Mountain Standard Time;
- Electronics associated with signal operation shall be fully functional;
- Signal poles shall be straight and true and shall not lean more than 10 mm in 1 m in any direction;

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- Poles, control cabinets and other signal hardware shall have no structural corrosion and all visible corrosion areas are to be re-galvanized by methods approved by the Department; and
- Power supplies are protected and in good condition.

The Contractor shall cooperate with the Department to coordinate the transfer of supply of electrical power at the end of the Operating Period.

500.1.9 CONDITION OF THE DRAINAGE SYSTEM

All components of the drainage system on or related to the New Infrastructure must be installed and functioning as designed. Culverts shall have no perforations. Any perforated culvert shall be replaced or lined as directed by the Department. All ditches, culverts, storm sewers, manholes, inlet and outlet structures, stormwater management ponds and other appurtenances shall be fully operational and clear of any debris or accumulated material.

500.1.10 CONDITION OF CONCRETE CURBS, GUTTERS,
SIDEWALKS, BARRIERS (NON-STRUCTURE RELATED)

All concrete infrastructure on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- Broken, spalled or damaged concrete shall be replaced where required to restore functionality;
- Curb height shall meet the requirements of the design specifications and in no case shall be less than 150 mm;
- Differential elevation at joints or cracks that exceeds 5 mm shall be repaired or replaced to remove the differential elevation and remove any tripping hazard;
- Concrete that is cracked in multiple locations within the same general area of a sidewalk or otherwise results in a discontinuity that may pose a tripping hazard or be a safety concern shall be removed and replaced; and
- Concrete surfaces that exhibit scaling and results in a rough surface texture shall be removed and replaced.

500.1.11 CONDITION OF LANDSCAPING

All lands disturbed by the Contractor shall have been reclaimed and Reclamation Certificates obtained prior to handback, with a copy of all such Reclamation Certificates provided to the Department as soon as practicable.

All landscaping on the New Infrastructure must be in place and functioning as designed and meet or exceed the following:

- There are no bare spots greater than one square metre in size;
- There is a minimum of 80% ground cover for any 100 square metre area;
- No noxious weeds are present; and

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- Grass and/or weeds in the Road Right of Way shall not exceed 300 mm in height.

500.1.12 CONDITION OF FENCING

All fencing on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All posts must be sound and vertical;
- All wires must be in place with no noticeable sag; and
- All gates must be in place and fully operational.

500.1.13 CONDITION OF PAVEMENT MARKINGS

All pavement markings on the New Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All sections of roadway shall have markings with a minimum retroreflectivity of 150 mcd/lux/m² based on a minimum of five discreet measurements in any area of concern;
- Nominal 100 mm wide markings shall be within a tolerance of 100 mm to 110 mm;
- Nominal 200 mm wide markings shall be within a tolerance of 200 to 210 mm;
- All direction dividing, lane dividing or continuity markings shall not exceed a maximum dimensional length deviation of +/- 100 mm for a specified 6.0 m or 3.0 m length of space;
- All markings shall be at the proper location in accordance with the designed markings and in no case shall vary from the design location by more than 100 mm; and
- All painted markings shall display the following:
 - No excessive (more than 10%) overspray;
 - No splattering of paint;
 - Clean definitive edges;
 - No more than five tracks per km; and
 - Uniform distribution of glass beads across the line.

500.1.14 CONDITION OF ROAD TRAFFIC NOISE MITIGATION

All road traffic noise mitigation elements by the Contractor's design on the New Infrastructure shall be installed and functioning as designed and meet or exceed the following:

- Road traffic noise as measured in accordance with Section 200.2.14 (Noise Attenuation) shall not exceed 65 dBA Leq₂₄.

500.1.15 CONDITION OF DELINEATORS

All delineators on the New Infrastructure shall be installed and functioning as designed and meet or exceed the following:

- Delineators shall exhibit a minimum retroreflectivity of 80% of the design value;

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- Delineator guideposts shall be plumb within 13 mm throughout their length; and
- Delineators shall be within 5% of design height and not deviate from design locations by more than 50 mm.

**500.2 BRIDGE STRUCTURES HANDBACK REQUIREMENTS - NEW
INFRASTRUCTURE**

500.2.1 GENERAL

At the end of the Operating Period, the bridge structures shall be handed back to the Department. The structures shall be in adequate condition and function as designed with no loss of structural strength and shall meet the handback performance requirements at the end of the Term. The Contractor shall complete any required maintenance or rehabilitation prior to the end of the Term to meet the required functionality state and handback condition prior to returning the bridge structures to the Department's control and management.

Notwithstanding the handback performance requirements stated in this section and Sections 400.5.3.2 (Individual Component Requirements – Bridges), 400.5.3.3 (Individual Component Requirements – Bridge Culverts) and 400.5.3.4 (Individual Component Requirements – Sign Structures), all individual components rated 4 or less under the Department's *Bridge Inspection and Maintenance (BIM) System* shall be considered in non-conformance and the Contractor shall perform repairs to achieve a rating of 5 or higher.

500.2.2 INDIVIDUAL COMPONENT REQUIREMENTS - BRIDGES

With the exception of Section 500.2.2.1 (Concrete Bridge Decks), bridges shall meet the performance requirements specified in Section 400.5.3.2 (Individual Component Requirements – Bridges) at the end of the Term.

Concrete bridge decks shall meet the performance requirements stated in Section 500.2.2.1 (Concrete Bridge Decks) at the end of the Term.

With the exception of Section 500.2.2.2 (Concrete Curbs, Barriers and Medians), bridges shall meet the performance requirements specified in Section 400.5.3.2 (Individual Component Requirements - Bridges) at the end of the Term.

Concrete curbs, barriers and medians shall meet the performance requirements stated in Section 500.2.2.2 (Concrete Curbs, Barriers and Medians) at the end of the term.

500.2.2.1 Concrete Bridge Decks

Unless noted otherwise the bridge deck shall not have any physical defects or chemical deterioration.

Concrete bridge decks cast-to-grade shall not have any cracks greater than 0.1 mm in width and a linear measurement of 0.2 m of cracking per square metre of bridge deck area.

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The underside of all concrete decks shall be free of stains resulting from deterioration, efflorescence and exudation.

Any cracking on the deck underside shall be limited to a maximum width of 0.3 mm.

The following handback performance requirements for specialized Level 2 inspections shall be met:

Year 30 of the Operating Period

CSE test results showing a minimum of 75% of readings less negative than -0.300 V.

Maximum total average chloride content of 0.020, by percent weight, at the top mat of reinforcing or 100 mm depth, whichever is less.

The deck area shall not be delaminated or debonded as determined by chain drag testing or hammer sounding in accordance with ASTM D4580.

Level 2 testing shall be carried out in accordance with the requirements of the Department's *Level 2 Bridge Inspection Manual*.

500.2.2.2 Curb, Barriers and Medians

There shall be no physical defects or chemical deterioration.

Cracking shall be limited to a maximum width of 0.3 mm occurring at a maximum frequency of one crack every 2 m over the length of the bridge structure.

There shall be no exposure of utility voids or other formed voids.

Differential movement in the horizontal or vertical direction shall be limited to 6 mm.

The following handback performance requirements for specialized Level 2 inspections shall be met:

Year 30 of the Operating Period

CSE test results showing a minimum of 75% of readings less negative than -0.300 V.

The curbs, barriers and medians shall not be delaminated as determined by chain drag testing or hammer sounding in accordance with ASTM D4580.

CSE and chloride testing shall be carried out in accordance with the requirements of the Department's *Level 2 Bridge Inspection Manual*.

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**500.2.3 INDIVIDUAL COMPONENT REQUIREMENTS – BRIDGE
CULVERT STRUCTURES**

Bridge culvert structures shall meet the handback performance requirements specified in Section 400.5.3.3 (Individual Component Requirements – Bridge Culverts) at the end of the Term.

**500.2.4 INDIVIDUAL COMPONENT REQUIREMENTS - SIGN
STRUCTURES**

Overhead and cantilever sign structures shall meet the handback performance requirements specified in Section 400.5.3.4 (Individual Component Requirements – Sign Structures) at the end of the Term.

**500.2.5 INDIVIDUAL COMPONENT REQUIREMENTS –
RETAINING WALLS**

Retaining wall structures shall meet the handback performance requirements specified in Section 400.5.3.2.15 (Wingwalls and Retaining Walls) and Section 400.5.3.2.22 (Other Bridge Structure Elements) at the end of the Term.

**500.3 ROADWAY HANDBACK REQUIREMENTS - EXISTING
INFRASTRUCTURE**

At the end of the Term, when the Department assumes responsibility for the Existing Infrastructure, the roadway shall meet or exceed the following requirements:

500.3.1 PAVEMENT SURFACE CONDITION

The pavement surface, including lanes and shoulders, shall be free of pitting, potholes, ravelling, scaling, delamination, localized roughness, localized deficiencies, and other deficiencies.

- All asphalt concrete pavement transverse and random cracks between 2 mm and 25 mm and all longitudinal cracks between 2 mm and 12 mm shall be routed and sealed. Transverse cracks greater than 25 mm and longitudinal cracks greater than 12 mm shall be spray patched.
- All Hydraulic cement concrete random cracks between 2 mm and 20 mm in width shall be sawn/routed and sealed, and sawn/routed cracks missing sealant shall be re-sealed.
- Areas of localized roughness shall be repaired. Localized roughness shall be any abrupt deviation in excess of 6 mm when measured with a 1.2 m straight edge.
- Roadway surface shall be clean and free of dirt, sand and other debris.
- All cracks shall be sealed with a sealant acceptable to the Department.

500.3.2 CONDITION OF ALL SIGNS

All signs on the Existing Infrastructure must be in-place and functioning as designed and shall meet or exceed the following:

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- Have an acceptable level of retroreflectivity. No signs shall exhibit reduced or blotchy retroreflectivity in excess of 25% of the sign area;
- Regulatory signs shall have a minimum retroreflectivity of 250 cd/lux/m² at an observation angle of 0.2° and a light entry angle of -4°;
- Information signs shall have a minimum retroreflectivity of 170 cd/lux/m² at an observation angle of 0.2° and a light entry angle of -4°;
- Signs shall exhibit no sign-sheeting material delaminations from the sign blank;
- Sign posts shall be maintained straight and true and shall not lean more than 25mm in 1m in any direction; and
- Signs shall be kept level, within 25mm in 1m, and properly orientated for the travelling public.

500.3.3 CONDITION OF GUARDRAIL

- All accident damaged guardrail on the Existing Infrastructure must be repaired or replaced and functioning as designed; and
- All guardrails shall be clean and any reflective markers shall be functioning as designed.

500.3.4 CONDITION OF BARRIERS

- All accident damaged barriers on the Existing Infrastructure must be repaired or replaced and functioning as designed; and
- All barriers shall be clean and any reflective markers shall be functioning as designed.

500.3.5 CONDITION OF LIGHTING

All lights/luminaires on the Existing Infrastructure must be installed and functioning as designed and meet or exceed the following:

- Accident damaged lighting system components must be repaired or replaced and be functioning as designed; and
- Each individual light/luminaire shall be operational, provide light output in accordance with the manufacturer's rated design parameters, and overall illumination in accordance with the Detailed Designs.

500.3.6 CONDITION OF TRAFFIC SIGNALS

All signal systems on the Existing Infrastructure must be functioning as designed and meet or exceed the following:

- All signal lights, including any crosswalk lights or advance warning devices, shall be fully functional;
- Traffic detection devices shall be fully functional;
- Time clocks in the traffic controllers shall be accurate matching Mountain Standard Time;

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- Electronics associated with signal operation shall be fully functional;
- Signal poles shall be straight and true and shall not lean more than 10 mm in 1 m in any direction; and
- Power supplies are protected and in good condition.

500.3.7 CONDITION OF THE DRAINAGE SYSTEM

All components of the drainage system on or related to the Existing Infrastructure must be functioning as designed. All ditches, culverts, storm sewers, manholes, inlet and outlet structures, stormwater management ponds and other appurtenances shall be fully operational and clear of any debris and accumulated material.

**500.3.8 CONDITION OF CONCRETE CURBS, GUTTERS,
SIDEWALKS, BARRIERS (NON-STRUCTURE RELATED)**

All concrete infrastructure on the Existing Infrastructure installed by the Contractor must be functioning as designed and meet or exceed the following:

- Broken, spalled or damaged concrete shall be replaced where required to restore functionality;
- Differential elevation at joints or cracks that exceeds 5 mm shall be repaired or replaced to remove the differential elevation and remove any tripping hazard;
- Concrete that is cracked in multiple locations within the same general area of a sidewalk or otherwise results in a discontinuity that may pose a tripping hazard or be a safety concern shall be removed and replaced; and
- Concrete surfaces that exhibit scaling and results in a rough surface texture shall be removed and replaced.

500.3.9 CONDITION OF LANDSCAPING

All landscaping on the Existing Infrastructure must be in place and functioning as designed and meet or exceed the following:

- Grass and/or weeds within the Road Right of Way shall not exceed 300 mm in height;
- No noxious weeds are present; and
- Seeded area shows no bare spots greater than 1 m² in size.

500.3.10 CONDITION OF FENCING

All fencing on the Existing Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All posts must be sound and vertical;
- All wires must be in place with no noticeable sag; and
- All gates must be in place and fully operational.

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500.3.11 CONDITION OF PAVEMENT MARKINGS

All pavement markings on the Existing Infrastructure must be installed and functioning as designed and meet or exceed the following:

- All pavement markings shall have a minimum retroreflectivity of 150 mcd/lux/m² based on a minimum of five discreet measurements in any area of concern;
- Nominal 100 mm wide markings shall be within a tolerance of 100 mm to 110 mm;
- Nominal 200 mm wide markings shall be within a tolerance of 200 to 210 mm;
- All direction dividing, lane dividing or continuity markings shall not exceed a maximum dimensional length deviation of +/- 100 mm for a specified 6.0 m or 3.0 m length of space;
- All markings shall be at the proper location in accordance with the designed markings and in no case shall vary from the design location by more than 100 mm; and
- All painted markings shall display the following:
 - No excessive (more than 10%) overspray;
 - No splattering of paint;
 - Clean definitive edges;
 - No more than five tracks per km; and
 - Uniform distribution of glass beads across the line.

500.3.12 CONDITION OF DELINEATORS

All delineators on the Existing Infrastructure shall be installed and functioning as designed and meet or exceed the following:

- Delineators shall exhibit a minimum retroreflectivity of 80% of the design value;
- Delineator guideposts shall be plumb within 13 mm throughout their length; and
- Delineators shall be within 5% of design height and not deviate from design locations by more than 50 mm.

**500.4 BRIDGE STRUCTURES HANDBACK REQUIREMENTS -
EXISTING INFRASTRUCTURE**

At the end of the Term, maintenance and operations responsibilities for the bridge structures shall be handed back to the Department. There are no handback requirements for bridge structures in the Existing Infrastructure at the end of the Term.