City of St. Albert
Municipal Engineering Standards

November 2021

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Overview: Intent/Use/Revision

1 General

All development within the City of St. Albert is to be designed and constructed in accordance with the Municipal Engineering Standards. The distinction between private property and public property is irrelevant to the adherence to the Municipal Engineering Standards. No variance from the Municipal Engineering Standards shall be permitted unless written approval of the City Engineer is obtained. To request a variance from the Municipal Engineering Standards, a Standards Deviation form (found in Appendix B) must be completed and submitted to the City Engineer for review. A written request for variance will be reviewed between November 15th and March 31st, avoiding active construction seasons. As such, a request received in the current calendar year will be considered for implementation into the following calendar year. The City of St. Albert authorized inspector will reject installations that do not adhere to the Municipal Engineering Standards.

Assessment of non-compliance with these standards will be up to the sole discretion of The City of St, Albert. Interpretation of these standards and their intent will default to The City of St. Albert and its representatives.

1.1 Guiding Documents

The Municipal Engineering Standards will reference the guiding principles found in the following documentation. Where there is a discrepancy between the guiding document and the Municipal Engineering standards, the consultant shall defer to the more stringent standard or specification for design. If this is not easily definable, then the Consultant shall defer to the appropriate St. Albert representative. The guiding documents include, but are not limited to, the following:

- Complete Streets Guidelines and Implementation Strategy, August 2018
- *Geometric Design Guide for Canadian Roads*, Transportation Association of Canada (TAC), latest edition.
- City of St. Albert Utility Master Plan, June 2014 Update.
- City of St. Albert Transportation Master Plan, 2015.
- *CAN/CSA Codes,* Canadian Standards Association, latest editions.
- *AASHTO Standards and Specifications,* American Association of State Highway and Transportation Officials, latest editions.
- *Annual Book of ASTM Standards,* American Society for Testing and Materials, latest edition.
- *AWWA/ANSI Standards,* American Water Works Association, latest edition.
- Most current and relevant versions of the *National Research Council Canada's* codes, including but not limited to the national building, fire, and energy codes.

- Standards and guidelines for municipal waterworks, wastewater and storm drainage systems, Alberta Environment and Parks, latest edition.

1.2 Definitions

1.2.1 General

.1 "As-Built" means a document that reflects the installed, fabricated, constructed, or commissioned condition of an item or project based on information provided by another party and not verified by the professional member. As-Built drawings document how a project was actually constructed in the field and identify variances from the initial design.

.2 "Change Authorization" means a written communication issued by the City Engineer authorizing a departure from these Standards in accordance with *Article 2.1.3* of these Standards.

.3 "City" shall refer to the City of St. Albert.

.4 "City Engineer" shall refer to the professional engineer, or designated representative, authorized by the City to authorize changes to these Standards.

.5 "City Representative" the person(s) designated by the General Manager of Planning and Engineering Services to act on behalf of the City.

.6 "City's Right to Stop Work" shall mean the City has the general and absolute right upon providing written notice to the contractor, to halt or terminate the work at any time.

.7 "Clearing" removal and proper disposal of exposed objectionable matter from an area. This may include but is not limited to trees, roots, grass, underbrush, rubble, any type of structures, etc.

.8 "Construction Completion Certificate (CCC)" the written acceptance certificate issued by the City acknowledging the completion of construction of a municipal improvement or facility. Once the CCC is issued, the maintenance period commences.

.9 "Consultant" shall mean the professional engineer responsible for the Design. Where applicable throughout these Standards, this term may refer to or include the Landscape Architect or the Developers designated representative.

.10 "Contractor" shall mean the person, firm, or corporation that undertakes the installation of municipal infrastructure on behalf of the Developer or the City.

.11 "Design" shall mean the designs, reports, studies, engineering drawings, technical specifications, and associated documents, including the execution and implementation of such, pertaining to a Development, Subdivision, facility(s), or other municipal improvement within the City of St. Albert.

.12 "Designated Flood Line" - The designated flood line is indicated on the maps in Schedule G of the Land Use Bylaw. The cross-sections provided on the maps in Schedule G are based on the Big Lake Basin Task Force: Floodplain Delineation for the City of St. Albert – Sturgeon River, Final Report of May 15, 2007 and Big Lake Basin Task Force: Floodplain Delineation for the City of St. Albert – Carrot Creek, Final Report of March 15, 2007; and have been taken perpendicular to the natural boundaries of the watercourses at their highest perpendicular points.

.13 “Developer” shall mean the person, firm, or corporation named within a Development Agreement, whether as the owner or an agent for the owner of the land included therein.

.14 “Development” means

a) an excavation or stockpile and the creation of either of them,

b) a building or an addition to or replacement or repair of a building and the construction or placing of any of them on, in, over or under land,

c) a change of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the use of the land or building, or

d) a change in the intensity of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the intensity of use of the land or building;

.15 “Engineering Drawings” shall mean the detailed engineering drawings and specifications prepared by the Consultant for a Subdivision that form part of a development agreement.

.16 “Existing Ground” constitutes the existing state of the ground at the onset of design.

.17 “Interim” shall be a term used to denote items which currently function within a transitionary phase. Thus an “interim” item is one that shall transition to a permanent condition at some specified time.

.18 “Inundation” shall refer to an overflow; a flood; a rising and spreading of water over grounds.

.19 “Lot” a portion of a subdivision or any other parcel of land intended as a unit for transfer of ownership, or lease to, or separate use of, another, or for development. The word “lot” includes, but is not limited to, “plot” or “parcel”.

.20 “Lot Area” the area contained within the property lines of a lot, excluding space within any street right-of-way but including the area of any easement.

.21 “Municipal Infrastructure” includes roads, utility works, landscaping, and other surface or underground improvements to be owned and/or operated by the City.

.22 “Municipal Reserve (MR)” shall mean land owned by the municipality for development of parks and school grounds in accordance with the Municipal Government Act. And are intended for active or passive park and recreation areas for the use of the public. Municipal reserve lands may not be sold, leased, or otherwise disposed of without removing the MR designation. Municipalities may remove the designation only after giving notice, holding a hearing and considering the views of those affected. The land may then be sold or used for any purpose. Proceeds from the disposal of municipal reserves may be used for park or recreation purposes only.

.23 “On Street Construction Permit” (OSCP) is a permit identifying intended construction details of location(s), contact(s), date(s) and scope of work and is required for any construction activity on City of St. Albert property or within the road right-of-way.

.24 “Original Ground” constitutes the state of the ground previous to any earthworks development.

.25 “Prime Contractor” is as defined by the Occupational Health and Safety Act – Alberta.

.26 “Public Utility Lot” means land required to be given under Division 8 of the Municipal Government Act for public utilities. Generally, lots reserved for public utilities;

.27 “Record Drawing” means a professional document prepared by the professional member to record design changes to an initial design for which he or she has accepted responsibility and which represents the final design of the project. Typically issued or retained as verification that on-site conditions are in accordance with the final design.

.28 “shall”, ‘should”, “may” The word “shall” denote a mandatory requirement. The word “should” or “may” denotes an optional or suggested recommendation.

.29 “Site Servicing Permit” (SSP) is required prior to any service connection to City water, sanitary or storm infrastructure. An approved SSP is required prior to construction. Fines will be enforced for construction occurring prior to permit approval.

.30 “Standards” refers to the latest version of these municipal engineering standards in their entire scope, as further defined in Article 1.3.2.

.31 “Subdivision” shall mean the particular subdivision stage of the development that is proposed for consideration as per the development agreement.

.32 “Temporary” shall be a term used to denote items that will function for some specified time and will then be removed or replaced. “Temporary” items do not transition into a permanent condition.

1.2.2 Landscaping

.1 “Arborist” shall mean a person who is versed in the art of arboriculture, including tree surgery, the prevention and cure of diseases and the control of insect pests. Arborists Shall have current certification by the International Society of Arboriculture (ISA).

.2 “Berm” A mound of earth used to buffer or screen a land use with landscaping.

.3 “Borrow Material” Includes topsoil, clay, silt, sand, gravel, and peat within the area of the Work.

.4 “Buffer” land area used to visibly separate one use from another through screening and distance.

.5 “Caliper” the diameter or thickness of the trunk of a nursery-grown tree as measured no less than 150 mm above the ground root flare level for trees with a caliper up to 100 mm.

.6 “Common Excavation” includes topsoil, clay, silt, sand, gravel, and peat within the area of the Work.

.7 “Coniferous” a plant with foliage that typically persists and remains green year-round, commonly known as evergreens.

.8 “Consultant” the consultant acting on behalf of the developer to coordinate the preparation of all engineering and landscape detailed design drawings including specifications as may be required as per these Standards.

.9 “Critical Root Zone” - an area on the ground around a tree that is within the drip line of a tree.

.10 “Deciduous” means a plant with foliage that is shed annually.

.11 “Developer Representative” - the developer, the landscape architect or person(s) designated by the developer who has the authority to approve or reject the contractor’s work, request inspections and have the authority to exchange other open space development information with City representatives.

.12 “Diameter Breast-Height (DBH)” - the standard measurement of tree size (for trees existing on site). The tree trunk is measured 1.4 m (4.5 feet) above ground. If the tree splits into multiple trunks below 1.4 m, measure the trunk at its most narrow point beneath a split.

.13 “Drip Line” a vertical line extending from the outermost branches of a tree to the ground.

.14 “Environmental Reserve (ER)” shall means lands dedicated to the municipality to be preserved in its natural state and the enhancement of the environment. Environmental reserve consists of swamps, gullies, coulees, natural drainage courses and areas subject to flooding, steep slopes and strips not less than 6 m in width at the edge of any lake, river, stream or other body of water in accordance with the Municipal Government Act.

.15 “Fill” - an earth structure built up by successive lifts of a specified material at specified densities.

.16 “Final Acceptance Certificate (FAC)” is the written acceptance certificate issued by the City for the municipal improvements, once all repairs, defects, and deficiencies have been completed and the Maintenance Period has expired. This certificate releases any further guarantee or maintenance responsibilities by the Developer for the local improvements specified in the certificate.

.17 “Intensive Use” shall means an area of high use such as trails, play equipment areas, spray parks, sports fields and other recreation facilities.

.18 “Land Disturbing Activity’ - any activity which may result in soil erosion from water or wind and the movement of sediments into waters or onto lands within the development zone, including but not limited to clearing, dredging, grading, excess transportation and filling of land but not including agriculture practices.

.19 “Landscape Architect” - the consultant acting on behalf of the developer or prime consultant to coordinate the preparation of all landscape drawings, inspection of all onsite work and coordinate with Planning and Engineering Services for the issuance of CCC’s and FAC’s.

.20 “Landscape Contractor” the accredited professionals retained by the developer to complete landscape development. Landscape contractor requirements include: reputable, experienced, have current membership in the Landscape Alberta Nursery Trades Association, have Certified Landscape Trade Journeymen and ISA-certified Arborists, ensures all work be done under the direction and supervision of a foreman with at least 5 years’ experience, ensures work conform to best management practices (BMP) and the Canadian Standards for Nursery Stock (Latest edition), ensures a Licensed Pesticide Applicator for noxious and prohibited noxious weed control as per the Alberta Weed Control Act & Regulations.

.21 “Landscape Development” shall mean all landscaping, or its protection, in public spaces or environmental reserve.

.22 "Maintenance" Shall mean maintenance, which is suitable to the time of year, soil conditions and weather condition of the plant material to ensure it is capable of sustaining healthy and vigorous growth.

.23 "Maintained Parks" shall mean parks that require ongoing maintenance such as grass cutting, irrigation, trash removal and regular maintenance.

.24 "Naturalization" a type of habitat restoration; the deliberate reintroduction of species that are native to a given area or are well adapted to the climate circumstance; activities that are intended to improve and enhance the natural environment. The biodiversity and ecosystem function of a naturalized ecosystem is lower compared to a reference habitat but higher compared to a reclaimed ecosystem.

.25 "Natural Area" an area of natural vegetation that is generally undisturbed, unmaintained, and is self-perpetuating. It includes not only trees, but also native shrubs, ground covers, wildflowers, vines, and grasses.

.26 "Open Spaces, Green Spaces or Public Open Spaces" shall mean any parcel of land retained as permanently vegetated land, which is set aside and designated as reserve for a public use.

.27 "Prepared Sub-grade" - the soil immediately beneath a pavement structure that has been prepared as specified for the construction of a pavement structure.

.28 "Recreation Amenities" shall include, but not limited to tennis courts, play structures or equipment, sports fields, outdoor ice rinks, spray parks, skate parks and trails.

.29 "Soil Volume" - adequate below-ground space for root development, nutrient availability, moisture, and anchorage.

.30 "Stormwater Management Facilities" shall mean to develop effective drainage systems that balance the objectives of maximizing drainage efficiency and minimizing adverse environmental impacts.

.31 "Temporary Protection" shall mean fencing, barricades, signage or other adequate means of protection for a particular area such as newly seeded or sodded areas, partially constructed play structures and existing plant material to be preserved.

.32 "Unsuitable Material" includes peat, roots, stumps, topsoil, frozen soil, garbage, or other material deemed unsuitable for fill by the City.

.33 "Weeds" shall mean all plants, and seeds, designated "Noxious" or "Prohibited Noxious" under the Weed Control Regulation of the Alberta Weed Control Act, latest edition.

1.3 Intent and Use of this Document

1.3.1 Intent

.1 The objective of these Standards is to provide a clear guiding framework for designers and developers in the design of municipal infrastructure in the City of St. Albert. These standards are intended to ensure that new municipal infrastructure is acceptable to the City with regard to overall quality, safety and environmental considerations, functionality, operation and maintenance requirements, and life cycle costs. The developer and consultant are responsible for ensuring that municipal infrastructure is designed and constructed to achieve the City's objectives in this regard.

1.3.2 Scope and Interpretation

.1 These Standards apply to the design and installation of all municipal infrastructure for capital projects and private development within the City of St. Albert.

.2 These Standards do not cover the design or installation of street lighting, ornamental lighting, power, gas, telephone and cable services. New development areas shall construct street lighting to the specifications outlined in the most current *Fortis Alberta Street Lighting Catalogue.*

.3 The Engineering Standard Drawings, as referred to in various sections, shall form an integral part of these Standards. Engineering Standard Drawings can be found in Appendix A of these Standards.

.4 The City reserves the right to make the final decision regarding the interpretation of the intent of these Standards.

.5 The designer shall abide by the standards outlined within this document. All construction shall abide by the specifications outlined within this document. Where development is anticipated to be surrounded by existing infrastructure, the City may allow new development to match the standards/specifications of the existing boundary.

1.3.3 Use of General Design Standards

.1 These Standards define the minimum acceptable requirements to be satisfied in the planning, design, and construction of municipal infrastructure within the City of St. Albert. More stringent planning, design, and/or construction criteria should be applied by the consultant as appropriate.

.2 The City's acceptance of the design covers only compliance of the design with respect to these Standards and is not a warranty of the design.

.3 Notwithstanding the requirements of these Standards, the Developer and Consultant shall remain fully responsible for the Design.

.4 Where a departure from these Standards might achieve a better design with regard to infrastructure quality, safety and environmental considerations, functionality, operation and maintenance requirements, or life cycle costs, the Consultant is encouraged to present a change proposal to the City in accordance with *Article 2.1.3* of this section.

.5 The City reserves the right to suspend construction activity due to inclement weather, inadequate construction, unsafe conditions, or any other reason deemed necessary by the City Engineer.

1.3.4 Statutory Requirements for Approvals by Other Authorities

.1 It is the responsibility of the designer to ensure the design conforms to all applicable statutes, laws, bylaws, regulations, ordinances, orders, directives, permits, licenses and requirements of governmental or other public authorities having jurisdiction, and all amendments thereto.

.2 Wherever the standards of other authorities are referred to in these Standards, the current edition of such standards shall apply.

.3 Where two or more applicable standards govern the design, the more restrictive shall apply.

2 Process

The following figure outlines the preferred sequencing of the development process within the City of St. Albert. The City holds the right to alter this sequencing on a project-by-project basis:

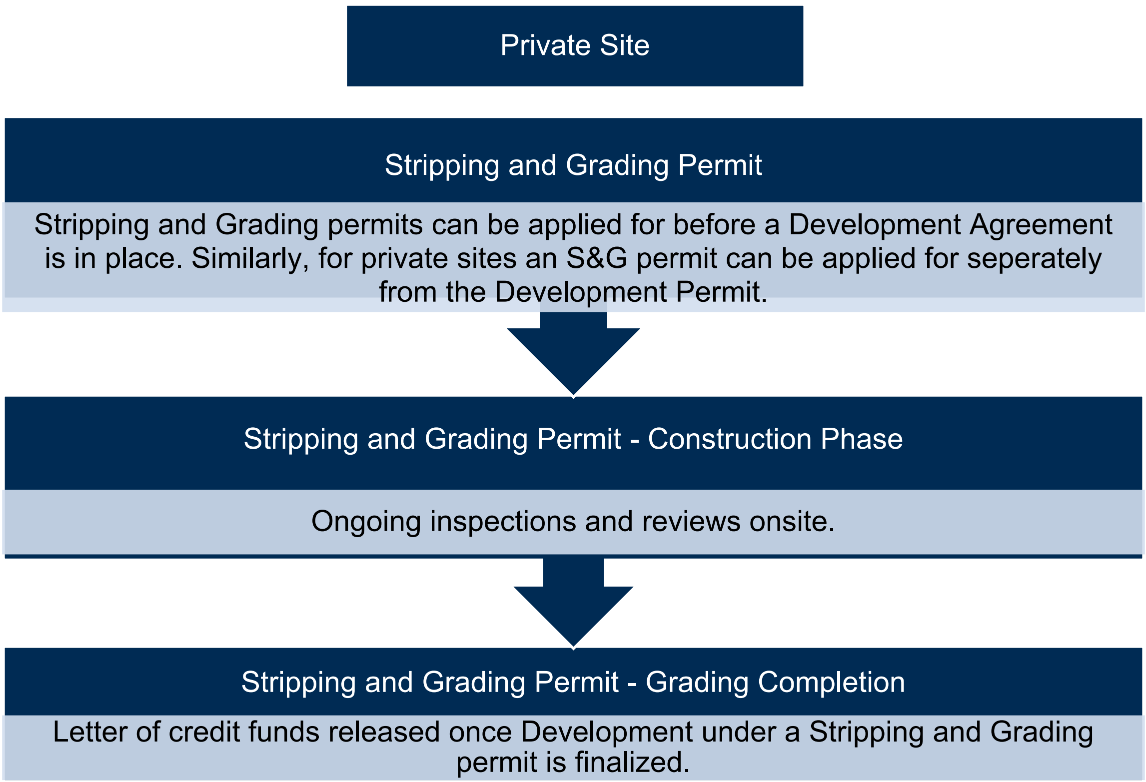


Figure 2.1: Stripping and Grading Permit Process

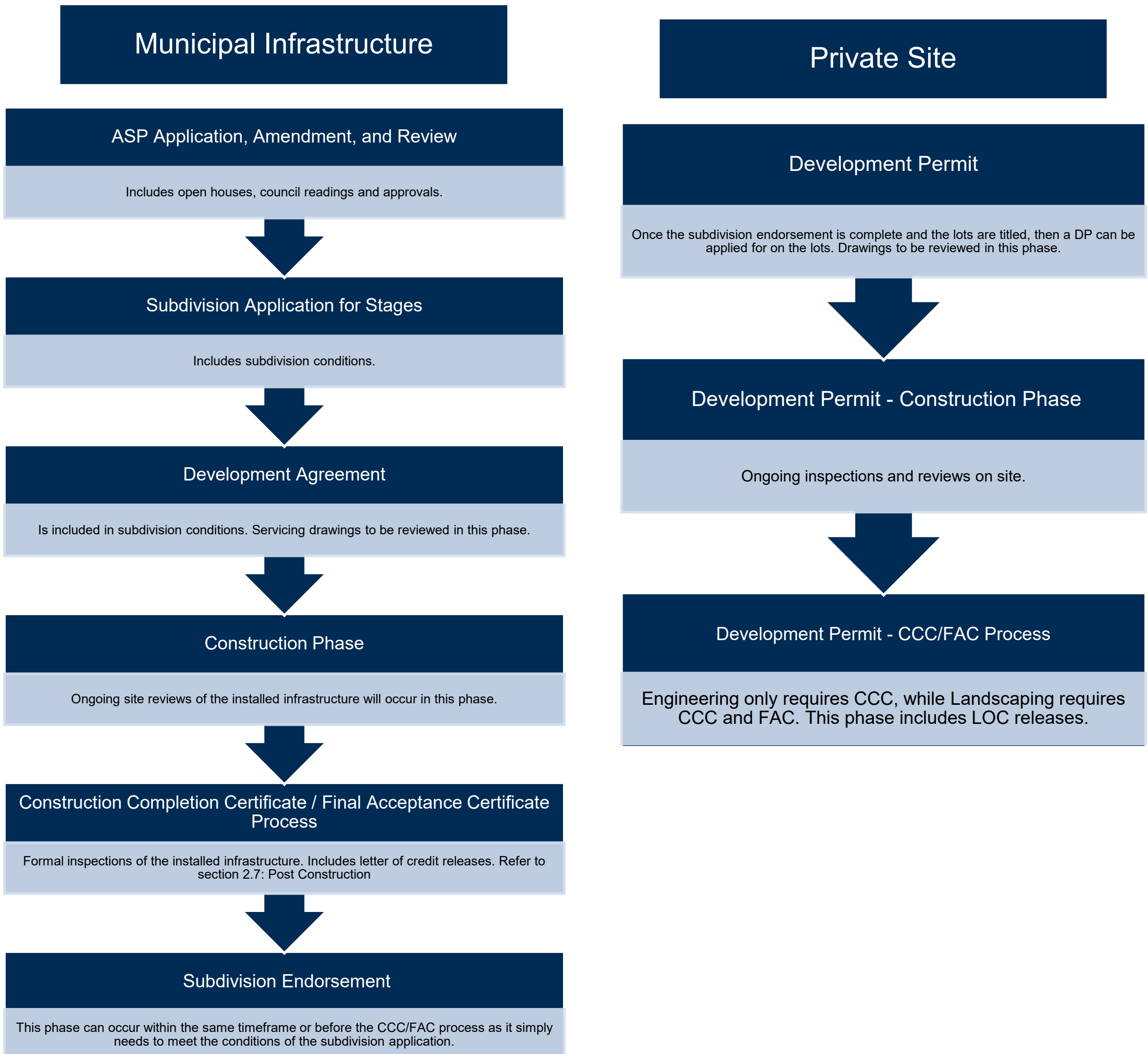


Figure 2.2: Subdivision Development Process

2.1 General Submission Processes Requirements

2.1.1 Introduction

The following standards apply to detailed design drawings submitted to the City for review as part of the Development Agreement application process (refer to *Article 2.3.1*), and to the as-built and record drawings for the completed Subdivision (refer to *Article 2.7.5*).

2.1.2 General

.1 Detailed design drawings shall provide a complete description of the existing and proposed infrastructure, provide sufficient information to construct the proposed infrastructure, and indicate any provisions for future extension of utilities and systems.

.2 All drawings shall include the following:

a) A suitable title which identifies the project;

b) Drawing scale;

c) North direction indicator;

d) Date of issue; and

.3 The title block must indicate the following information:

a) Developer's name;

b) Consultant's name;

c) Subdivision name and stage number;

d) Drawing name;

e) Drawing number;

f) Revision number (subsequent to approval);

g) Bar Scales (horizontal and vertical);

h) Table listing the name, signature, and signature date for the designer, drafter, checker, and approver;

i) Table listing the revision number, date, description, designer, and approver for all drawing revisions;

j) Table listing the dates for each of the various issues (i.e. preliminary, tender, construction, record drawing) of the drawing with the initials and date of the approver corresponding to each issue;

k) Professional stamps and permits, as applicable; and

l) A 10 cm wide by 1.5 cm tall space in the lower right hand corner of the drawing for the City's drawing number.

.4 Dimensions and measurements shall be in metric units.

.5 All elevations shall be referenced to geodetic datum.

.6 Lettering must clearly legible, 2 mm size or larger.

.7 Drawings shall be standard A-1 size (594 mm by 841 mm).

.8 Where drawing submissions to the City are required, in addition to the specified number of hardcopies, also provide the City with one (1) copy of the applicable drawings in AutoCAD-format and Portable Document Format (.pdf) electronic files.

2.1.3 Complete Streets Process

Applying the Complete Streets Lens

.1 Knowledge about the *Complete Streets* process for the development of the current road cross sections is important for the planning and design of existing streets. Starting with a blank slate is not possible for all street projects and in some cases St. Albert's existing streets will have to be retro-fitted to meet the needs of all users being considered. In these cases, understanding of the Complete Streets process will be even more vital because the street will require a unique design based on the design elements presented in *The Complete Streets Guidelines and Implementation Strategy* and these standards. The information below seeks to aid users of the Guide in applying the Complete Streets lens to the planning and design of the streets in St. Albert.

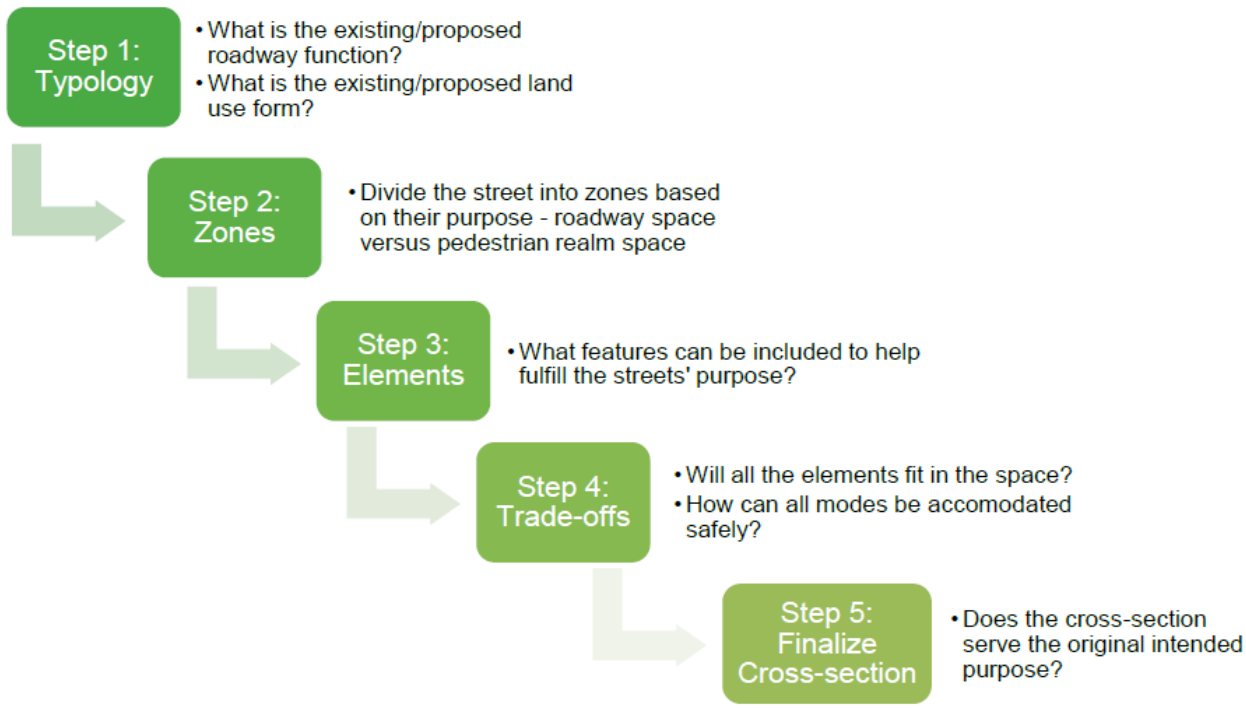


Figure 2.3

.2 For more information about the Complete Streets process and the development of the current cross sections please refer to the St. Albert Complete Streets Guidelines and Implementation Strategy document.

2.1.4 General Design Standards Variance Request Process

.1 Where the Designer is inclined to use a Design which differs from these Standards or which is not covered by these Standards, the Designer may apply to the City to review the Design.

.2 The City will review requests to revise these Standards, provided such requests are submitted using the Standards Deviation Form available upon request. The revision request process is described in more detail on the second page of the form.

.3 The City will review such change proposals on a case-by-case basis.

.4 The Designer must provide a detailed proposal describing the Design to the City for review. The proposal must be prepared, signed, and sealed by a professional engineer, landscape architect, architect, or other industry professional, as applicable to the Design.

.5 The proposal shall include sufficient detail regarding the proposed method or material to be used in the Design, including justification with respect to the impact on infrastructure quality, safety and environmental considerations, functionality, operation and maintenance requirements, and life cycle costs. The City may request additional information as required to make an informed decision regarding the proposed design.

.6 No departure from these Standards shall be permitted except with written authorization of the City Engineer. A change authorization shall be issued recording any such revision.

.7 A Change Authorization is only valid for the Development or Subdivision under consideration.

.8 Notwithstanding review and acceptance of any such proposal by the City Engineer, the Developer and Consultant shall remain fully responsible for the Design.

2.2 Planning

2.2.1 Planning and Development – Document Requirements

The following requirements supplement the City's Municipal Development Plan, as amended, and the applicable requirements and procedures of the Planning and Development Department for Area Structure Plans, as detailed in the City's *Terms of Reference for Area Structure Plan Technical Report*. These planning requirements must adhere to the standards specified in the other applicable sections of these Standards These technical reports may be requested at the discretion of the City for any new or amendment application for MDP, ASP, ARP, and LUB, or for a major development permit for a multi-family site. commercial or industrial development, to provide the following information regarding proposed municipal infrastructure:

.1 Refer to the latest edition of the City's Municipal Development Plan.

.2 The City withholds the right to request a declaration indicating all federal and provincial requirements have been met, including the capability to request proof of an Environmental Site Assessment for respective developments.

.3 The city reserves the right to request additional environmental report, when conditions warrant.

.4 The technical report may be required to include the following information regarding proposed municipal infrastructure under the City's planning and development documents:

a) Geotechnical Report

The geotechnical report for planning and development documents shall outline all lands included within the City's planning and development documents (such as an Area Structure Plan) and shall contain all required review and analysis to meet the requirements of the applicable articles of these Standards. An updated geotechnical report is required at every stage of development. The report shall include, but may not necessarily be limited to, the following information. The City reserves the right to request confirmation of historical data used therein and for the consulting Engineer to provide a letter confirming its validity. This letter must be provided for any Geotechnical reporting that is 10 years or older from the date of submission or at the City's request. The City also reserves the right to request supplementary geotechnical reporting at their discretion:

i) Map and legal description of all lands covered;

ii) Summary of the field drilling program;

iii) Summary of laboratory testing;

iv) Site description with details regarding the surface, subsurface, and groundwater conditions, and frost action;

v) Soil alkalinity and resistivity test results with recommendations regarding the type of concrete to be used and any corrosion protection that might be required;

vi) Identification of areas with high groundwater tables;

vii) Recommendations with respect to any geotechnical conditions in the area that impact design, construction, and/or maintenance of the proposed municipal infrastructure;

viii) Identification of areas requiring special design/construction considerations;

ix) Top of bank setbacks for areas adjacent to creeks, watercourses, or ravines. These must be reflected on the drawings and registered as caveats on applicable land titles.

b) Transportation Systems

i) Please refer to the City of St. Albert Transportation Impact Assessment (TIA) Guidelines, latest edition. The TIA Guidelines (most up to date) shall supplement these Municipal Engineering Standards as requirements and considerations as per the document.

ii) A Transportation Impact Assessment shall be completed by an experienced Professional Engineer qualified to conduct traffic operations engineering in the Province of Alberta. The final TIA report shall be sealed by a qualified Professional Engineer licensed to practice in Alberta. If there is a valid TIA in place a new one is not required.

iii) Applicants are advised to contact the City of St. Albert prior to beginning work on any Transportation Impact Assessment, to confirm details of required scope, content, and collect any background traffic information the City may be able to provide.

iv) Land use and expected trip generation of proposed development, trip distribution, and existing and forecasted levels of service;

v) Identify all public access points for all multi-family residential, commercial and industrial parcels. These parcels should have two (2) points of public access/frontage wherever possible. The intended form of traffic control shall be identified for each respective access.

vi) A Transportation Impact Assessment must be included for all developments that will:

1. Result in greater than 100 peak hour trips generated;
2. Propose a new driveway access directly connecting to an arterial (Crosstown/Connector) street;

3. Propose a new public roadway or a closure of any portion of an existing public roadway is proposed;
4. Propose a new school: elementary, secondary, post-secondary, or commercial school, community hall, indoor recreation centre, or stadium as defined in the Land Use Bylaw;
5. Have the potential to include a drive-through business or gas bar, as defined in the Land Use Bylaw; or,
6. Have the potential to create adverse operational or safety issues to any road user group.

vii) Conceptual plan showing the location of all roads, sidewalk, trails within the development;

viii) Classification of all proposed roads (i.e. Boulevard, Crosstown, Connector, Neighbourhood, Local, Lane);

ix) Identification of truck routes and dangerous goods routes;

x) Identification of all intersections with intended form of traffic control (Stop / Yield, Signalized, Roundabout);

1. Identify (from existing or forecasted levels of service) intersections to be signalized, as per the TIA;
2. Prior to any recommendations of traffic signals, the intersections shall be analyzed and proposed as alternative intersection designs (roundabouts).

xi) Assessment of any special crossing requirements for vehicular, rail, and pedestrian traffic;

xii) Discussion, description and details of proposed traffic calming measures or safety improvements to the development shall be provided.

xiii) Alignment of proposed pedestrian, bicycle corridors, circulation routes and other active modes of transportation. This includes multi-use trail systems.

xiv) Alignment of any proposed transit routes;

xv) Description of any impacts of the proposed development on existing infrastructure and any proposed measures intended to offset negative impacts on such existing infrastructure; and

xvi) Description of any noise impacts to the proposed development from arterial (crosstown/connector) roads and any proposed measures intended to mitigate such impacts.

The City may request additional analysis for planning and development documents featuring high traffic generation land uses and developments within areas of the city with limited capacity for increased traffic volumes.

c) Water Systems

i) Land use, expected peak demands, and fire flow requirements;

ii) Conceptual servicing plan showing the approximate location of major water mains, and any other significant water system facilities;

iii) Definition of the pressure zone to be used for the development with delineation of pressure zone limits where more than one pressure zone may apply to the development;

iv) Detailed description of the phasing of the development noting trigger points when water distribution facilities or upgrades shall be required; and

v) Description of any impacts of the proposed development on existing infrastructure and any proposed measures intended to offset negative impacts, including capacity limitations, on such existing infrastructure.

The City may request that the technical report include a computer network analysis for the proposed water system. *WaterCAD* is acceptable modeling software for design. Use of other programs must be pre-approved by the City.

d) Wastewater Collection Systems

i) Land use and sewage generation rates;

ii) Expected peak flows and design flows;

iii) Conceptual servicing plan showing the approximate location of major sewer mains, lift stations, and any other significant wastewater collection system infrastructure;

iv) Detailed description of the phasing of the development noting trigger points when wastewater facilities or upgrades shall be required; and

v) Description of any impacts of the proposed development on downstream infrastructure and any proposed measures intended to offset negative impacts, including capacity limitations, on such downstream infrastructure.

The City may request that the technical report include a computer analysis for the proposed wastewater collection system. *PCSWMM* is acceptable modeling software for design. Use of other programs must be pre-approved by the City.

e) Stormwater Management Systems

i) Definition of the general catchment areas;

ii) Pre-development peak runoff flows and volumes, including all inflow and outflow points in the area;

iii) Post-development rate is fixed at 2.5 L /sec/ha;

iv) Conceptual overland drainage plan illustrating flow routes and trapped low points within the proposed Development and clearly demonstrating the continuity of flow from upstream developments through the Development;

v) Conceptual servicing plan showing the approximate location of major sewer mains, stormwater management facilities, storm outfalls, and any other significant stormwater management system infrastructure including identification of access points;

vi) Approximate alignment of proposed trunk sewers;

vii) Approximate location of storm ponds and corresponding storage volumes;

viii) Proof of wetlands compensation shall be provided in accordance to the Wetland Restoration/Compensation Guide from Alberta Environment;

ix) Proposed connection locations to downstream major and minor drainage systems, including proposed release characteristics at each connection compared to pre-development characteristics;

x) If the site is near any river, creek, watercourse, or wetland, a plan of the floodplain and a letter providing recommendations to limit the risk of flooding must be included;

xi) Detailed description of the phasing of the development such that the identified peak release rates are not exceeded at any time. This should include trigger points at which various stormwater facilities or upgrades shall be required;

xii) Description of any impacts of the proposed development on downstream infrastructure and any proposed measures intended to offset negative impacts, including capacity limitations, on such downstream infrastructure; and

xiii) A map or detailed description of the major drainage system flow route from the development boundary to the major drainage system outlet. Such outlets are typically considered as the nearest water body or natural channel where storm runoff from the development would discharge.

The City may request that the technical report include a computer analysis for the proposed stormwater management system. *MIKE Urban* is acceptable modeling software for design. Use of other programs must be pre-approved by the City.

f) Lift-Stations and Associated Infrastructure

i) In addition to the items required for water, wastewater, and stormwater systems, the following is required to justify the use of lift-stations and Associated Infrastructure;

ii) Lifecycle analysis that will detail evidence supporting the estimated period before lift station infrastructure will require maintenance and/or upgrades.

iii) Cost benefit analysis that will outline future costs to the City for maintenance and upgrades during the lifecycle of the lift-station and its associated infrastructure.

The City reserves the right to request additional analysis for the justification of use of lift-stations.

g) Landscaping/Open Space Design

i) Location and route for any trail systems through the Development;

ii) Location and conceptual details of entryway features;

iii) Approximate location and details of any proposed fencing, berming retaining walls, decorative pavements, or other significant landscaping features that may reduce conflicts between residential and proposed new land use;

iv) Retention of existing vegetation;

v) Provision for future linkages with existing developments;

vi) Integration of land use with existing natural environment;

vii) Identify locations of proposed environmental reserve (ER) and/or municipal reserve (MR); and

viii) Identify concepts for integration of stormwater management facility with the open space plan. Considerations of MR credit to be concurrent with the MDP.

2.3 Development Agreement

2.3.1 Application Requirements

Development Agreement applications must include a Development Agreement Request Form complete with all necessary supporting documentation. A sample of the Development Agreement Request Form is attached in Appendix B-1. More information regarding the development agreement process as it relates to these Standards is provided on the form.

.1 The following information shall be provided with the Engineering Drawing Submission. If any of the following information has already been submitted prior as part of the ASP submission, resubmission is not required if the engineer provides an update that all information is still current an accurate.

a) Geotechnical Report

The geotechnical report for the subdivision shall contain all required review and analysis to meet the requirements of the applicable articles of these Standards. An updated Geotechnical review shall be completed for each location as specified in the Development Agreement. The City reserves the right to request confirmation of historical data used therein and for the consulting Engineer to provide a letter confirming its validity. This letter must be provided for any Geotechnical reporting that is 10 years or older from the date of submission or at the City's request. The City also reserves the right to request supplementary geotechnical reporting at their discretion. The following shall outline the minimum requirements of the report:

i) The report must be prepared by a qualified Geotechnical Engineer licensed to practice in Alberta;

ii) The report must outline the project description, scope and purpose of the investigation;

iii) The report must outline the site description and characteristics – including, but not limited to, descriptions of site geology and topography;

iv) The report must outline the site & laboratory investigation. This includes, but is not limited to;

1. Description of all field and laboratory testing performed;
2. Description of the equipment and procedure used in the investigation;
3. The types of soil and rock samples and the procedures used in their collection;

4. Summary of data and results (such as borehole logs) as collected through the investigation;

v) Analysis of field & laboratory test results and the Geotechnical Engineer's derived conclusions on soil conditions, groundwater conditions, geotechnical concerns, etc.;

vi) Geotechnical recommendation(s) with regard to site grading, foundations, retaining walls, slab-ongrade, construction procedures, concrete type, pavement design, weeping tile subdrains, testing and inspection during construction;

vii) Estimated weeping tile flow rates;

viii) Recommendations for pavement structure construction based on geotechnical conditions. This must include information regarding CBR values, design traffic loading volumes, and pavement design life; For ESALS design refer to the current issue of TAC standards; and

ix) Recommendations for stormwater management facility construction.

b) Stripping & Grading Permit

i) Erosion Sediment Control Report:

1. Report Text
2. Introduction
3. Site location and characteristics
4. Proposed development
5. Erosion and Sediment controls
6. Inspections and Maintenance
7. Closure
8. References
9. Appendix A- Project Figures
10. Topsoil strip plan – haul routes and stockpile details
11. Marginal material plan – retention areas, haul routes and stockpile details
12. Snake pit plan – as required
13. Cut fill plan
14. Compaction plan
15. Engineered Fill Plan (areas with >1m fill measured from stripped surface up to pre-grade surface)
16. Interim drainage (post strip plan)
17. Erosion and Sediment Control plan
18. Natural area protection plan – as required

ii) Drawing Submission:

1. Topsoil strip plan – haul routes and stockpile details
2. Marginal material plan – retention areas, haul routes and stockpile details
3. Cut fill plan
4. Compaction plan
5. Engineered Fill Plan (areas with >1m fill measured from stripped surface up to pre-grade surface)

6. Interim drainage (post strip plan)
7. Erosion and Sediment Control plan
8. Natural area protection plan – as required

c) Transportation System

i) Refer to the City of St. Albert Transportation Impact Assessment (TIA) Guidelines, latest edition. The TIA Guidelines shall supplement these Municipal Engineering Standards as requirements and considerations as per the document.

ii) Refer to the City of St. Albert *Complete Streets* Guidelines and Implementation Strategy (latest edition). These Guidelines shall supplement these Municipal Engineering Standards as requirements and considerations as per the document.

iii) A Transportation Impact Assessment shall be completed by an experienced Professional Engineer qualified to conduct traffic operations engineering in the Province of Alberta. The final TIA report shall be sealed by a qualified Professional Engineer licensed to practice in Alberta. If there is a valid TIA in place a new one is not required.

iv) Applicants are advised to contact the City of St. Albert prior to beginning work on any Transportation Impact Assessment, to confirm details of required scope, content, and collect any background traffic information the City may be able to provide.

v) Calculated trip generation rates and identification of the ultimate number of dwelling units served at each road link and intersection;

vi) Identification of truck routes and dangerous goods routes and description of any special measures in the Design to address these routes;

vii) Identification of all intersections and form of traffic control (Stop / Yield, signalized, roundabout).

1. Identify (from existing or forecasted levels of service) intersections to be signalized, as per the TIA;
2. Prior to any recommendations of traffic signals, the intersections shall be analyzed and proposed as alternative intersection designs (roundabouts).

viii) Description of any special crossing designs for vehicular, rail, wildlife, and pedestrian traffic;

ix) Traffic calming or improved pedestrian crossing design (i.e.: pedestrian curb extensions) shall be provided at all known or anticipated key crossing points such as Neighbourhood roadway trail – trail crossings, crossings at or in vicinity to park / school space, Neighbourhood to Neighbourhood intersections (if not a roundabout intersection design);

x) Discussion, description and details of proposed traffic calming measures or safety improvements to the development shall be provided.

xi) Identification and discussion of transit routes through the Subdivision;

xii) Description of any impacts of the Subdivision on existing infrastructure and any measures to be completed to offset the negative impacts on such existing infrastructure;

xiii) Description of the pavement design;

xiv) Description and details regarding any temporary roadways or accesses required for regular and emergency traffic during the construction and phasing of the development;

xv) Noise Impact Assessment, signed and sealed by a professional engineer, where applicable;

xvi) Description and details on any noise attenuation infrastructure;

xvii) Description of any special materials or methods required for construction; and

xviii) Description of quality control testing and inspection to be instituted during and following construction.

d) Water System

i) Population calculations;

ii) Average and peak demand calculations;

iii) Hydrant flow test results;

iv) Fire flow calculations and a water network analysis which demonstrates that necessary fire flows will be maintained throughout all stages of the Development;

v) Detailed hydraulic calculations;

vi) Description of pressure zone(s) and any required pressure reducing infrastructure;

vii) Criteria and results summaries for any computer simulation models;

viii) Pipe design calculations;

ix) Description of any special materials or methods required for construction; and

x) Description of quality control testing and inspection to be instituted during and following construction.

e) Wastewater Collection System

i) Population calculations;

ii) Average and peak flow calculations;

iii) Inflow/infiltration calculations;

iv) Detailed hydraulic calculations;

v) Description and details of any required lift stations and force mains;

vi) Criteria and results summaries from any computer simulation models;

vii) Pipe design calculations;

viii) Description of any special materials or methods required for construction; and

ix) Description of quality control testing and inspection to be instituted during and following construction.

f) Stormwater Management System

i) Design flow calculations for minor and major systems;

ii) Description of the stormwater management system demonstrating that peak release rates from the development are below defined limits;

iii) Detailed hydraulic calculations;

iv) Description and details of any required lift stations and force mains;

v) Criteria and results summaries from any computer simulation models;

vi) Pipe design calculations;

vii) Analysis of the capacity and characteristics of the downstream receiving drainage course and identification of any measures to be completed to prevent downstream flooding and/or for erosion and sediment control;

viii) Details and calculations for major system conveyance infrastructure;

ix) Expected flow depths and velocities for critical locations within the development's stormwater management system (i.e. major system conveyance infrastructure, inlets, outlets, overflows, and outfalls);

x) Description of lot grading and landscape design as related to the drainage plan;

xi) Details regarding any interim stormwater management system infrastructure and protective measures required, including sediment and erosion controls, during the construction and phasing of the Development;

xii) Detailed description of the design of any stormwater management facilities including details on extent, depth, volume, and duration of ponding in stormwater management facilities, orifice sizing, and trapped low points including a description of how the storage provided by such corresponds to the requirements of the drainage plan for the Development;

xiii) Stormwater quality control BMP infrastructure design calculations;

xiv) Storm outfall design details;

xv) Description of any special materials or methods required for construction; and

xvi) Description of quality control testing and inspection to be instituted during and following construction.

g) Open Space Design

i) Identify parks, schools and recreation facilities;

ii) Identify MR lands, ER lands, buffer strips, trails, pathways, walkways, sidewalk; and

iii) Consideration for recreation facilities.

.2 Erosion and Sediment Control Plan

a) An erosion and sediment control plan is required to define all procedures to be undertaken to control such during construction. Refer to the City of Edmonton Erosion and Sediment Control Guidelines and Field Manual for specific requirements (current Edition).

b) All water discharged, by gravity flow or pumping, to a watercourse or to storm sewer conveyance infrastructure must be filtered or treated in accordance with suitable best management practices (BMPs) prior to release.

c) The plan should detail the BMPs to be employed, including both temporary and permanent measures.

d) The Developer shall be responsible for ensuring the erosion and sediment control plan is fully implemented during construction.

2.3.2 Application Review Process

.1 The Development Agreement application, complete with all necessary supporting documentation, must be provided to the City for review upon conditional subdivision approval from subdivision approving authority.

.2 The Development Agreement will not be issued until all required submissions have been reviewed and accepted by the City.

.3 Incomplete submissions, submissions with excessive errors, or submissions lacking appropriate authentication or endorsement, as determined by the City, may be rejected and returned by the City without review.

.4 Review by the City is for the sole purpose of ascertaining conformance with the Municipal Engineering Standards (current edition). This review shall not constitute the City's approval of the Design, nor relieve the Designer of responsibility for errors or omissions in the submittal or of responsibility for meeting all requirements of the Standards.

.5 The Designer shall make any changes to the submission which the City may require, consistent with the Municipal Engineering Standards, and resubmit unless otherwise directed by the City. When resubmitting, the Designer shall notify the City in writing of any revisions made by the Designer other than those requested by the City, in the City's previous review. The time period for review by the City may be increased if multiple review cycles are required.

.6 The Developer shall not proceed with construction until the City has accepted the submission and executed a Development Agreement for the Subdivision.

2.3.3 Scope of Municipal Improvements

The following lists the municipal improvements that will generally be included on most Development Agreements. The most common improvements will be encompassed by this list and thus should abide by this standard nomenclature. If a development will include an improvement not covered within the following list, then the nomenclature and scope of that improvement will be agreed upon within the development agreement process:

.1 "The Underground"

a) Including water mains, hydrants, valves, sanitary and storm sewers, manholes, catch basins, service connections and any other related components.

.2 “Paved Roads, Monolithic Sidewalks, Curb and Gutter, Street Identification and Regulatory Traffic Signage”

a) The paved roads, monolithic sidewalks, curbs and gutters, road islands, all traffic signs, street signs, subdivision identification signs, traffic control devices and other related components.

.3 “Separate Sidewalks”

a) The separate sidewalks, bus pads and other related components.

.4 “Laneways”

a) The paved laneways (alleys).

.5 “The Electrical Distribution System”

a) The electrical distribution servicing facilities including primary cable, the transformers, all secondary conductors, power bases and pedestals, switching or service cubicles, service connections, the street and walkway lighting system, all secondary conductors, luminaires, controllers, bases, poles, and other related components.

b) Note: this improvement will undergo only CCC.

.6 “Shared Use Paths”

a) Asphalt shared use paths / multi-use trails.

.7 “Walkways” (Note: confirm which type of walkway is included. i.e. asphalt, concrete or both.)

a) The asphalt walkways / The concrete walkways / the asphalt and concrete walkways.

.8 “The Subdivision Landscaping”

a) The boulevards, walkways, TOB and road island landscaping excluding the “Local Boulevard Landscaping.”

.9 “Local Boulevard Landscaping”

a) The boulevard landscaping within local road rights-of-way, which will include activities such as grading, installation of sod or seed, and planting of trees.

.10 “Landscaping Amenities”

a) The landscaping amenities and other related components.

.11 “Fencing”

a) The fencing. The fencing must be constructed so that it is located inside the property lines of the individual lots created upon registration of the plan of subdivision for the development lands.

.12 “Noise Attenuation Fencing”

a) The noise attenuation fencing and berms. The noise attenuation fencing must be constructed so that it is located inside the property lines of the individual lots created upon registration of the plan of subdivision for the development lands.

.13 "Grass Drainage Swales"

a) The grass drainage swales.

.14 "Concrete Drainage Swales"

a) The concrete drainage swales.

.15 "The Offsite Underground"

a) Note: the scope of this improvement will be as described by the consulting engineer and agreed upon by the City during the development agreement process.

.16 "Commercial / Industrial Improvements" (Note: details to be confirmed by consultant)

a) All surface improvements onsite, underground improvements onsite, surface and underground improvements offsite (scope as defined in the development agreement), surface restoration and all onsite landscaping.

.17 "Pavement Markings"

a) All pavement and traffic control markings/paint lines.

.18 "Temporary Improvements"

a) Note: the scope of this improvement will be as described by the consulting engineer and agreed upon by the City during the development agreement process.

.19 "The Storm Water Management Facility"

a) The storm water management facility and all appurtenances thereto.

.20 Any other improvements which may be shown on local improvement plans,

.21 Any other local improvements not listed above but required by the City Engineer.

.22 Any other local improvements required by Subdivision Authority, Development Authority, a Development Officer, or the Subdivision and Development Appeal Board.

2.3.4 Design Revisions After a Development Agreement is Issued

.1 If, for any reason, it becomes necessary to revise the Design after the Development Agreement has been issued, the Designer shall obtain the City's acceptance of such revision prior to construction proceeding in accordance with the revision.

.2 Construction of the proposed revision shall not proceed until the City has issued written acceptance of the revision.

2.4 Submission Standards

2.4.1 Required Drawings

The following drawings are required and shall include the information specified:

.1 Cover Sheet

a) The cover sheet shall identify the subdivision name and stage number and/or development name, Developer's name, Consultant's name, and the City of St. Albert.

b) A key plan of the City of St. Albert will be included and will clearly indicate the location of the overall development and identify the location of the subdivision stage.

.2 Legend and Abbreviations Sheet

a) This drawing shall indicate and define all symbols and abbreviations used in the drawings. It shall also include a subdivision level plan of project site in relation to localized context within greater development. Alternatively, the City may authorize use of legends on individual drawings, as required.

.3 Index and Legal Plan

a) This plan drawing shall delineate the coverage of each plan/profile drawing covering the Subdivision for the drawing set.

b) This plan drawing shall illustrate all legal and easement information for the site, including restrictive covenants.

c) The plan shall indicate the proposed land uses for the site and identify any fill conditions.

.4 Water System, Wastewater Collection System, and Stormwater Management System Infrastructure Overall Plan

a) Site servicing designs that propose utility servicing underneath buildings will not be accepted. The onus is on the design engineer to prove that all other design alternatives are not possible.

b) With respect to the water system, this plan shall include the following:

i) Alignment, diameter, and material of all water mains;

ii) Location of all valves, hydrants, and other appurtenances;

iii) Location of potential future extensions; and

iv) Dimensions.

c) With respect to the wastewater collection system, this plan shall include the following:

i) Alignment, diameter, grade, pipe material, and direction of flow of all sewer mains;

ii) Location of all manholes and other appurtenances;

iii) Location of potential future extensions.

d) Tables summarizing design calculations for the wastewater collection system in residential areas shall list the following information for each sewer main. Tables may be included on a separate plan if required:

i) Sewer main identification number;

ii) Upstream and downstream manhole identification numbers;

iii) Upstream and downstream manhole rim and invert elevations;

iv) Incremental number of lots directly served by sewer main;

v) Cumulative number of lots served by sewer main (i.e. upstream number of lots served plus incremental number of lots);

vi) Population density per lot (capita/lot);

vii) Incremental population directly served by sewer main;

viii) Cumulative population served by sewer main (i.e. upstream population served plus incremental population);

ix) Peaking factor;

x) Design domestic flow rate (m3/s);

xi) Incremental area directly served by sewer main (ha);

xii) Cumulative area served by sewer main (i.e. upstream sewer main area plus incremental drainage area, in ha);

xiii) Inflow rate (m3/s), Infiltration rate (m3/s) or combination thereof;

xiv) Design flow rate (m3/s);

xv) Pipe size (mm);

xvi) Pipe grade (%);

xvii) Pipe length (m);

xviii) Pipe capacity (m3/s); and

xix) Flow velocity (m/s).

Separate tables may be provided to describe interim and ultimate conditions where staging of the development will occur and impose distinct conditions on the proposed wastewater collection system. At the request of the City. Alternative servicing and identification of projected future loading to be shown as requested by the City.

e) With respect to the stormwater management system, this plan shall include the following:

i) Alignment, diameter, grade, pipe material, and direction of flow of all sewer mains;

ii) Location of all manholes, catch basins, and other appurtenances;

iii) Alignment, diameter, and direction of flow of all foundation drain discharge collection sewers with the location of cleanouts;

iv) Location of all stormwater management facilities including all applicable information regarding normal water levels, high water levels, storage volumes, freeboards, pond bottom elevations, side slopes, contributing basin size inlet and outlet elevations and locations, overflow elevations and locations;

v) Location of potential future extensions;

vi) Notation indicating the lowest allowable building opening elevation for lots adjacent to stormwater management facilities; and

f) Tables summarizing design calculations for the stormwater management system shall list the following information for each sewer main. Tables may be included on a separate plan if required:

i) Sewer main identification number;

ii) Upstream and downstream manhole identification numbers;

iii) Upstream and downstream manhole rim and invert elevations;

iv) Incremental drainage area directly served by sewer main (ha);

v) Cumulative drainage area served by sewer main (i.e. upstream sewer main drainage area plus incremental drainage area, in ha);

vi) Runoff coefficient, C, for drainage area directly served by sewer main;

vii) Incremental drainage area multiplied by the runoff coefficient for drainage area directly served by sewer main;

viii) Cumulative total of runoff coefficient multiplied by drainage area (i.e. upstream sewer main calculation plus incremental calculation);

ix) Inlet time (min);

x) Travel time (min);

xi) Rainfall intensity (mm/hr);

xii) Calculated design flow (m3/s);

xiii) Pipe size (mm);

xiv) Pipe grade (%);

xv) Pipe length (m);

xvi) Pipe capacity (m3/s); and

xvii) Flow velocity (m/s).

Separate tables may be provided to describe interim and ultimate conditions where staging of the development will occur and impose distinct conditions on the proposed stormwater management system. At the request of the City. Alternative servicing and identification of projected future loading to be shown as requested by the City.

g) Tables summarizing design calculations for the stormwater management system shall list the following information for each catch basin and lead. Tables may be included on separate plan if required:

i) Catch basin identification number;

ii) Street name;

iii) Frame type;

iv) Depth of flow (mm);

v) Lead diameter (mm);

vi) Lead slope (%);

vii) Design flow rate (m3/s);

viii) Catch basin capacity (m3/s); and

ix) Lead capacity (m3/s).

.5 Road and Walkway Overall Plan

a) This plan drawing shall illustrate the location of all road rights-of-way, lanes, boulevards, sidewalks, trails, walkways, and emergency access including interim conditions.

b) Identify light duty and heavy duty pavement including but not limited to asphalt or concrete areas.

c) Identification of road right-of-way names or temporary designations.

d) Alignments and dimensions of adjacent roads, lanes, boulevards, and walkways including identification by names or designations.

e) Alignments and locations of existing and proposed surface infrastructure including curb, gutter, sidewalk, sidewalk connectors, curb ramps, bus stop pads, Fortis Improvements, street lights, driveways, hydrants, manholes, bollards, catch basins, asphalt tie-ins , turnarounds, and any other surface structures.

f) The location of potential future extensions shall be identified.

.6 Traffic Control Plan

a) Signage plan identifying street names, regulatory signs, transit pads and transit pad location signs, details, sign placement, and any required temporary or permanent thermoplastic lane markings.

b) Identify traffic calming components.

.7 Stormwater Drainage Basin Overall Plan

a) This plan shall illustrate the stormwater drainage basin within which the overall development, defined by the Area Structure Plan, is located.

b) The limits of the drainage basin shall be clearly delineated.

c) The location and identification of the Subdivision shall be indicated.

d) The alignment of any existing or proposed trunk sewer mains within the drainage basin shall be shown, along with their respective pipe diameters.

e) Stormwater catchment areas shall be delineated within the Subdivision.

f) Existing and proposed stormwater management facilities, and overflow areas within the drainage basin shall be located and identified.

~~g)~~ Major drainage routes through the drainage basin, along with any receiving drainage courses, shall be illustrated and identified. The plan shall include a schematic diagram outlining the overall stormwater stage basin. The schematic must include major trunk alignments and overall neighborhood catchments.

h) Where major system flows shall discharge or overflow into watercourse, ravine, or environmental reserve, the rate and projected frequency of the flows shall be noted on the plan.

i) Delineation, identification, and area of all local drainage areas contributing drainage to the proposed stormwater management system

.8 Wastewater Drainage Basin Overall Plan

a) This plan shall illustrate the wastewater drainage basin within which the overall development, defined by the Area Structure Plan, is located.

b) The limits of the drainage basin shall be clearly delineated.

c) The location and identification of the Subdivision shall be indicated.

d) The alignment of any existing or proposed trunk sewer mains within the drainage basin shall be shown, along with their respective pipe diameters.

e) Wastewater catchment areas shall be delineated within the Subdivision.

f) The plan shall include a schematic diagram outlining the overall wastewater stage basin. The schematic must include major trunk alignments and overall neighborhood catchments.

g) Delineation, identification, and area of all local drainage areas contributing drainage to the proposed wastewater collection system; and

.9 Lot Grading Overall Plan

a) The plan shall include, at a minimum;

i) The existing surface contours starting at 10metres outside the development boundary and throughout the site;

ii) The proposed lot perimeter elevations in relation to current existing ground elevations, including transition zones with elevation changes of 0.5m or greater.

iii) Clear demonstration that the lot grading design contains surface drainage within the bounds of the property.

- Single family residential lots shall convey site drainage to public property without adversely affecting adjacent property.
- Multi-family and commercial lots shall collect all site drainage into an on-site stormwater management system. The major overland flow from this on-site system shall be directed to public property, not adjacent property.

iv) The proposed finished grades;

v) The anticipated/proposed building main floor elevation for private site development;

vi) Storage areas, ponding depths, overflow locations; and

vii) The proposed curb line grades.

b) Provide existing spot elevations along development boundaries at 10m intervals. These boundary elevations are to be maintained as part of the overall grading design plan.

c) This plan shall indicate the proposed finished surface elevations at lot corners, the proposed direction of flow of surface drainage on each lot.

d) The plan shall indicate the proposed finished grades of roadways and other surfaces within the Subdivision with arrows indicating direction of overland flow.

e) The location of any geodetic benchmarks to be used in the construction of the project shall be identified.

f) Existing surface contours shown at 0.5 m intervals.

g) The geotechnical report should be referenced for builders to consult in the design/construction of building foundations, weeping tiles, and foundation drain discharge systems. The minimum recommendations of the Geotechnical report shall be incorporated into the design.

h) Notes should be included which indicate to builders the requirements with respect to roof leader discharges and foundation drainage, cross-referenced to the applicable detail for stormwater discharge piping. The plan shall indicate the intentions for the roof top drainage conveyance and downspout location design.

i) The plan shall include typical three-dimensional details of the various lot grading types with a depiction of the house, required slopes around the house, and lot grades. Each lot on the plan shall be labeled to identify the applicable detail corresponding to the proposed lot grading type for that lot.

j) Lots requiring greater than 1.0 m of fill from original ground contours (predevelopment) to meet the proposed grades should be clearly indicated on the plan.

k) Where the use of swales has been accepted by the City, the plan shall indicate the locations, easement requirements, slopes, cross-sections, and construction details for the swales. Additional spot grades shall be provided at the boundary of the easement, at the midpoint of the swale or at other appropriate locations depending on the swale length, and at the property line. Concrete swales are only permissible with written permission from the City Engineer.

l) The plan must clearly convey any restrictions with respect to building design and lot grading. Building foundation elevation restrictions for lots adjacent to a stormwater management facility is one example of this.

m) Any easements or restrictive covenants related to the stormwater management system must be shown and identified on the plan.

n) Where more than one sheet is required for the lot grading plan, each sheet shall include the typical details and notes which apply.

o) Where concrete swales are required, the channel capacity analysis is required to verify the conveyance of a 1:5 year storm event within the concrete swale and 1:100 year storm even within the bounds of the easement from the contributing area.

.10 Erosion and Sedimentation Control (ESC) Plan

a) This plan shall identify all erosion and sedimentation control strategies in the development.

b) ESC measures including, but not limited to, silt fencing, catch basin socks, and sediment retention basins must be identified on the plans and include detail drawings.

c) Existing roads to be monitored daily for cleaning must be identified on the plan.

d) This plan shall be included as part of the Environmental Construction Operations (ECO) plan, as outlined in the City's ECO Plan Framework and will outline processes and procedures to be undertaken to manage environmental liabilities.

e) Note that field conditions may dictate ESC measures beyond what is reflected within the plans. ESC measures are thus to be reviewed in the field.

.11 Power and Telecommunications Plan

a) This plan shall indicate the alignments for power, telephone, cable television and all other telecommunications lines.

b) The location of any surface features related to these utilities (i.e. light standards, transformers, boxes, etc.) must be clearly identified.

c) The location of any surface features which may conflict with the arrangement of these utilities (i.e. driveways, hydrants, curb valves, manholes, catch basins, street furniture, etc.) must be illustrated.

d) Applicable utility company approvals must be shown on the plan or otherwise accompany the drawing submission.

.12 Gas Plan

a) This plan shall indicate the alignments for gas lines.

b) The location of any surface features related to this utility must be clearly identified.

c) The location of any surface features which may conflict with the arrangement of these utilities (i.e. driveways, hydrants, curb valves, manholes, catch basins, street furniture, etc.) must be illustrated.

d) Applicable utility company approvals must be shown on the plan or otherwise accompany the drawing submission.

.13 Landscaping Plans

a) Landscaping plans shall include the following:

i) Location of any commercial, institutional, industrial, and multi-family within the Subdivision;

ii) Locations of driveways;

iii) Location of street furniture;

iv) Location of underground structures and storm sewer lines;

v) Location of swales and drainage routes;

vi) Location of curbs and boulevards;

vii) Location of public sidewalks;

viii) Location of private approaches;

ix) Location of parking areas;

x) Location of proposed retaining walls;

xi) Proposed location of boulevard trees;

xii) Planting schedules, including botanical and common name of all proposed plant material, total quantity of each plant on public and private property, height and/or spread of each shrub or perennial at the time of installation, minimum caliper size of each tree at the time of installation. Drawings should include 75% maturity tree spread, not to extend onto private property;

xiii) Notes regarding root ball type and size, tree branching heights for boulevard trees, special conditions, or unique installation criteria;

xiv) Identification of existing vegetation, trees and/or other natural features to remain in place;

xv) Outline of planting beds and tree wells, including the type and depth of mulch;

xvi) Location of anticipated irrigation systems;

xvii) Details of hard and soft landscape installations;

xviii) Identification of existing plant material that will be retained;

xix) Identification of existing trees to be relocated;

xx) Identification of areas to be sodded and seeded, with the applicable seed mix specified;

xxi) Proposed mowed and non-mowed areas;

xxii) Location of proposed site amenities and fencing, with construction details and elevations;

xxiii) Location of trails with details, signage, and proposed drainage;

xxiv) Total measurements (in m2) of shrub beds, flower beds, islands, buffers, PULs, MRs, ERs, SWMFs, and parks;

xxv) Total measurements (in m2) of proposed seeded and sodded areas, and existing vegetation;

xxvi) Provide a breakdown of private and public landscaping; and

xxvii) Any other details that may relate to the final landscape design.

b) The plan shall identify the following areas:

i) Preservation Areas (ER);

1. Preservation areas are portions of parks, which are to remain in the natural condition;

ii) Naturalization Zones;

1. Naturalization zones are portions of parks, which are proposed for reclamation to as natural a state as possible. They include manicured areas and/or disturbed or partially disturbed natural areas;

iii) Manicured Zones;

1. Manicured areas are portions of parks that have defined ‘special use areas. They imply some development as identified in the minimum standards and maintenance that is relatively intense compared to preservation and naturalization areas. Manicured areas include areas where larger numbers of park users are anticipated; i.e. sports fields, playgrounds, community uses; and
2. Existing Environmentally Sensitive Areas, Historical Areas, Wetlands, Vacant Farmsteads, existing water bodies and wildlife corridor.

c) This plan shall indicate the location of all street furniture including, but not necessarily limited to, signage (including identification of type), hydrants, bollards, light standards, power transformers, telephone boxes, cable boxes, mail boxes, bus shelters, benches, garbage cans, manhole covers, valve covers, playgrounds, trails, trees, retaining walls, picnic tables, bike racks and fencing.

d) The plan shall include proposed elevations to the bottom rail of all developer fencing.

e) The plan shall indicate the permitted driveway locations for each lot. A standard detail drawing shall be included that illustrates the allowable offset from the adjacent property line.

f) The plan should also illustrate sight triangles for all intersections.

g) This plan shall be in accordance with the setbacks specified in these Municipal Engineering Standards.

h) The landscaping plan shall be prepared, signed, and sealed by a landscape architect licensed to practice in the Province of Alberta by the Alberta Association of Landscape Architects.

.14 Plan and Profile Drawings

Plan and profile drawings shall meet the following requirements:

a) General

i) Plan and profile drawings shall be drawn to a scale of 1:500 horizontal and 1:50 vertical;

ii) There must be a clear delineation between proposed and existing features; and

iii) The drawings must show the location and identification of existing and proposed survey markers in the area.

iv) Plan and profile drawings must be provided for roads, alleys, walkways, onsite and offsite utilities including, but not limited to, temporary infrastructure, or any other structures deemed necessary by the City Engineer. Profiles are not required for SWMF walkways.

b) Road Right-of-Way Information

The following information must be included on the plan portion of the drawing:

i) Legal subdivision information including block and lot numbering;

ii) Alignment of proposed road right-of-way or easement including name or temporary designation;

iii) Alignments of adjacent roads, walks, lanes, interim connections, utility rights-of-way, easements, and reserves including identification by name or ownership;

iv) Existing and proposed surface infrastructure including curb, gutter, sidewalk, sidewalk connectors, trails, curb ramps, bus stop pads, and boulevard area;

v) Dimension of right-of-way width measured relative to adjacent property lines;

vi) Dimensioned measurements of curb, gutter, sidewalk, and boulevard locations;

vii) Horizontal curve data for the centreline of each roadway including chainages of the beginning-of-curve (BC), end-of-curve (EC), delta angle, radius, chord length, and arc length. The radius of curb returns must be indicated. This information may be listed in table-format;

viii) Elevations, along the curb and gutter, of all changes in vertical alignment; and

ix) Elevations of the BC and EC for all curb returns including the grades and chainage around the curve.

The following information must be included on the profile portion of the drawing:

x) Existing or Original ground profile along the centreline of the proposed roadway or utility with proper labeling as such;

xi) Proposed lip of gutter profile with grade expressed in percentage, accurate to two decimal places;

xii) Vertical curve data including chainages and elevations for beginning-of-vertical-curve (BVC), end-of-vertical-curve (EVC), point-of-vertical-intersection (PVI), external value (e), length of curve, elevation and chainage of the low point of sag curves and high point of crest curves, and rate of gradient change (k value); and

xiii) Lip of gutter grade at all intersecting proposed and existing roads.

c) Water System Information

The following information must be included on the plan portion of the drawing:

i) Horizontal alignment of proposed water mains with dimensioned measurements locating each from adjacent property lines;

ii) Diameter of water mains;

iii) Location of all related appurtenances including hydrants, tees, bends, crosses, valves (use different symbols for gate valves and butterfly valves), blow offs, and plugs; and

iv) Location of all service connections and curb valves, with dimensioned measurements locating each individual service lateral from the property lot corner along with the service pipe invert elevation at the property line.

The following information must be included on the profile portion of the drawing:

v) Vertical alignment of proposed water mains within the profile alignment;

vi) Elevation, diameter, and utility type of existing and proposed utilities which cross or intersect the profile;

vii) Top-of-pipe elevation at all tees, bends, crosses, plugs, and grade changes;

viii) Pipe diameter, pipe type, pipe class, and bedding class;

ix) Description of tie-in points of the proposed system to the existing system; and

x) Identification of areas requiring special construction methods such as trenchless installation methods, shored construction, casings, or limited working space areas.

d) Wastewater Collection System and Stormwater Management System Information

The following information must be included on the plan portion of the drawing:

i) Horizontal alignment of proposed sewer mains and foundation drain discharge collection sewers, with dimensioned measurements locating each from adjacent property lines;

ii) Diameter and direction of flow of sewer mains and foundation drain discharge collection sewers;

iii) Location of all related appurtenances including manholes, catch basins (including frame and cover type, elevation at gutter), plugs, cleanouts, inlet structures, and outlet structures;

iv) Sequential identification numbering of all mains, manholes, and catch basins. The City shall provide revised identification numbers for updating the record drawings;

v) Horizontal alignment, diameter, grade (in percentage, accurate to two decimal places), pipe type, pipe class, and length of all catch basin leads. Much of this information may be listed in table-format;

vi) Radii of curved sewers; and

vii) Location of all service connections with dimensioned measurements locating each individual service lateral from the property lot corner along with the service pipe invert elevation at the property line.

The following information must be included on the profile portion of the drawing:

viii) Vertical alignment of proposed sewer mains and foundation drain discharge collection sewers within the profile alignment;

ix) Elevation, diameter, and utility type of existing and proposed utilities which cross or intersect the profile;

x) Diameter, grade (in percentage, accurate to two decimal places), pipe type, pipe class, bedding class, and length of sewer mains between each manhole;

xi) Invert elevation of all pipes at each manhole;

xii) Rim and slab top elevation at each manhole;

xiii) Calculated design flow rate, design flow velocity, and total flow capacity for each section of sewer main. This information may be listed in table-format;

xiv) Description of tie-in points of the proposed system to the existing system;

xv) Identification of areas requiring special construction methods such as trenchless installation methods, shored construction, casings, or limited working space areas;

xvi) Chainage of BC and EC, radii, and curve length for curved sewers;

xvii) Identification of any unique manhole features including drop structures and safety platforms; and

xviii) Locations of riser connections to the sewer mains.

.15 Stormwater Management Facility Overall Plan

a) This plan shall illustrate cross sections and details for any stormwater management facility (SWMF) constructed as part of the development;

b) The cross sections shall label the bottom of lake/pond, normal water level, high water level, 1:5, 1:25, and freeboard with elevations;

c) The cross sections shall label the SWMF side slopes and the original ground profiles;

d) The details shall include, but are not limited to, stage-volume, stage-area, and stage-drawdown curves for all stormwater management facilities. Details illustrating all relevant SWMF structures must be included as well.

e) The plan shall illustrate the 1:5 and 1:25 stormwater levels within the SWMF respectively.

f) The plan shall illustrate normal water level (NWL), high water level (HWL), freeboard (FB), safety ledge, side slopes between FB-HWL, HWL-NWL, NWL-safety ledge, forebay/sediment traps, inlet and outlet locations, access, spill way location (if applicable), and any other relevant items.

.16 Cross-sections

a) Provide a plan with cross-sections for all road right-of-way's and walkways/shared-use-paths.

b) Alignments and locations of existing and proposed surface infrastructure including curb, gutter, sidewalk, trees, lighting and any other structures.

c) Identify proposed pavement structure.

.17 Detail Drawings

a) Standard details and typical cross-sections must be included in the engineering drawings for each project.

b) Standard details and typical cross-section shall be in accordance with the Engineering Standard Drawings, attached in Appendix A these Municipal Engineering Standards.

c) Details and cross-sections shall be drawn to a scale that clearly portrays the required information with clarity and legibility.

2.4.2 Review Timelines

.1 Submission review is an iterative process. The 1st submission review period will typically be 4-6 weeks pending various factors such as current workload, drawing quality, application delays, lack of supplemental material, or any other unforeseen circumstance.

.2 The City will notify the consultant if the review period is anticipated to be substantially longer. The City holds no obligation to abide to the review period but will work to complete reviews in a timely manner.

2.5 Commercial, Institutional, Industrial, and Multi-Family

2.5.1 General

.1 All commercial, institutional, Industrial, and multi-family development require the application of a development permit. During the DP process the City will specify if there are further requirements for building permits contingent on the nature of the development.

2.5.2 Drawing Requirement

.1 Application for development permits for commercial, institutional, Industrial, and multi-family sites must be accompanied by a design report (refer to Article 2.6.2 {a}), grading plan, overall utility plan, ECO plan and any other relative plans as deemed necessary by the City Engineer.

2.6 Development Permit

2.6.1 Private Site Development

.1 All private site development requires the application of City permits. City permits include development permits and/or stripping and grading permits. During the DP process the City will specify if there are further requirements for building permits contingent on the nature of the development.

.2 Application for development permits for private sites must be accompanied by a design report (refer to Article 2.6.2 {a}), grading plan, overall utility plan and any other relative plans as deemed necessary by the City Engineer.

2.6.2 Infill and Redevelopment Projects

.1 Applications for a development agreement and/or development permits for infill and redevelopment projects must be accompanied by a design report, lot grading plan, and overall utility plan. For some minor residential infill sites, the lot grading plan and overall utility plan may be combined onto one singular plan and Landscaping plans may not be required at the City's discretion. Please note that Garden/Garage Suites are to be contained all within parcel. There is no tie into City infrastructure.

a) Design Report

i) Two (2) hard copies and one (1) digital copy of the report must be provided for the City's review.

ii) The report should define the methodology utilized by the Designer, clearly demonstrate conformance of the Design with these Standards, and contain all pertinent information regarding the Design.

iii) The report shall include:

1. Project background, site information, context plan, aerial photos, existing site photos, and zoning plan.
2. Changes to the project as a result of Concept/Pre-Design submission, or subsequent discussions.
3. Identification of design elements that deviate from St. Albert standards and guidelines.

iv) The report shall be signed and sealed by a professional engineer, licensed to practice in the Province of Alberta.

v) The information provided in the report shall follow that prescribed in Article 2.3.1, as applicable to the nature of the proposed development.

b) Lot Grading Plan

i) The lot grading plan shall follow the requirements of Article 2.4.1.

c) Overall Utility Plan

i) The overall utility plan shall follow the requirements of Article 2.4.1.

ii) The plan shall identify sump pump discharge location and include a note stating "No groundwater or stormwater shall be discharged to the wastewater collection system."

d) Landscaping Plan

i) The landscaping plan shall follow the requirements of Article 2.4.1.

e) Erosion and Sediment Control Plan

i) Provide and adhere to an Erosion and Sediment Control Plan in accordance with Article 2.3.1.

.2 Each infill and redevelopment site will be unique in its utility servicing requirements. As such, the City may request additional details regarding the design in order to ascertain its acceptability.

.3 The development agreement and/or building permit will not be issued until the design report, lot grading plan, overall utility plan and landscaping plan have been submitted, reviewed, and accepted by the City.

.4 Construction activities shall follow the applicable requirements provided in Articles 4.11 and 4.12.

.5 Record drawings must be provided to the City once the project is complete.

2.7 Contract Administration and Maintenance Requirements

2.7.1 Prior to Commencement of Construction

2.7.1.1 Easements

.1 The Developer shall be responsible for securing all the necessary easements to protect municipal infrastructure not located within a road right-of-way or utility lot.

.2 All permanent easements shall be registered prior to application to the City for a construction completion certificate for municipal infrastructure. The Construction Completion Certificate shall not be issued until this is completed.

2.7.1.2 Crossing Agreements

.1 Where a crossing of gas or oil pipelines, power transmission lines, or a railway is required by a Design, the Developer shall be responsible for securing and coordinating the crossing agreement with the necessary authorities.

.2 The Developer shall be responsible to comply with all terms and conditions of the crossing agreement.

.3 Prior to application to the City for a construction completion certificate for municipal infrastructure subject to a crossing agreement, the Developer shall apply to the City and the crossing agreement authority to have the crossing agreement transferred to the City's name where applicable. If it is not possible to transfer the agreement to the City's name, then St. Albert must be notified and then discussions about concessions may take place. The construction completion certificate shall not be issued until all applicable crossing agreements are transferred to the City.

2.7.2 During Construction

.1 Before construction begins the Development Agreement must be executed or the Development Permit must be issued by the City.

.2 Prior to construction a pre-construction meeting must also take place. The meeting is to be coordinated by the consultant and attended by the developer, contractor(s), and a St. Albert representative. Before franchise utility installation, another meeting is to take place coordinated by the consultant and attended by representatives from St. Albert, Fortis Alberta, ATCO, and the respective telecommunications company(s).

.3 Ensure that locates are performed prior to any construction for all City owned and external authority utilities including deep underground, franchise, and telecommunications lines, Alberta First Call and any other appropriate authorities.

.4 Review and approve all below grade utilities flagged before construction commences.

.5 Protect existing landscaped areas including natural areas, sod, trees and shrubs. Existing landscaped areas must retain their original condition by the end of the construction including, but not limited to, the health of vegetation, the functionality of the landscape, and the aesthetic appeal.

.6 The Developer shall ensure that adjacent property is protected from dust, sand, and wet soil during construction. It is the Developer's responsibility to ensure all debris is removed from adjacent lands, and construction damage is repaired to its original condition.

.7 During construction the contractor shall abide by all relevant bylaws.

.8 Any modifications to the design must first be approved by the City inspector. The City inspector will deem if it is necessary for a redline process to take place or if the change can be applied in the field and documented within the record drawings. The consultants Engineer must then confirm in writing that the change will not otherwise influence the original design directive and will not result in any conflicts. If the change does influence the original design directive or at the discretion of the inspector, the City Engineer will then review and deem if it is necessary for a redline process to take place.

.9 For landscaping:

a) Approve rough grading, topsoil spreading, new seeding and sodding, new tree locations.

b) Approve plant materials prior to installation.

c) Coordinate review of topsoil and recommend amendments as required. Contact City to review topsoil.

d) The City will inspect plant materials prior to installation for vigor and form requirements and the existence of disease or pests if requested.

e) If interim inspections are required, the Developer's Landscape Architect shall notify the City's representative 2 business days in advance at each stage of construction when the work is ready for inspection.

f) The Developer's Landscape Architect shall submit to the City a request in writing for permission to use collected plant materials.

2.7.2.1 Landscape Construction Process

.1 The Developer's contractor(s) shall adhere to the following procedures through the construction process:

i) Ensure that utility locates are performed prior to any construction, including Alberta First Call and other appropriate authorities.

ii) Review and approve all below grade utilities flagged before construction commences.

iii) Protect existing landscaped areas including natural areas, sod, trees and shrubs.

iv) Arrange for a project initiation meeting on site with Planning and Engineering Services to ensure there is a clear understanding of the City's requirements during construction, establish a construction start date, and agree upon the progress schedule and subsequent inspection stages.

v) Approve rough grading, topsoil spreading, new seeding and sodding, new tree locations.

vi) Approve plant materials prior to installation.

vii) Coordinate review of topsoil and recommend amendments as required. Contact City to review topsoil.

viii) Direct the review and inspection of all construction and installation while in progress.

.2 The City will inspect plant materials prior to installation for vigor and form requirements and the existence of disease or pests if requested.

.3 If interim inspections are required, the Developer's Landscape Architect shall notify the City's representative 2 business days in advance at each stage of construction when the work is ready for inspection.

.4 Contractor(s) shall provide details of the source location in writing if requested by the City.

.5 The failure of landscape construction to comply with approved plans and specifications will be considered sufficient cause to stop work or invoke the security clauses of the Development Agreement. Construction deficiencies shall be rectified to meet the appropriate plans and specifications, at the Developer's expense.

.6 The Developer's Landscape Architect shall submit a request to the City in writing for plant material substitutions. If approved, the Developer's Landscape Architect shall identify the approved changes on the red line or the record drawing, as appropriate.

.7 The Developer's Landscape Architect shall submit to the City a request in writing for permission to use collected plant materials. Plant material must satisfy specifications outlined in *section 4.4.7.2.1.1.*

.8 Every precaution shall be taken not to damage, injure or mark existing structures or landscaping on City owned property. Should the Developer, its consultants, contractors, employees, or equipment incur any damage, it shall be restored at the Developer's expense to the satisfaction of the City. If remediation work is not done by the Developer, the work will be completed by the appropriate City department or delegate at the Developer's expense.

.9 The Developer shall ensure that adjacent property is protected from dust, sand, and wet soil during construction. It is the Developer's responsibility to ensure all debris is removed from adjacent lands, and construction damage is repaired to its original condition.

2.7.3 Post Construction

2.7.3.1 Inspection Requirements

Pre-Inspection

The City will consider an application for CCC or FAC only when the Developer's Engineer has certified to the City that:

.1 The Local Improvements have been fully inspected and verified with a Pre-CCC/FAC Inspection Report confirming that the construction of installation of the Local Improvements is free of deficiencies and the site is ready for inspection by the City

Construction Completion Certificate

.1 Where a complete application for a CCC is filed, the City must make an inspection of the Local Improvement or the category of Local Improvement or Landscaping.

.2 Subject to the development agreement, the City must make the inspection within 30 days after the Developer has filed a completed application for a CCC.

.3 The City Inspector may determine that the weather or ground conditions are so adverse as to prevent the completion of an inspection of the Local Improvement or category of Local Improvement or Landscaping within the time required under the Development Agreement. The determination will be to the sole discretion of the City Inspector and/or the City Engineer.

.4 Should the City Inspector and/or Engineer determine that the onsite inspection cannot proceed within the time required under the Development Agreement, the City must give notice in writing to the Developer and the Developer's Engineer and must start the inspection as soon as reasonably possible after weather and ground conditions permit.

.5 The Developer's Engineer must coordinate and be present for the City's inspection. If the Developer's Engineer is not able to be present on the date of the City's inspection, the City is not obligated to conduct the inspection and may reschedule to the next date that is convenient for both the City and the Developer's Engineer.

Deficiency Requirements

The following outline general deficiency requirements. If the following conflicts with the development agreement, then all parties shall defer to the stipulations as outlined in the respective development agreement.

.1 The Developer's Engineer must provide the Deficiency List no later than ten (10) business days from the date of inspection. If the Developer's Engineer fails to provide the Deficiency List in the time specified, the Developer must apply for another Inspection by the City.

.2 The City may amend the Deficiency List provided by the Developer’s Engineer within fourteen (14) business days of receiving the Deficiency List.

.3 The Combination of the defects identified in the Developer's Engineer’s Deficiency List as amended by the City forms the Finalized Deficiency List.

2.7.3.2 Operation and Maintenance Manuals

.1 One (1) physical copy and one (1) digital copy of all applicable operation and maintenance manuals shall be provided to the City prior to application to the City for a construction completion certificate. The construction completion certificate shall not be issued until such documents are provided to the City.

.2 Commissioning reports for various infrastructures shall be incorporated into the applicable operation and maintenance manuals.

2.7.3.3 Quality Assurance and Control Testing

.1 The following sections outline the requirements for quality assurance and control testing. If it is found that infrastructure is not being built to acceptable tolerances outlined in these standards, then the City holds the right to suspend construction at their discretion. The contractor will then meet with a City representative to determine the impact of the non-compliance, and to specify the necessary remedial action to be taken by the contractor. Remedial action can include, but is not limited to acceptance, acceptance with pay adjustment, or removal and replacement at no cost to the City of St. Albert. Construction may continue upon written authorization from the City.

2.7.3.3.1 Water System

.1 The following documentation shall be submitted by the deadlines as shown in Table 2.7.1 below:

Item	Deadline
Pressure and Leakage Test Results	Prior to C.C.C. inspection.
Chlorine Residual Test Results	Prior to C.C.C. inspection.
Bacteriological Test Results	Prior to C.C.C. inspection.
Taste and Odor Test Results	Prior to C.C.C. inspection.
URW Documentation & Crossing Permits	Prior to C.C.C. signing by Engineer.
As-Built Quantities and Costs Report	Prior to C.C.C. signing by Engineer.
Hydrant Flow Test Requests	Prior to C.C.C. signing by Engineer.
Water Facility Reports (Valves, Hydrants, Blow offs, etc.)	Within three months after C.C.C inspection.
Water Service Reports	Within three months after C.C.C inspection.
Water Main Grade Sheets	Within three months after C.C.C. inspection.
As-Built Drawings (for COSA review)	Within six months after C.C.C inspection.
Final As-Built Drawings	30 days after receipt of COSA's response on as-built drawings.

Table 2.7.1: Submissions Required After Water Main Construction

<u>Quality Assurance</u>

Refer to *article 4.5.1.2.2.*

<u>Quality Control Testing</u>

Refer to *article 4.5.1.2.3.*

<u>Inspection and Testing</u>

Refer to *article 4.5.1.2.13*

<u>Flushing and Disinfecting</u>

Refer to *article 4.5.1.2.14*

<u>Sampling</u>

Refer to *article 4.5.1.2.15*

<u>Inspection of Valves and Hydrants</u>

Refer to *article 4.5.1.2.16*

<u>Hydrant Flow Testing</u>

Refer to *article 4.5.1.2.18*

2.7.3.3.2 Wastewater Collection System

<u>Quality Assurance</u>

Refer to *Article 4.5.1.2.2.*

All PVC pipe shall be tested by the manufacturer and marked in accordance with CAN/CSA-B182.2.

<u>Quality Control Testing</u>

Refer to Article 4.5.1.2.3.

<u>Sewer Main Inspection and Testing</u>

Refer to *article 4.5.2.2.9.*

<u>Sewer Service Inspection and Testing</u>

Refer to *article 4.5.2.2.10.*

<u>Final Inspection</u>

Refer to *article 4.5.2.2.11.*

2.7.3.3.3 Stormwater Collection System

<u>Quality Assurance</u>

Refer to *Article 4.5.1.2.2.*

All PVC pipe shall be tested by the manufacturer and marked in accordance with CAN/CSA-B182.2.

<u>Quality Control Testing</u>

Refer to Article 4.5.1.2.3.

<u>Sewer Main Inspection and Testing</u>

Refer to *article 4.5.3.2.10.*

Sewer Service Inspection and Testing

Refer to *article 4.5.2.2.10.*

Final Inspection of Sewer Mains

Refer to *article 4.5.2.2.11.*

2.7.3.3.4 Roadways

Quality Assurance

Refer to *article 4.3.1.2.2.*

Quality Control Testing

Refer to *article 4.3.1.2.3.*

Tolerances

Refer to *article 4.3.1.2.11.*

Rejected Work

Refer to *article 4.3.1.2.14.*

2.7.3.3.5 Curbs, Gutters and Sidewalks

Quality Assurance

Refer to *article 4.3.1.2.2.*

Quality Control Testing

Refer to article 4.3.2.2.3.

Tolerances

Refer to *article 4.3.2.2.18.*

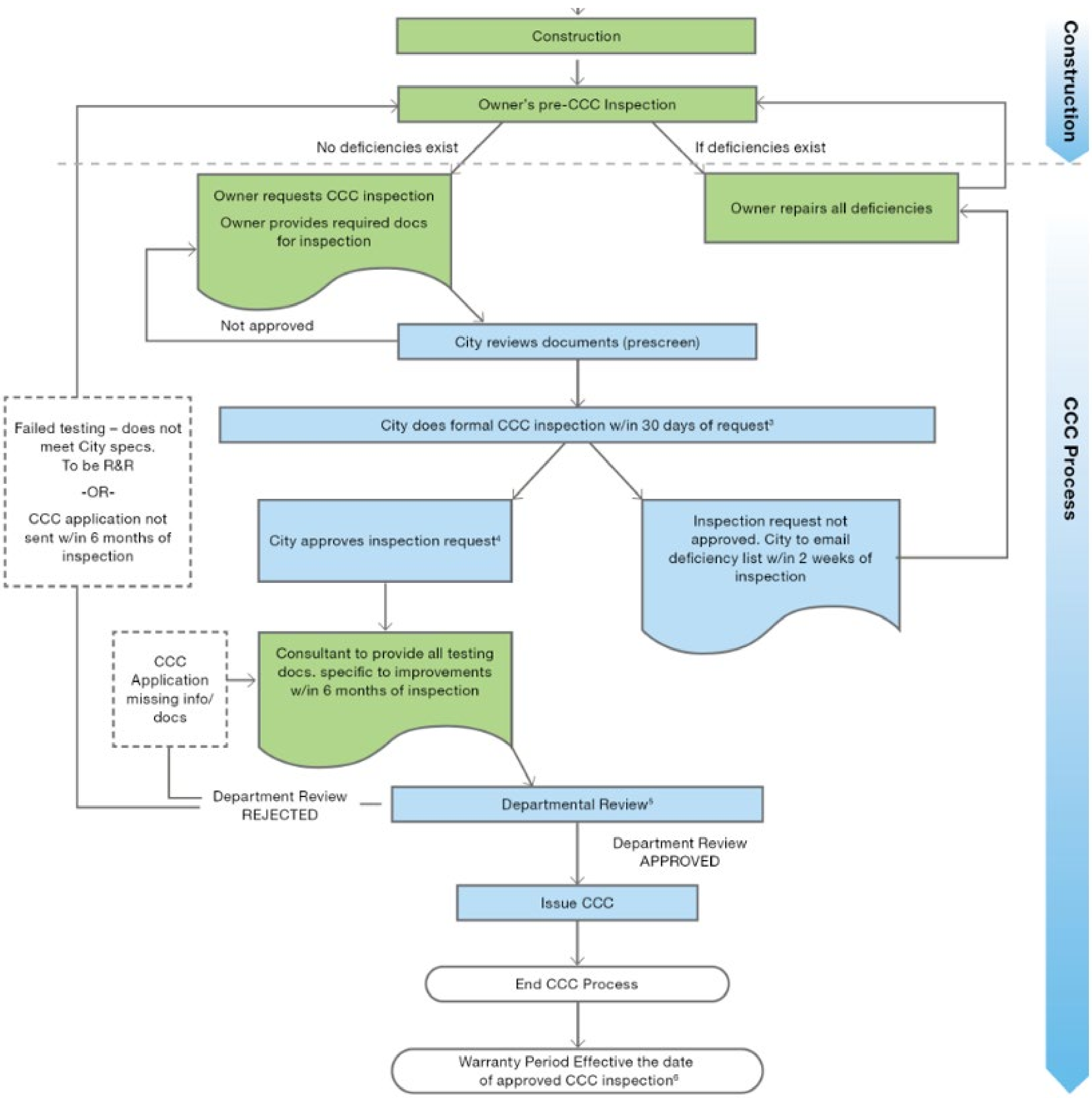
Rejected Work

Refer to *article 4.3.2.2.19.*

2.7.3.4 Construction Completion Certificate (CCC)

The following flowchart outlines the CCC process in St. Albert:

Figure 2.7.1



.1 Prior to applying to the City for a Construction Completion Certificate (CCC) inspection, the Consultant shall fully inspect the work and ensure that the constructed infrastructure is complete, functional and fully commissioned in accordance with the accepted engineering drawings and these Municipal Engineering Standards.

.2 A CCC Request Form must be provided to the City, complete with all necessary supporting documentation. A sample of the CCC Request Form is attached in Appendix B-2. More information regarding the CCC process is provided on the form.

.3 To receive CCC for underground items, the following items must be accounted for or provided to the city:

a) CCC Application
b) CCC Request Form
c) Deficiency Free Inspection Report
d) Watermain Pressure and Leakage Test
e) Watermain Bacteria/Chlorination Summary
f) Hydrant Flow Test
g) Bacteria Test Results
h) CCTV Tapes and Logs
i) CCTV Consultant Report
j) Lot Grade Verification Letter
k) Test Results (Bedding Sand)
l) AESRD Application
m) Infrastructure Summary Tables.

.4 To receive CCC for surface items, the following items must be accounted for or provided to the city:

a) CCC Application
b) CCC Request Form
c) Deficiency Free Inspection Report
d) Asphalt Density Assessment
e) Asphalt Thickness Assessment
f) Concrete Strength Assessment
g) Surface Test Results
h) Trench Backfill Report
i) Lot Grading Verification Letter
j) Infrastructure Summary Table.

.5 CCC inspections may be requested once a deficiency free pre-inspection is confirmed. At the discretion of the City of St. Albert and weather permitting and site amenities can be inspected between May 1st and October 15th, provided snow cover, temperature, and other considerations do not prevent the ability to perform a thorough inspection. The City may allow inspections outside of these dates at their discretion. If an inspection occurs after October 15 of any year additional warranty may be required as described in Appendix B-2 because of operation constraints of infrastructure.

.6 The Developer may make an application for a CCC for:

a) all of the Local Improvements, if the Developer has completed all of the required Local Improvements;

b) a category of Local Improvements as set out in the Development Agreement if the Developer has completed all of the elements of that category; or

c) all of the Landscaping, if the Developer has completed all of the required Landscaping.

.7 The Developer acknowledges that if the Developer makes an application for a CCC for a category of Local Improvement, the City Engineer will not consider the application or issue a CCC for that category unless all the Works, construction and installation, contemplated by that category are completed.

.8 Before a Developer makes an application for an inspection, the Developer must ensure that the site is prepared to facilitate the City conducting the inspection.

.9 The Developer must make the application for an inspection in writing in the form required by the City.

.10 The City is not required to consider an application for a CCC under the development agreement unless:

a) the Developer has complied with the obligations with respect to Landscaping Plans set out in the DA; and

b) the Developer's Engineer has certified to the City that:

i) the Developer's Engineer has inspected the Local Improvements, or category in respect of the Local Improvements for which the application for a CCC has been made, or Landscaping; and in the Developer's Engineer professional opinion:

ii) the construction or installation of the Local Improvements or category of Local Improvements or Landscaping is constructed or installed in accordance with this Agreement;

iii) is free of deficiencies; and

iv) the site is ready for an inspection by the City.

<u>Issuance of CCC</u>

.11 Subject to the DA, after conducting the inspection and, if necessary, re-inspection, if the City Engineer is satisfied, that the Local Improvements or any category of Local Improvements or the Landscaping has been constructed, installed, and maintained in accordance with the Development Agreement, the City Engineer must issue the CCC effective the date of the inspection or re-inspection, as the case may be, in the form set out in Schedule "J" for the applicable Local Improvements or the category of Local Improvements or the Landscaping.

.12 The City Engineer must not issue a CCC:

a) for any Local Improvements or category of Local Improvements or Landscaping until all easements, utility rights-of-way, restrictive covenants and encroachments required by the City with respect to the Development Area have been registered to the satisfaction of the City at the Land Titles Office;

b) for the Local Improvements or category of Local Improvements or any structure forming part of the Landscaping that crosses a pipeline or located on a pipeline right-of-way until the Developer has submitted:

i) a copy of a Pipeline Crossing Agreement and/or Proximity Agreement permitting the Local Improvements to cross the pipeline, or in the case of a structure forming part of the Landscaping on the right-of-way, permitting the landscaping to be located on the pipeline right-of-way; and an assignment, in form and content satisfactory to the City, of all the rights under the Pipeline Crossing Agreement in favour of the City.

.13 The City Engineer must not issue a CCC for Landscaping until the City Engineer is satisfied that:

a) there has been successful seeding;

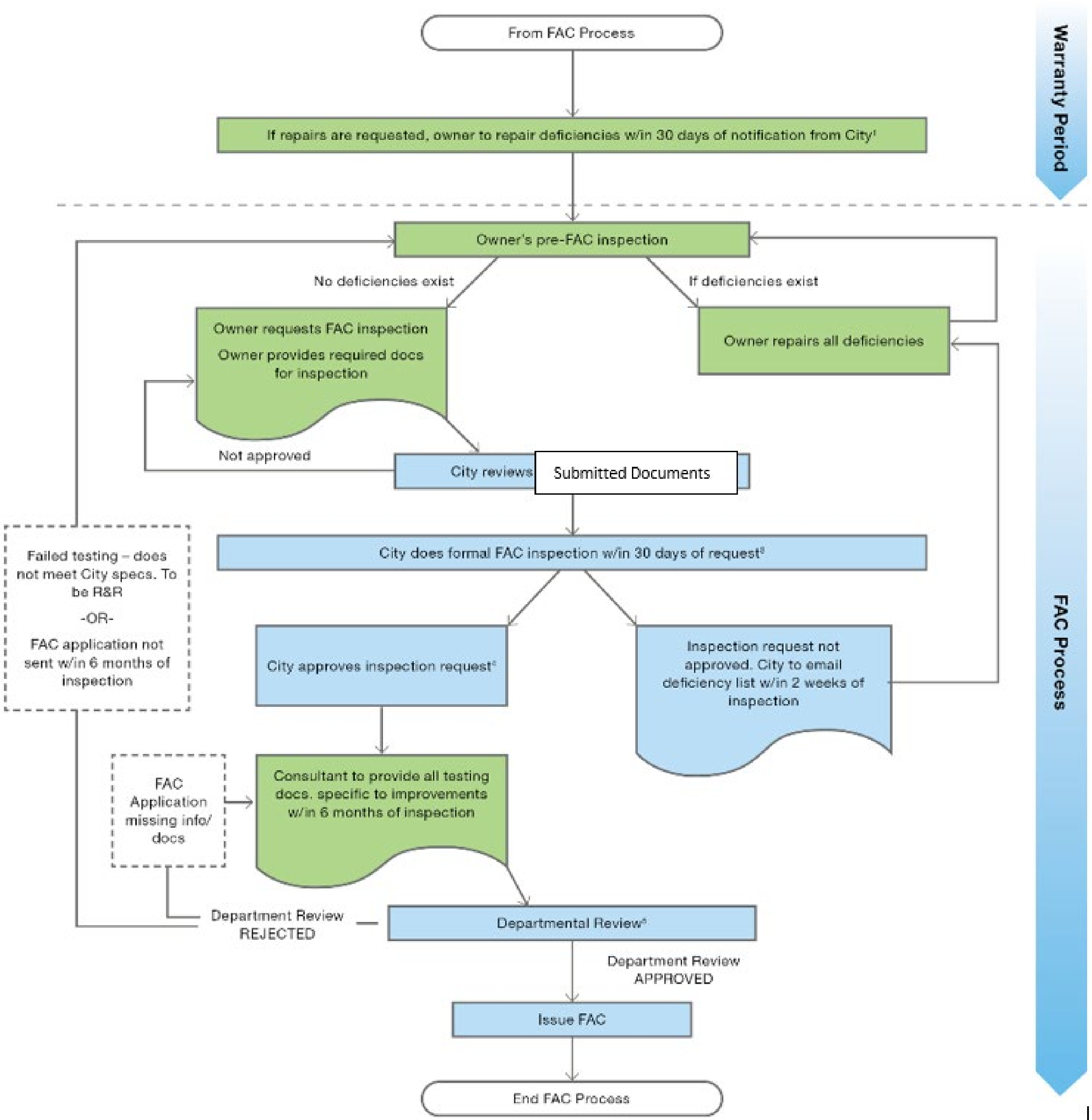
b) there has been successful germinating of grass areas or the sodding of those areas; and

c) the planting of trees and shrubs has been completed where and as designated by the Landscaping Plans.

2.7.3.5 Final Acceptance Certificate (FAC)

The following flowchart outlines the FAC process in St. Albert:

Figure 2.7.2



.1 Prior to applying to the City for a Final Acceptance Certificate (FAC), the Consultant shall fully inspect the work and ensure that the constructed infrastructure is free of defects or deficiencies in design, material, and/or installation.

.2 Prepare and submit a FAC Inspection Request Form, complete with all necessary supporting documentation. Once a deficiency free inspection is completed, prepare and submit an FAC request form, complete with all necessary supporting documentation. A sample of the respective forms are attached in Appendix B-3. More information regarding the FAC process is provided on the form.

.3 To receive FAC for underground items, the following items must be accounted for or provided to the city:

a) FAC Application

b) FAC Request Form

c) Deficiency Free Inspection Report

d) As-Built Drawing Approval

e) AESRD Application

f) CCTV Consultant Report

g) CCTV Tapes and Logs

.4 To receive FAC for surface items, the following items must be accounted for or provided to the city:

a) FAC Application

b) FAC Request Form

c) Deficiency Free Inspection Report

d) As-Built Drawing Approval

e) Asphalt Density Assessment

f) Asphalt Thickness Assessment

g) Concrete Repair Strength Assessment

h) Surface Test Results

.5 FAC will not be issued until all outstanding penalty fees are paid and confirmed to be received by the City.

.6 Where the Maintenance Period for the Local Improvements or category of Local Improvements or Landscaping is complete, the Developer may apply to the City for a FAC for the Local Improvements or category of Local Improvements or Landscaping.

.7 Within 30 days of receipt of complete application, the City Engineer must consider an application for a FAC and must conduct an inspection of the status of the Local Improvements or category of Local Improvements or Landscaping. The inspection is weather pending. Refer to the development agreement for information on weather conditions that would prevent an inspection from taking place.

.8 The process for inspection, identification of Deficiencies and re-inspection in relation to FACS shall be the same as that for CCCs with any necessary modifications.

.9 The Developer must forthwith repair the Deficiencies identified on the Finalized Deficiency List.

.10 The City Engineer must issue a FAC in the form set out in the Development Agreement for the Local Improvements or category of Local Improvements or Landscaping if the City Engineer is satisfied that the Developer:

a) has provided all inspection and testing records, and all As-Built Plans and Record Drawings required;

b) has complied with the Developer's obligations to maintain, repair and replace the Local Improvements or category of Local Improvements or Landscaping for the Maintenance Period; and

c) the Local Improvements meet the City Standards.

.11 Despite the issuance of a FAC, the Developer continues to have an obligation to repair and must repair any damage caused to Local Improvements or category of Local Improvements or Landscaping or other existing infrastructure caused by the Developer, its contractors, sub-contractors, employees, servants or agents.

.12 Despite the issuance of a FAC for the Landscaping, the Developer must, at its own expense, continue keeping the Development Area in a reasonably clean and tidy condition, including mowing the grass and eliminating weeds, refuse, litter and undesirable vegetation, all as the City Engineer in the City Engineer's sole discretion may require, except for:

a) those lands within the Development area which have been sold to an arms' length third party; and

b) Public Lands.

2.7.3.6 Maintenance Period

.1 The Maintenance Period for the Local Improvements or a category of Local Improvements or Landscaping starts with the issuance of the CCC and ends after the issuance of FAC.

.2 For the duration of the Maintenance Period, the Developer must:

a) Maintain the Local Improvements or category of Local Improvements or Landscaping in good condition and repair, ordinary wear that does not affect functionality or safety excepted; and

b) Repair or replace the Local Improvements or category of Local Improvements or Landscaping where the City Engineer determines that repair or replacement is necessary as a result of any cause other than negligence by the City, its servants, agents or contractors in the use and operation of the Local Improvements or category of Local Improvements or Landscaping.

.3 In addition to the obligation imposed under the DA, if the whole or any portion of the Local Improvements or category of Local Improvements or Landscaping become damaged within 5 years following the issuance of the final CCC for the Local Improvements or category of Local Improvements or Landscaping as a result of any subsidence or settlement of fill material where the Developer has placed fill material measuring 1 metre or more on the Development Area, the Developer must repair that damage, including replacement of any components of the Local Improvements or category of Local Improvements or Landscaping which are damaged beyond reasonable repair.

2.7.4 Survey Control Markers and Legal Pins

.1 Existing Control Markers

a) Every effort shall be made to protect existing markers.

b) The Developer shall be responsible for replacing any markers which are disturbed, destroyed, or missing, at the Developer's sole expense. Markers are to be replaced only by a licensed legal surveyor.

.2 Alberta Survey Control Markers (ASCM)

a) The Developer shall provide additional markers as required for the Development.

b) All elevations related to the development must be geodetic and referenced in ASCM near the development area. Elevations for site survey calibrations and site survey control must be derived from or confirmed with and ASCM elevation.

.3 Legal Pins

a) The Developer shall hire a licensed legal surveyor to install legal pins through the Development.

b) Legal pins shall be installed prior to Construction Completion Certificate (CCC) inspection.

c) The Developer shall be responsible for replacing any markers or legal pins which are disturbed, destroyed, or missing. Legal pins are to be replaced only by a licensed legal surveyor, at the Developer's sole expense. The City will not issue the Final Acceptance Certificate (FAC) until this is completed.

2.7.5 As-Built Record Drawings and Reports

.1 As-Built drawings shall include all the information specified in Section 2.0, updated to reflect how the project was actually constructed. All design information will be struck through and replaced with field verified construction data. This information will be shown in red text.

.2 No later than six months before the Final Acceptance Certificate (FAC) deadline, submit one (1) full size printed set of the As-Built drawings to the City for review.

.3 The cover sheet shall include the following information:

a) Date of construction completion;

b) Date on which the As-Built information was updated;

c) A table summarizing all underground utilities installed with information regarding pipe material, size, type, class, pressure rating, manufacturer, supplier, and applicable reference standard; and

d) A table summarizing the following information:

i) Name of the contractor for wastewater collection system infrastructure construction with construction start and completion dates;

ii) Name of the contractor for stormwater management system infrastructure construction with construction start and completion dates;

iii) Name of the contractor for water system infrastructure construction with construction start and completion dates;

iv) Name of the contractor for road infrastructure construction with construction start and completion dates;

v) Name of the contractor for sidewalk, curb, and gutter infrastructure construction with construction start and completion dates; and

vi) Name of the contractor for landscaping infrastructure construction with construction start and completion dates.

.4 If not yet completed, plans shall identify property lots by their address number, as provided by the City.

.5 Should the City, upon its review, note any errors, omissions, or discrepancies in the As-Built drawings, the drawings shall be returned to the Consultant with the City's comments. The Consultant shall correct the drawings and return to the City for review. This process shall be repeated until the City deems the As-Built drawings are acceptable. The time period for review by the City may be increased if excessive review cycles are required, and may impact the date of the Final Acceptance Certificate. The City may also assign drawing numbers and asset numbers upon the reviewed As-Built drawings for inclusion into the Record Drawing submission.

.6 Upon written acceptance of the As-Built drawings by the City, the Consultant shall convert red line markups to black text and prepare project Record Drawings. After verification by the professional member, the Consultant shall provide one (1) copy of the Record Drawings in AutoCAD-format electronic files, and one (1) set of signed PDF files.

.7 The FAC will not be issued by the City until all applicable Record Drawings have been reviewed and accepted by the City.

.8 For development permit projects upon private property, As-Built drawings can be provided in lieu of a Record Drawing submission.

A professional land surveyor must be retained to conduct a topographic survey of the completed project in order to document:

- Full site surface elevations.
- Building outline.
- Finished Floor Elevation of the Building.
- Rim & invert elevations for the sanitary system.
- Rim & invert elevations for the storm system.
- Valves and hydrants for the water system.

The professional land survey shall deliver to the City a PDF file of a representative site drawing with the topographic survey information superimposed. AutoCAD files are not required for Development Permit projects upon private property.

2.7.6 Landscape Post Construction

2.7.6.1 Construction Completion Certificate

In addition to the guidelines provided in Article 2.7.3.4, the following guidelines apply to the Construction Completion Certificates (CCCs) for landscaping activities.

.1 When landscape construction work is satisfactorily complete, the Developer's Landscape Architect shall submit a written request for a CCC inspection of the works using the form provided in Appendix B-2. The request shall include a proposed maintenance schedule and three (3) copies of the approved or redline drawings at an 11x17 size.

.2 CCCs are to be attained for the following improvements (and any others listed in the Servicing Agreement):

a) Turf and Plantings for Boulevards, including planting islands and entrance features.

b) Turf and Planting for MR, ER, SWMF, Arterial Roads.

c) Parks, Park Amenities and Playground Equipment.

d) Hard Surfaces and Special Pavements.

e) Fencing.

.3 In preparation for acceptance of the development by the City, CCCs shall be issued subject to the following conditions and procedures:

a) A stage needs to be a minimum of 80% complete prior to a CCC inspection for landscaping. Boulevards must be 100% complete prior to a CCC inspection for landscaping.

b) The Developer's Landscape Architect, contractor(s), and the City Representatives shall attend the CCC inspections. Attendees shall be requested to sign the CCC form to show agreement with any noted deficiencies.

c) CCC inspections for seeded areas will occur upon germination.

d) Following the CCC inspection, the City will forward a copy of the inspection report listing all deficiencies to the Landscape Architect, or delegate, and the contractor.

e) All deficiencies identified during the CCC inspection shall be repaired or corrected within a maximum of 3 weeks. Upon the correction of all listed deficiencies, the Landscape Architect or Delegate will request a re-inspection. If all deficiencies are corrected, the City will approve the CCC. If deficiencies are not corrected by the agreed date, the Developer's Landscape Architect must request a new CCC inspection. The maintenance period will commence from the CCC approval date.

f) The Developer shall maintain all work prior to the CCC and during the maintenance period after the CCC approval dates.

.4 CCC landscape inspections will be undertaken from June 1st - September 30. At the discretion of the City and weather permitting site amenities and fencing can be inspected year-round, provided snow cover, temperature, and other considerations do not prevent the ability to perform a thorough inspection.

.5 Boulevard tree quantities in addition to the quantities on the approved detailed landscape plans are not required.

2.7.6.2 Maintenance Period

.1 Work for a minimum warranty period as outlined in the signed Servicing Agreement, or as identified below. Deficiencies shall be corrected at the Developer's expense.

.2 Upon issuance of the CCC, the maintenance period shall be:

a) Pathways/Trails – 2 year.

b) Signage – 1 year.

c) Sod – 1 year, or as soon as germination is completely knitted.

d) Seed – 2 years, or 95% germination.

e) Plant Material – 2 years for all trees (less than 75 mm caliper) and shrubs on public property (Note: 1 year for trees on private property, or as otherwise indicated on the Development Permit), 2 years for all perennials.

f) Trees (75 mm caliper or greater) – minimum 3 years (subject to extension proportional to increase in caliper size, subject to review and direction of the City).

g) Site Amenities – 1 year.

h) Landscaping (Development Permit) – 1-year Private property, 2 years Public property.

.3 Maintenance shall include but not be limited to pruning, watering, cultivating, weeding, mulching, tightening and repair of guy wires and stakes, resetting plants to proper grades or upright position, restoration of the planting saucer, application of such sprays or other materials as necessary to keep plantings free of insects, diseases and in vigorous and viable condition and winter maintenance (snow clearing on pathways/trails).

2.7.6.3 Final Acceptance Certificate

In addition to the guidelines provided in Article 2.7.3.5, the following guidelines apply to the Final Acceptance Certificates (FACs) for landscaping activities.

.1 After the required maintenance period has come to an end, the Developer's Landscape Architect shall submit a written request for an FAC inspection using the form provided in Appendix B-3. The request shall include maintenance logs and three (3) copies of the approved record landscape drawings at an 11x17 size.

.2 FACs are to be attained for the following improvements (and any others listed in the subdivision conditions):

a) Turf and Plantings for Boulevards, including planting islands and entrance features.

b) Turf and Planting for MRs, ERs, SWMFs, arterial roads, PULs, parks, islands, and entrance features.

c) Parks, Park Amenities and Playground Equipment.

d) Hard Surfaces and Special Pavements.

e) Fencing (on public land only).

.3 In preparation for acceptance of the development by the City, FAC shall be issued subject to the following conditions and procedures:

a) The Developer's Landscape Architect, Contractor(s), and City Representatives shall attend the FAC inspection. Attendees shall be requested to sign the FAC form to show agreement with any noted deficiencies.

b) Following the FAC inspection, the City will forward a copy of the inspection report listing all deficiencies to the Landscape Architect or delegate.

c) All deficiencies identified on the FAC inspection shall be repaired or corrected within fifteen (15) business days. Upon correction of all listed deficiencies the Landscape Architect or delegate will request a re-inspection. If all deficiencies are corrected, the City will approve the FAC. If deficiencies are not corrected by the agreed date, the Developer's Landscape Architect must request a new FAC inspection. The maintenance period expires upon FAC approval.

.4 FAC inspections may be requested between June 1 and September 30, weather permitting, at the discretion of the City and provided snow cover, temperature, and other considerations do not prevent the ability to perform a thorough inspection.

.5 If tree and shrub replacements are required, a maximum of 25% of the trees and shrubs can be replaced during the deficiency correction period. Quantities exceeding 25% of replaced trees and shrubs will result in a FAC rejection. The application can be submitted for inspection the following growing season. This ensures the trees and shrubs has grown over a winter season.

3 Design Guidelines

3.1 Grading

3.1.1 General Principles

.1 The level-of-service requirements for lot grading include provision of protection against surface flooding and property damage for the 1 in 100 year return frequency design storm. Through control of surface elevations, designs should be such that maximum flow or ponding surface elevations are 150mm below the lowest anticipated finished ground elevations at buildings. An overflow route or sufficient ponding volume must be provided from or at all sags or depressions to provide for this 150 mm freeboard with the maximum depth of ponding is limited to 350 mm.

.2 In the design of lot grading plans, the designer must achieve a proper relationship and balance between the street elevation, building grade elevation, surrounding development and existing topography.

.3 The implications of required noise attenuation berms and other elevation controlling features are to be fully addressed by the designer. It is also important to ensure that the lot grading design and the anticipated house or building designs are complementary. Reverse slope driveways and other features that would be likely to capture runoff or fail to drain during major rainfall events should be discouraged.

.4 The Developer must ensure that builders are informed of any potential problems or restrictions respecting building design and lot grading. The lot grading plan will be used as one of the principle means by which this information is communicated.

3.1.2 Stripping and Grading Permit

3.1.2.1 General

.1 Stripping and Grading permits are Development Permits that are required for private site developments.

.2 Stripping and Grading permits may allow for development beyond just earthworks.

.3 Stripping and Grading permits are not required for municipal development where the Development Agreement acts as the regulatory document.

3.1.2.2 Reference Requirements

.1 The following are requirements for a Stripping and Grading permit to be issued. The City of St. Albert reserves the right to request more documentation in addition to the items listed below:

a) Completed Stripping and Grading permit application.

b) Cost Estimate of development.

c) Letter of Credit and Certificate of Insurance.

d) Various plans including:

i) Site plan showing the affected area and the area explicitly stated in hectares.
ii) Area of topsoil stripping.
iii) Cut and fill locations.
iv) Compaction plan.
v) Drainage plan.
vi) Location of stockpiling, construction access points, haul route of materials.
vii) Erosion and sedimentation control plan

e) Environmental Construction Operation (ECO) plan.

3.1.3 Lot Grading

a) It is preferred that lots shall be designed to drain from back to front. Where the nature of the terrain imposes unreasonable difficulty in achieving this objective, the City may authorize an alternate approach, provided all other applicable conditions are met. Such situations shall be reviewed by the City on a case-by-case basis. The City may require the installation of suitable flow velocity and erosion controls, and the establishment of a suitable easement along the back of the lots.

b) Split lot drainage should be avoided when possible but will be acceptable where lots front and back onto road and/or public rights-of-way or where there is unreasonable difficulty in achieving back to front drainage. A portion of a split lot will be allowed to drain through a receiving lot with a minimum of 3% grade. This option may be used where the nature of the terrain imposes unreasonable difficulty for alternate approaches. For all instances, proper drainage must be accommodated through fencing or any other barriers.

c) Refer to Appendix A for Engineering detailed drawings outlining lot grading.

d) A minimum grade of 10% shall be provided out to a minimum of 2 m around all residential buildings. If there is less than 1.5m from the wall to the property line then provide a minimum drop of 0.15m.

e) A minimum grade of 2% and maximum grade of 10% shall be provided on all landscaped areas.

f) A minimum grade of 2% and maximum grade of 8% shall be provided on all driveways.

g) Lot and landscape grading shall be designed such that the maximum depth of peak flows and ponding shall be a minimum of 150 mm below the lowest anticipated finished ground elevation at buildings. A suitable overflow route or sufficient ponding volume must be provided from or at all ponding areas to achieve this minimum freeboard and limit ponding to a maximum depth of 350 mm.

h) Reverse slope driveways or other lot improvements that may capture runoff and fail to drain during major rainfall events shall be avoided.

i) For details on zero lot drainage refer to Engineering detailed drawings 7.13 – 7.16 within Appendix A.

3.1.4 Swales

.1 The use of swales in design is discouraged in St. Albert for private residential lots. Commercial lots are permitted the use of swales. Grass swales are preferable to concrete swales.

.2 The use of swales is to be avoided in private residential infrastructure. Use of swales in private residential infrastructure will be up to the discretion of the City Engineer and contingent on the designer providing justification for their use.

.3 All swales must be able to convey storm flows produced by 1:5 year storms without inundation. Swales within easements must be able to convey 1:100 year storm flows without inundation.

.4 Grass swales must have a minimum slope of 1.5%. Reduced grades on grass swales may be considered at the discretion of the City Engineer with use of permeable pipes or other LID design, as this is preferable to the use of concrete swales. Concrete swales must have a minimum slope of 0.6%. Slopes used in design must ensure that adequate capacity will be achieved.

.5 Flow velocity must not exceed 3 m/s.

.6 The depth of peak flows and ponding in swales are to be limited so that major system flows will not constitute a significant hazard to the public, or result in significant erosion or other property damage. Where erosion is anticipated an ESC Plan should be designed to suit site specific situations.

.7 Alternative low impact development (LID) design such as bioswales or vegetated swales may be accepted by the City. The design must be proposed to the City Engineer and will be reviewed on a case by case basis.

3.1.5 Remnant Parcel and Open Space Grading

.1 The design must ensure that remnant parcels of land adjacent to the development do not become inundated with storm flows after grading. Overland drainage design shall not permit flows to cross into remnant parcels of land unless it is to be graded along with the development.

.2 At the discretion of the City Engineer, the City may require that remnant parcels adjacent to developments are regraded to ameliorate existing inundation.

.3 Open space grading will permit the use of sheet grading with a minimum 1.5% slope contingent on the discretion of the City Engineer.

3.1.6 Retaining Walls

For the construction of retaining walls measuring 1.0m in height or greater, the Developer shall apply for a Development Permit and provide the following:

.1 Submission of Design Report to identify:

a) Summary of the Engineer's assessment, including the geotechnical investigation;

b) Identify the type of retaining wall to be constructed;

c) Lifecycle analysis of the structure which identifies the period of time post construction which the structure is expected to meet the design criteria;

d) Include the results of the site and geotechnical investigation. List all design criteria and methodology. This includes, but is not limited to,

i) Drainage requirement, geotechnical design recommendations, site limitations, etc.;

e) Recommendations for monitoring and maintenance;

.2 Submission of the structural design drawings for the retaining wall(s). The drawings must be prepared by a qualified Professional Engineer who is licensed to practice in Alberta and must be accompanied by a site plan and a structural plan in addition to the requirements below:

a) Provide a profile along the length of the retaining wall showing variations in wall height, fill height behind the wall, and invert elevations of the wall foundation drains. Cross-sections showing typical wall details, including wall batter, foundation preparation, leveling pad details, drainage provisions, erosion protection of exposed slopes above the wall, and guardrail details (if required)

.3 Submission of Assurance Statements upon completion of the retaining wall. The Engineer of Record should complete the Assurance Statement confirming that the retaining wall design meets the specified performance criteria and that the permanent wall lateral deformations will meet the requirements for service-level performance and damage-level performance

.4 For field reviews & design changes:

a) During construction of the retaining wall, the Engineer of Record must have field review carried out and documented. If design changes during construction result in departures from technical specification and “Issued for Construction” drawings, these changes should be documented and updated on the Record Drawings (As-built Drawings are discouraged)

.5 All retaining walls must adhere to the current Land Use Bylaw and all applicable building codes.

3.2 Underground

.1 In addition to all design standards listed in the following articles, the designer must strive to abide by the minimum horizontal clearances as summarized in table 3.2.1. Expressed written approval from the City must be received to deviate from these minimum clearances.

Table 3.2.1: Summary of Minimum Horizontal Clearances

	Water Main	Wastewater Main	Stormwater Main	Catch Basins	Manholes	Hydrants	WAT/STM/SAN Services	Street Poles	Gas Lines	Trees	Pedestals (1)	Transformers (2)
Water Main	N/A	3.0m	3.0m	1.5m	1.5m	N/A	N/A	N/A	2.0m	N/A	3.0m	3.0m
Wastewater Main	3.0m	N/A	2.0m	1.5m	1.5m	N/A	N/A	N/A	2.0m	N/A	3.0m	3.0m
Stormwater Main	3.0m	2.0m	N/A	1.5m	1.5m	N/A	N/A	N/A	2.0m	N/A	3.0m	3.0m
Catch Basins	1.5m	1.5m	1.5m	N/A	N/A	3.5m	2.0m	N/A	2.0m	N/A	3.0m	3.0m
Manholes	1.5m	1.5m	1.5m	N/A	N/A	5m	N/A	N/A	2.0m	N/A	3.0m	3.0m
Hydrants	N/A	N/A	N/A	3.5m	5m	N/A	2.0m	3.5m	2.0m	3.5m	3.0m	3.0m
WAT/STM/SAN Services	N/A	N/A	N/A	2.0m	N/A	2.0m	N/A	2.0m	2.0m	2.0m	3.0m	3.0m
Street Poles	N/A	N/A	N/A	N/A	N/A	3.5m	2.0m	N/A	2.0m	3.5m	3.0m	3.0m
Gas Lines	2.0m	2.0m	2.0m	2.0m	2.0m	2.0m	2.0m	2.0m	N/A	2.0m	1.5m	1.5m
Trees	N/A	N/A	N/A	N/A	N/A	3.5m	2.0m	3.5m	2.0m	N/A	3.0m	3.0m
Pedestals (1)	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	1.5m	3.0m	See Note (1)	See Note (1)
Transformers (2)	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	1.5m	3.0m	See Note (1)	3.0m

Note:
(1) Secondary Pedestals need a 1 m working clearance along its sides. Secondary Pedestals could be attached along the sides/back of the transformer. Stand-alone pedestals (including Power, TELUS and SHAW) shall have a minimum separation of 2.0 m from the padmount transformer.
(2) Padmount Transformers need a minimum of 1.5 m working clearance along its back and sides. A 4 m clearance is required in front of the padmount transformer.
(3) Clearances denote distance from edge of structure.

3.2.1 Water System

3.2.1.1 General

The water system shall be designed with sufficient capacity to convey peak flows. The Design must include hydraulic network analyses for the Development, updated for each subdivision stage. The City shall provide the necessary boundary conditions for the hydraulic analyses. The following *minimum* criteria shall apply to the Design, as applicable to the Development:

.1 Average and Peak Demands:

a) Design Population: Equal to the ultimate estimated population for the design area.

b) Population Density for Residential Areas: 40 persons/ha or otherwise specified in the approved ASP.

c) 25,000 L/ha/day for Commercial/Institutional.

d) Average Day Demand: Design Population x 320 L/capita/day.

e) Maximum Day Demand: Average Day Demand x 2.0.

f) Peak Hour Demand: Average Day Demand x 4.0.

g) Where the Development may have commercial users with appreciable water demands, such shall be duly considered in the hydraulic analyses.

.2 Fire Demand:

a) Fire demand conditions shall be analyzed based on the criteria provided in *Water Supply for Public Fire Protection, A Guide to Recommended Practice*, Fire Underwriters Survey, latest edition.

b) For commercial, institutional, industrial, and multi-family residential lots with internal fire suppression systems, the Design must include hydraulic analyses to determine the required system configuration and sizes to provide direct flow to the fire suppression systems in combination with hydrant flows.

c) The Designer is responsible for satisfying themselves as to the available fire flow to, or near, the site prior to completing the Design. It shall be the Designer's responsibility to complete a hydrant flow test on a nearby hydrant to determine available fire flow if deemed necessary. Hydrant flow tests must be coordinated through the City's Utilities department. A copy of the hydrant flow test results must be provided to the City.

d) The Designer must ensure that the City's requirements are met with respect to onsite hydrant requirements based on the type of the proposed development and the layout of the site. The City will provide input in this regard during its review of the Design.

.3 Water System Looping required:

a) For all single family developments of 20 or more residential lots.

b) For all multi-family and commercial site developments.

c) On an interim basis, as approved by the City, allowances up to 150 units may be serviced on a single feed as noted in section 3.2.1.2.8

3.2.1.2 Water Mains

.1 Pipe Diameter:

a) Minimum 150 mm for residential developments.

b) Minimum 300 mm for commercial developments.

.2 Flow Velocity:

a) Maximum 3.0 m/s.

.3 Hazen-Williams Roughness Coefficient, C (based on the use of PVC pipe):

a) 130 for pipes ≤ 200 mm diameter.

b) 150 for pipes > 200 mm diameter.

.4 Normal Operating Pressure:

a) 350 kPa (50 psi) to 700 kPa (100 psi).

.5 Peak Hour Demand Operating Pressure:

a) Minimum 280 kPa (40 psi) at ground level at any point in the system (by hydraulic analysis). Interim pressure conditions, as approved by the City, may be permitted to allow minimum peak hour pressures of 220 kPa (32 psi).

.6 Maximum Day Demand Plus Fire Flow Operating Pressure:

a) Minimum 140 kPa (20 psi) at ground level at any point in the system (by hydraulic analysis).

.7 Pipe Design

a) Strength design shall be integral to the pipe selection process.

.8 Horizontal Alignment

a) Water mains shall be located within the road right-of-way, in accordance with the Engineering Standard Drawings in Appendix A.

b) For commercial, institutional, industrial, and multi-family residential developments, the Consultant shall design typical cross-sections depicting the locations of the various necessary infrastructure to suit the particular development. Such cross-sections shall be subject to the review and acceptance of the City.

c) Water mains must be located at least 3.0 m horizontally from any sewer main, 2.0 m horizontally from any gas line, and 1.5 m horizontally from any catch basin or manhole, as measured between the nearest walls of the two mains.

d) In accordance with Article 3.3.1.5, cul-de-sacs which exceed 120 m but that are less than 170 m in length require an additional hydrant and looping of the water main to the cul-de-sac through the Public Utility Lot (PUL). Refer to the Engineering Standard Drawings in Appendix A.

In addition install isolation valve at both ends of the PUL. Cul-de-sacs which exceed 170 m in length require a minimum 6.0 m wide PUL for emergency vehicle access and looping of the water main.

e) Without limiting the requirements of Article 3.3.1.5, PUL widths shall be a minimum of 4.0 m for a single utility and 6.0 m for two utilities. A 1.0 m easement is required on the lots to either side of a PUL.

f) Curved water mains shall run parallel to the centreline of the road.

g) Water mains through new subdivisions must be looped. The City may temporarily waive this requirement for a staged subdivision, up to 150 lots in size, where the Developer can demonstrate that the required fire flows can be provided through a single water feed to the stage. Looping must be provided within an agreed upon period of time of temporarily servicing the development.

h) The maximum length of a dead-end line is 120 m. A hydrant shall be provided at the end of the dead-end, and each dead-end line must be equipped with an isolation valve.

i) Where practical, combinations of maximum 45 degree bends shall be used over 90 degree bends. The use of 90 degree bends may apply in situations where limited space is demonstrated and will be reviewed on a case-by-case basis.

.9 Vertical Alignment

a) Water mains shall be installed to provide a minimum depth of cover of 2.65 m, as measured from the top of the pipe to the final finished grade at the surface.

b) Mains shall be installed to provide adequate water service connection depth at the property line.

c) At crossings of water mains with sewer mains, the following requirements shall apply:

i) Water mains shall cross over sewer mains with a minimum of 0.30m clearance between the outside of pipes to allow for proper bedding and support of both mains.

ii) Where it is necessary for a water main to cross under a sewer main, the water main shall be protected by providing the following:

- A minimum vertical separation of 0.5 m, as measured between the nearest pipe walls of the two mains;
- The sewer main shall be structurally supported to prevent joint deflection and settling; and
- A full length of pipe shall be used for the water main at the crossing location. The pipe section shall be centered beneath the sewer main so that the nearest joints in the water main are equidistant from the crossing location.

d) Where a transmission water main elevation profile has a crest with a change in elevation of greater than two pipe diameters, as measured from the obvert of the pipe at the lowest (sag) point to the invert of the pipe at the highest (crest) point, an air-release device, such as a blow-off or hydrant, shall be provided near the crest point to remove trapped air from the main. If a blow-off hydrant is designed for, then the hydrant must be labeled as a blow-off hydrant upon the drawings. If an air release device is required, then it is to be installed in a chamber with a minimum diameter of 1800 mm and include an isolation valve for the device.

e) Hydrants will be required on all dead end streets for flushing purposes.

3.2.1.3 Hydrants

.1 Hydrants shall be located within the road right-of-way in accordance with the Engineering Standard Drawings in Appendix A.

.2 Refer to the Engineering Standard Drawings in Appendix A for a typical hydrant detail.

.3 The centre of the hydrant barrel shall be a minimum of 0.3 m in front of the sidewalk and a maximum of 1.5 m from the face of the curb. Hydrants shall not be perched above sewer mains.

.4 The maximum distance between hydrants shall not exceed 150 m in single-family residential areas and 120 m in commercial, institutional, industrial, and multi-family residential areas.

.5 Wherever possible, hydrants shall be located at the projection of property lines to avoid potential conflict with driveways. At intersections, hydrants shall be located adjacent to corner cut-offs. Where hydrant placement must be immediately adjacent to a potential driveway location, the City may direct that bollards be installed to protect the hydrant.

.6 For cul-de-sacs, a hydrant must be installed at or near the entrance intersection. Cul-de-sacs exceeding 120 m in length require a hydrant and looping of the water main in accordance with Articles 3.3.1.5 and 3.2.1.2.

.7 Hydrants shall be located a minimum of 5 m from any sewer manhole. Hydrants shall have a minimum clearance of 3.5m otherwise.

.8 Hydrants shall be located such that the distance from any building to a hydrant shall not exceed 75 m of unobstructed distance. For commercial, institutional, industrial, or multi-family residential buildings with standpipes, there must be a hydrant located within 45 m of the standpipe with unobstructed vehicle access provided between the hydrant and the fire department connection to the building.

.9 If deemed necessary, the City may require additional hydrants be installed at high-value or high-risk properties.

.10 All hydrants shall be off-line type. Hydrant leads shall include a valve, located on the boulevard area adjacent to the hydrant within the road right-of-way.

3.2.1.4 Water Main Valves

.1 Wherever possible, water main valves shall be located at the projection of property lines to avoid potential conflict with driveways. At intersections, valves shall be located at the beginning of curb returns.

.2 Valves shall be located such that, in the event of a shutdown, no more than 1 hydrant will be out of service, no more than 3 valves shall be required to achieve the shutdown, and no more than 20 single-family residential units will be affected by the shutdown.

.3 Valves shall be the same size as the water main to which they connect.

.4 Provide a valve near tie-in locations for proposed future extensions of the water main. No services to be tied in past the boundary valve until further extension of the water main is constructed.

.5 When a branch connection off an existing water main is required, the Design must provide for wet-tapping into existing water mains. Wet-tapping shall be accomplished through use of a tapping valve and sleeve while maintaining uninterrupted service through the existing water main. All tapping coupons are to be retrieved from the main.

3.2.1.5 Pressure Reducing Valves

.1 Pressure reducing valves may be required to achieve the design pressure zone(s) through the subdivision.

.2 Pressure reducing valve design shall be based on the hydraulic network analysis for the subdivision and consultation with the City.

.3 Computed network pressures both up and down stream are to be supplied by Consultant with proposed pressure reducing valve drawing submission.

3.2.1.6 Backflow Prevention Valves

.1 Backflow prevention valves shall be required at all commercial, institutional, industrial, and multi-family sites;

.2 If the water network is looped within the URW, backflow prevention valves may not be required at the discretion of the City;

.3 Reference Engineering standard Details in Appendix A;

3.2.1.7 Water Service Connections

.1 Each lot and multi-family unit shall have its own water service connection designed in accordance with the following articles and the Engineering Standard Drawings in Appendix A.

.2 Service connections for commercial lots, institutional, industrial lots, and apartment developments shall be sized according to the anticipated user requirements.

.3 Service connection pipe diameter shall be 25 mm. The Designer shall verify the minimum pipe diameter requirements for lots with extraordinarily long service connections and/or multi-floor buildings where available pressure may pose a problem for the building's plumbing fixtures.

.4 Wherever possible, service pipes shall be aligned at right angles to the main. If installation is not at right angles to the main all connections, bends, tees, curb cocks, elevations, and locations shall be identified on the record drawings.

.5 Water service connections shall have a depth of bury of 3.0 m at property line, as measured from the pipe invert to the final finished grade.

.6 Service connections shall be located such that they do not conflict with potential driveway locations, except on pie-lots on cul de sacs.

.7 Water service connections shall include a main stop at the connection to the water main and a curb stop located at the property line, in accordance with the Engineering Standard Drawings in Appendix A. Curb valves shall be located off of paved surfaces.

.8 Lot services shall be located as shown on the Engineering Standard Drawings in Appendix A, as applicable.

.9 Where the water service is 50 mm or smaller in size, the water and wastewater services may be located in a common trench. Where services are located in a common trench, provide minimum 300 mm horizontal and vertical separation between water and sewer services.

.10 Where the water service is larger than 50 mm diameter, water service pipes shall be located in a separate trench, at least 3 m from any sewer services and 2.0 m from any other buried utility lines.

.11 Service connections shall be extended beyond the gas line into the lot to terminate at 0.15 m inside the lot easement boundary.

.12 For service connections 100 mm in diameter and larger that connect to an existing water main, the Design must provide for wet-tapping into existing water mains. Wet-tapping shall be accomplished through use of a tapping valve and sleeve while maintaining uninterrupted service through the existing water main. Note: The tapping valve is to be left in 100 % open position, denso wrapped and cathodically protected. Tapping valve is to be buried with no operating stem and valve box to the surface unless requested by the City. Location of the tap to be identified on an as-built drawing with measurements to two permanent reference points and GPS coordinates.

3.2.2 Wastewater Collection System

3.2.2.1 General

The wastewater collection system shall be designed with sufficient capacity to convey peak flows, including an allowance for inflow and infiltration (I/I). The following *minimum* criteria shall apply to the Design, as applicable to the proposed development:

.1 Average and Peak Flows in Residential Areas:

a) Population Density: minimum 40 persons/ha or as specified in the approved ASP.

b) Average Sewage Generation Rate: 280 L/capita/day.

c) Peaking Factor: $1+\frac{14}{4+\sqrt{P}}$, where P = contributing population in 1,000s.

.2 Average and Peak Flows in Commercial Institutional and Industrial Areas:

a) Average Sewage Generation Rate: 6,170 l/ha/day.

b) Peaking factor will vary with the nature of the development. The Consultant shall conduct an analysis of the proposed commercial and institutional/industrial developments to estimate the peaking factor. Regardless of the results of the analysis, a minimum peaking factor of 3.0 shall apply.

.3 Inflow/Infiltration (I/I) Allowance:

a) Inflow: 0.4 L/s for every manhole located within a sag area on a roadway with some form of water inflow control in place.

b) Infiltration: 0.28 L/s/ha.

3.2.2.2 Gravity Sewer Mains

.4 Pipe Diameter:

a) Minimum 200 mm.

.5 Flow Velocity:

a) Minimum 0.6 m/s.

b) Maximum 3.0 m/s.

.6 Manning's "n":

a) n = 0.013

.7 Required Sewer Capacity:

a) Estimated Design Flow / 0.86

.8 Pipe Slope

a) Minimum slope shall conform to the following table.

Pipe Diameter (mm)	Minimum Slope (%)
200	0.40
250	0.28
300	0.22
375	0.15
450	0.12
≥ 525	0.10

b) The minimum slope of the first upstream section of sewer main shall have a minimum slope of 1.0%.

c) For curved sewer installation, consider the following table that addresses degree of curvature of sewer mains and the impact on the percent increase to the minimum pipe slope and minimum manhole spacing and incorporate into the design.

C/L Sewer Radius (m)	Increase Minimum Pipe Slope (%)	Minimum Manhole Spacing (m)
92-100	50	92
100-150	40	95
150-200	30	105
200-250	20	115
205-300	10	125
>300	0	135

.9 Pipe Design

a) Strength design shall be integral to the pipe selection process.

.10 Horizontal Alignment

a) Sewer mains shall be located within the road right-of-way, in accordance with the Engineering Standard Drawings in Appendix A.

b) For commercial, institutional, industrial, and multi-family residential developments, the Consultant shall design typical cross-sections depicting the locations of the various necessary infrastructure to suit the particular development. Such cross-sections shall be subject to the review and acceptance of the City.

c) Sanitary sewer mains must be located at least 3.0 m horizontally from any water main and 2.0 m horizontally from any storm sewer main or gas line, as measured between the nearest pipe walls of the two mains.

d) Without limiting the requirements of Article 3.3.1.5 of these Standards, Public Utility Lot (PUL) widths shall be a minimum of 4.0 m for a single utility and 6.0 m for two utilities. A 1.0 m easement is required on the lots to either side of a PUL.

e) Curved sewers shall run parallel to the centreline of the road.

f) Pipe deflection shall be as per manufacturer specifications.

.11 Vertical Alignment

a) Mains shall be installed to provide a minimum depth of cover of 2.6 m, as measured from the top of the pipe to the final finished grade at the surface.

b) Mains shall be installed to provide adequate sewer service connection depth at the property line for each individual lot service.

c) At crossings with water mains, refer to Article 3.2.1.2.

d) At crossings with storm sewer mains, the following requirements shall apply:

i) Typically, storm sewer mains shall cross above sanitary sewer mains with sufficient vertical separation to allow for proper bedding and support of both mains.

ii) Where it is necessary for a storm sewer main to cross under a sanitary sewer main, the storm sewer main shall be protected by providing the following:

- A minimum vertical separation of 0.3 m, as measured between the nearest pipe walls of the two sewer mains;
- The sanitary sewer main shall be structurally supported to prevent joint deflection and settling; and
- A full length of pipe shall be used for the sanitary sewer main at the crossing location. The pipe section shall be centered above the storm sewer main so that the nearest joints in the storm sewer main are equidistant from the crossing location.

3.2.2.3 Manholes

.1 The maximum distance between manholes shall not exceed 135 m. The distance between manholes for curved sewers is based on the table in Section 6.2.5(c).

.2 Manholes are required at all changes in pipe diameter, grade, and direction, at junctions, and at the ends of mains. Curved sewers must abide by manufacturers recommendations and minimum angle.

.3 Manholes must be located to accommodate access by maintenance equipment and vehicles including PUL's and offsite locations / installations.

.4 Wherever possible, manholes shall be located on the projection of property lines to avoid conflict with driveways.

.5 At manholes where changes in pipe diameter occur, the crowns, or obverts, of the mains shall be placed at the same elevation. Regardless of the design flow and pipe slope, pipe diameter shall not be permitted to be decreased through the downstream direction.

.6 For straight-run manholes, a minimum drop of 12 mm shall be provided between the manhole inlet and outlet. For corner-run manholes, a minimum drop of 50 mm shall be provided between the manhole inlet and outlet.

.7 For corner-run manholes, designed to achieve a necessary change in direction of the sewer main, the angle of direction change shall not exceed 90º. This may be further restricted in cases where the estimated sewer flows through the main are not high enough to achieve sufficient cleansing velocity. For sewer mains greater than 600 mm in diameter, changes in flow direction at manholes shall not exceed 45° (degrees).

.8 Drop structures are required at manholes with a vertical separation of 750 mm or greater between the inlet and outlet mains. External drop structures must be provided for any sewer mains requiring a drop. Refer to the Engineering Standard Drawings in Appendix A for further information on drop structures.

.9 Do not locate manholes within sag areas or depressions where surface ponding might occur on hard surfaces (asphalt or concrete). Where such is unavoidable, provision must be made to suitably seal the manhole from surface runoff inflow including a F-39S frame and covers.

3.2.2.4 Wastewater Service Connections

.1 Each lot and multi-family unit shall have its own wastewater service connection designed in accordance with the following articles and the Engineering Standard Drawings in Appendix A.

.2 Service connections for commercial lots, institutional/industrial lots and apartment developments, shall be sized according to the anticipated user requirements.

.3 Wastewater service connections for residential lots shall be a minimum of 150 mm diameter and installed at a minimum 2% grade continuously from the service connection at the main to the service termination at the end of the front lot easement. Sags in gravity service connection pipes that hold standing water will be rejected by the City and require re-installation at the Developers expense.

.4 Maintain a minimum 0.6m horizontal spacing between services;

.5 Up to four (4) services may be tied directly into a precast manhole along the main line;

.6 Wastewater service connections for commercial and multifamily shall have a minimum 150 mm and a minimum slope to maintain a cleansing velocity (0.6 metres per second)."

.7 The City of St. Albert emphasizes prevention of backflow of wastewater into service lines. At the discretion of the City Engineer, inserted tees as a secure coupling or other preventative measures may be required. Special investigation must be undertaken for infill projects.

.8 Wastewater service connections shall have a depth of bury of 3.0 m at the property line, as measured from the pipe invert to the finished final grade at the location where the service enters the lot.

.9 If the connection is more than 5m deep, then servicing must be accomplished through use of a conveyance main qualified upon acceptance by the City Engineer. Secondary mains must abide to a 0.3m offset.

.10 Where bends are required, long radius-type bends shall be used. Alternatively, a combination of 22.5º bends and straight lengths of pipe may be used.

.11 Service connections shall be located such that they do not conflict with driveway locations. (When possible in cul de sac locations.)

.12 Lot services shall be located as shown on the Engineering Standard Drawings in Appendix A, as applicable.

.13 Where the water service is 50 mm or smaller in size, the water and wastewater services shall be located in a common trench. Where services are located in a common trench, provide minimum 300 mm horizontal and vertical separation between water and sewer services.

.14 Where the water service is larger than 50 mm diameter, water service pipes shall be located in a separate trench, at least 3 m from any sewer services and 2.0 m from any other buried utility lines.

.15 Service connections shall be extended beyond the gas line into the lot to terminate at 0.15 m inside the lot easement boundary. Services must be capped at install.

.16 At the end of cul-de-sacs, the three lots nearest to the manhole shall have their sewer services connected to the manhole just above the benching.

.17 Where the service length, measured from the main to the proposed building, will exceed 30 m, provide a cleanout at the property line. Cleanouts shall be in accordance with the Engineering Standard Drawings in Appendix A.

.18 Service connections for commercial, industrial, institutional and multi-family residential lots shall be designed with consideration of the depth requirements for servicing of these lots and the potential impact on the depth requirement for the downstream sewer main.

.19 For commercial, industrial, institutional and multi-family residential lots, a sampling manhole shall be provided on the wastewater service connection, either inside of the road right-of-way or at an accessible location upon private property (minimum 1.5m inside private property). The sampling manhole shall be installed at the time that the lot is developed.

3.2.2.5 Unapproved Connections

.1 Weeping tiles, roof leaders, and other stormwater or groundwater handling appurtenances shall not be permitted to tie-in to the wastewater collection system. Refer to Section 3.2.3 for the requirements pertaining to these systems.

3.2.2.6 Lift Stations and Sewage Force Mains

.1 Wherever possible, every reasonable effort should be made in the design to provide a drainage system for the Development that relies solely on gravity for conveyance in order to minimize the overall operation and maintenance requirements and life cycle costs of the system.

.2 Where absolutely necessary, the City may accept design proposals which include lift stations and force mains to convey wastewater and/or stormwater out of the Development.

.3 The Consultant shall consult with the City while conducting the Design to obtain the City's preliminary comments and input regarding any proposed lift station and force main. The City may have additional requirements of the Design in this respect.

.4 Please refer to Appendix I for all design and construction standards / specifications regarding lift stations.

.5 The Design shall fully describe the details regarding any proposed lift station and force main system. The City may request additional details regarding the design in order to ascertain its acceptability.

3.2.3 Stormwater Management System

3.2.3.1 General

.1 The City's stormwater management objectives are as follows:

a) Prevent all property damage and flooding, and minimize disruption to public activity due to runoff from a 1:5 year return frequency, or more frequent, rainfall event;

b) Prevent significant damage, physical injury, and loss of life due to runoff from a 1:100 year return frequency, or more frequent, rainfall event; and

c) Improve stormwater quality, through filtering of contaminants, prior to discharge to receiving watercourses and prevent erosion of the receiving watercourse.

.2 Refer to Article 3.2.3.11 for details regarding stormwater management system design for infill or redevelopment projects.

.3 Infill developments must abide by the following onsite storm water management requirements:

a) Approved stormwater rates;

i) Carrot Creek = 1.8l/s/ha

ii) Sturgeon River = 2.5 l/s/ha

b) Stormwater management requirements shall be evaluated by the design Engineer for each development respectively. Designers shall utilize LID wherever applicable and always limit environmental impact when possible;

.4 The City's stormwater management system consists of two distinct conveyance systems: a minor system and a major system (i.e. the dual drainage concept). Under this concept, the minor system is designed for drainage and the major system is designed for flood control.

a) The term the "minor system," is applied to the network of local and trunk sewers, inlets and street gutters which have traditionally been provided as a convenience system to rapidly carry away storm runoff from road surfaces. Minor systems have generally been designed with capacity to remove runoff from minor rainfall events. That is, those with relatively short return periods, i.e. occurring relatively frequently. The rate of storm runoff generated by less frequent, more intense, rainfall events will be greater and may exceed the capacity of the minor system.

b) Runoff in excess of the capacity of the minor system will pond in depression areas or follow whatever overflow escape route is available. This network of planned or unplanned ponding areas and overland flow routes is the "major system". An urbanized area will have a major drainage system, whether it is planned and designed or not. If a major system is adequately planned and designed and incorporated into the urban infrastructure, it should alleviate the potential inconvenience, property damage and loss of life, which could otherwise result from major rainfall events.

.5 In addition to the minimum requirements set forth by these Standards, the requirements of the Stormwater Management Guidelines for the Province of Alberta, Alberta Environment, latest edition, must be duly addressed by the Design. Wherever feasible and applicable, Alberta Environment's stormwater quality best management practices (BMPs) shall be applied within the Design. In accordance with Alberta Environment's Municipal Policies and Procedures Manual (latest edition), stormwater management techniques to improve water quality shall be included to effect a minimum of 85% removal of sediments of particle size 75 μm or greater.

.6 Effluent from sanitary sewers or any other potentially contaminated drainage from commercial sites shall not be discharged into storm sewers.

.7 The Design shall provide for the interception, conveyance, and storage of all overland drainage entering the Development indefinitely or in the interim period until development of surrounding areas occur. Furthermore, the stormwater management system shall be designed to ensure the Development does not adversely affect the existing drainage pattern of surrounding areas at any time.

.8 Where a capacity deficiency is determined within stormwater management infrastructure located downstream of the Development, the Developer and the City shall deliberate for a potential solution through the Development Agreement process.

3.2.3.2 Minor System General Design Criteria

The following *minimum* criteria shall apply to the Design for the minor system, as applicable to the proposed development:

.1 General

a) The minor system shall be designed to accommodate runoff generated by a 1:5 year rainfall event and flows from the foundation drain discharge system. Storm sewer mains shall be designed to accommodate, without surcharge, the anticipated design flow.

b) The minor system shall accommodate design flows such that:

i) An equivalent width of one traffic lane remains free from inundation at design flows on local and collector roadways;

ii) An equivalent width of one traffic lane in each direction remains free from inundation at design flows on arterial roadways; and

iii) No surcharging of sewer pipes occurs.

c) The application of computer simulation modeling is highly recommended to be employed for the Design, however, the Rational Method may be used for the detailed design of minor drainage systems that drain areas of 65 ha or less. Computer simulation modeling shall be required for the Design where the minor drainage systems drain areas larger than 65 ha. Computer simulation modeling shall be completed using a computer program acceptable to the City and in accordance with acceptable standard design practices. Modeling results shall be fully detailed in the Design Report to be submitted with the application for the Development Agreement.

d) *MIKE Urban* is acceptable modeling software for design. Use of other programs must be pre-approved by the City.

.2 Design Flows

a) The Rational Method shall be employed to estimate design flows for areas smaller than 65 ha, as follows:

$$Q = \frac{CiA}{360}$$

Where: Q = runoff rate (m3/s)
C = runoff coefficient
i = rainfall intensity (mm/hr)
A = contributing area (ha)

b) Runoff Coefficient

i) Where the site-specific conditions of ultimate site development are unknown, runoff coefficients may be selected from the following table on the basis of the zoning or proposed land uses for the Development.

Land Use	Runoff Coefficient, C	Imperviousness Range (%)
Parks, Reserves, Grassed Areas	0.15	10 – 50
Single Family Residential	0.65	40 – 60
Multi-Family Residential	0.7	50 – 100
Commercial	0.9	50 – 100
Paved Areas and Roofs	0.95	90 – 100

- Where the site-specific conditions of ultimate site development are known, runoff coefficients shall be consistent with the imperviousness (imp) for each respective land use and shall be calculated using the following formula for design rainfall events with a return period of 10 years or less.

$$C = (0.95 \times imp) + 0.1(1.0 - imp)$$

ii) To apply the preceding formula to determine the runoff coefficient for a design rainfall event with a return period greater than 10 years, modify the calculated runoff coefficient in accordance with the following table.

c) Rainfall Intensity

Return Period (t_R)	Runoff Coefficient Multiplier
10 year < $t_R \leq$ 25 year	1.1
25 year < $t_R \leq$ 50 year	1.2
t_R > 50 year	1.25

i) Rainfall intensity (i) is determined from the appropriate Intensity-Duration-Frequency (IDF) curve based on the time of concentration (t_c), as calculated by the following formula:

$$t_c = t_i + t_t$$

Where: t_c = time of concentration (min)
t_i = inlet time (min)
t_t = travel time (min)

ii) Inlet time, ti, is the time for drainage to travel from the extreme limits of the catchment to the first point of inflow into the storm sewer being designed. Inlet time is dependent on the imperviousness, ground slope, and size of the catchment. A maximum inlet time of 15 minutes shall apply to single-family residential areas. Inlet time must be less than 15 minutes for commercial, institutional/industrial, and medium/high density residential areas due to a larger percentage of the area being impervious. For conceptual or preliminary designs, inlet time can be estimated from the catchment area and imperviousness using the following table:

	Design Inlet Time (t_i)	Imperviousness		
		30%	50%	>70%
Area	$t_i \leq 8.0$ ha	8.0 min	8.0 min	5.0 min
	$8.0 < t_i < 40$ ha	9.2 min	9.2 min	6.0 min
	$t_i > 40$ ha	10.4 min	10.4 min	7.3 min

iii) Travel time, t_t, is the time for drainage to travel through the conveyance system from the point of inflow to the design location. Travel time is dependent on the pipe material, pipe slope, and the design flow rate.

iv) Rainfall data shall be as provided by a climate change study conducted by the University of Alberta and EPCOR. The data was collected at 11 different monitoring stations across the city of Edmonton over a span of 32 years (1984-2015). The data is summarized in the intensity tables below:

Table 3.2.2: IDF Curves - Intensity Table

See the Appendix for complete IDF curve – Intensity Table.

Table 3.2.3: IDF Curves - Intensity Table-Summary

Edmonton 13 Rain Gauges Upper Bound - IDF Period:
1984-2015 Maximum
Years of Record = 32
IDF Intensity (mm/hr)

Time		Return Frequency						
Minutes	**Hours**	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**
5	0.083	66.0	89.0	108.6	138.0	162.2	188.4	217.8
10	0.167	48.2	66.7	82.6	106.2	125.3	147.2	173.5
15	0.250	38.7	54.3	67.6	87.4	103.5	122.4	145.9
20	0.333	32.6	46.2	57.7	74.9	88.9	105.7	126.8
25	0.417	28.5	40.5	50.7	65.9	78.4	93.5	112.7
30	0.500	25.4	36.2	45.3	59.1	70.4	84.2	101.8
35	0.583	23.0	32.9	41.2	53.7	64.1	76.8	93.2
40	0.667	21.0	30.2	37.8	49.3	58.9	70.8	86.0
45	0.750	19.4	27.9	35.0	45.7	54.7	65.8	80.1
50	0.833	18.1	26.1	32.6	42.6	51.1	61.5	75.0
55	0.917	17.0	24.5	30.6	40.0	48.0	57.9	70.7
60	1	16.0	23.1	28.9	37.7	45.3	54.7	66.8
120	2	9.9	14.3	17.8	23.3	28.2	34.3	42.2
180	3	7.4	10.7	13.3	17.4	21.1	25.8	31.8
240	4	6.0	8.7	10.8	14.1	17.2	21.1	26.0
360	6	4.5	6.5	8.0	10.4	12.8	15.8	19.5
720	12	2.7	3.9	4.8	6.2	7.7	9.6	11.8
1440	24	1.6	2.4	2.9	3.7	4.6	5.8	7.1

Table 3.2.4: IDF Parameters

Rate=a(t+c)^b	Return Frequency						
Parameters	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**
a (t in min)	337.0	498.1	665.2	909.9	1027.7	1200.5	1498.1
b	-0.732	-0.735	-0.748	-0.757	-0.742	-0.733	-0.735
c (min)	4.3	5.4	6.3	7.1	7.0	7.5	8.8
R^2	0.994	0.997	0.998	0.998	0.998	0.997	0.994

d) Catchment Area

i) Catchment area is the area, in ha, of the catchment contributing inflow into the storm sewer being designed.

e) Foundation Drain Discharge Flows

i) The geotechnical report must include estimates for weeping tile flows and define any special design and construction considerations for foundations or other infrastructure within the Development that might be impacted by weeping tile flows causing settlement or other deleterious effects.

ii) To be connected to the storm main directly.

3.2.3.3 Gravity Sewer Mains

.1 Pipe Diameter:

a) Minimum 300 mm

.2 Flow Velocity:

a) Design mean flow velocity 0.9 to 1.0 m/s

b) Minimum 0.6 m/s

c) Maximum 3.0 m/s

.3 Manning's "n":

a) n = 0.013

.4 Pipe Slope:

a) Minimum slope shall conform to the following table:

Pipe Diameter (mm)	Minimum Slope (%)
150	0.60
300	0.22
375	0.15
450	0.12
≥525	0.10

b) The parameters for curved sewers are summarized in Section 6.2.5.c.

.5 Pipe Design

a) Strength design shall be integral to the pipe selection process.

.6 Storm Trunk Sewer Mains

a) Storm trunk sewers are defined as storm sewer mains which serve drainage areas greater than 30 ha or have a diameter of 1200mm or larger.

b) Storm trunk sewers shall be designed to accommodate, without surcharge, the anticipated design flow multiplied by a safety factor of 1.25 in order to account for potential future changes in land use and ensure trunk sewers do not surcharge before upstream lateral storm sewers.

c) In cases where a storm trunk sewer will receive both uncontrolled flow from a drainage area greater than 30 ha *and* controlled discharge from stormwater management facilities, the storm trunk sewer shall be designed to accommodate the anticipated uncontrolled design flow multiplied by a safety factor of 1.25 plus the design maximum outflow rates from the stormwater management facilities.

.7 Horizontal Alignment

a) Storm sewer mains shall be located within the road right-of-way, in accordance with the Engineering Standard Drawings in Appendix A.

b) For commercial and multi-family residential developments, the Consultant shall design typical cross-sections depicting the locations of the various necessary infrastructure to suit the particular development. Such cross-sections shall be subject to the review and acceptance of the City.

c) Storm sewer mains must be located at least 3.0 m horizontally from any water main and 2.0 m horizontally from any sanitary sewer main or gas line, as measured between the nearest pipe walls of the two mains.

d) City owned and operated storm sewer mains that must cross through, or be located within, private property or any other property controlled by other authorities, shall be protected by easements, secured by the Developer, in the name of the City as the grantee. Easements shall be of sufficient width to provide a minimum clearance of 0.6 m from the edge of the easement to the nearest side of the sewer main, and shall be a minimum of 4.0 m wide for a single utility and 6.0 m for two utilities for maintenance purposes. Manholes, catch basins, and other point infrastructure should not be located within easements unless specifically authorized by the City.

e) Without limiting the requirements of Article 3.3.1.5 of these Standards, Public Utility Lot (PUL) widths shall be a minimum of 4.0 m for a single utility and 6.0 m for two utilities. A 1.0 m easement is required on the lots to either side of a PUL.

f) In scenarios where roadways are designed on a long radius curvature, curved sewers shall run parallel to the centreline of the road. Long radius-type bends combined with straight pipe sections shall be used to achieve the curve. Excessive pipe bends may be subject to the provision of manholes at the discretion of the City.

.8 Vertical Alignment

a) Sewer mains shall be installed to provide a minimum depth of cover of 1.80 m, as measured from the top of the pipe to the final finished grade at the surface. Depth shall be adequate to provide the minimum depth of cover over sump pump discharge collection sewers and catch basin leads.

b) At crossings with water mains, refer to Article 3.2.1.2.

c) At crossings with sanitary sewer mains, refer to Article 3.2.2.2.

3.2.3.4 Manholes

.1 The maximum distance between manholes shall not exceed 135 m for sewers less than 1,200 mm in diameter. For sewers 1,200 mm in diameter or greater, the maximum distance between manholes shall not exceed 500 m.

.2 Manholes are required at all changes in pipe diameter, grade, and direction, at junctions, at the ends of mains. Curved sewers must abide by manufacturers recommendations and minimum angle.

.3 Wherever possible, manholes shall be located on the projection of property lines to avoid conflict with driveways.

.4 At manholes where changes in pipe diameter occur, the crowns, or obverts, of the mains shall be placed at the same elevation. Regardless of the design flow and pipe slope, pipe diameter shall not be permitted to decrease through the downstream direction.

.5 For straight-run manholes, a minimum drop of 12 mm shall be provided between the manhole inlet and outlet. For corner-run manholes, a minimum drop of 50 mm shall be provided between the manhole inlet and outlet.

.6 For corner-run manholes, designed to achieve a necessary change in direction of the sewer main, the angle of direction change shall not exceed 90º. This may be further restricted in cases where the estimated sewer flows through the main are not high enough to achieve sufficient cleansing velocity. For sewer mains greater than 600 mm in diameter, changes in flow direction at manholes should not exceed 45°, unless a suitable transition manhole is provided.

.7 Drop structures are required at manholes with a vertical separation of 1500 mm or greater between the inlet and outlet mains. External drop structures must be provided for any sewer mains that require a drop. Refer to the Engineering Standard Drawings in Appendix A, for further information on drop structures.

3.2.3.5 Catch Basins

.1 The maximum distance between catch basins along roadways shall not exceed 120 m.

.2 Catch basins shall be located such that no ponding shall occur during the 1:5 year, or more frequent, rainfall event.

.3 Provide sufficient catch basins such that the flow depth in gutters does not exceed the top of curb during the 1:5 year rainfall event.

.4 At intersections, locate catch basins with sufficient inlet capacity on the upstream side in order to prevent drainage from passing through the intersection.

.5 At curb returns, locate catch basins on the upstream side of crosswalks.

.6 At sag locations and depressions, locate catch basins with sufficient inlet capacity such that ponding does not exceed 150 mm for a minor event.

.7 Wherever possible, catch basins shall be located on the projection of property lines to avoid conflict with driveways.

.8 Catch basins shall be located upstream of traffic calming features.

.9 Catch basins shall have a minimum barrel diameter of 900 mm and minimum sump depth of 600 mm.

.10 For residential subdivisions, catch basins and leads shall not be located beyond the limits of the public rights-of-way. Where the lots are authorized to grade to the back, in accordance with Article 3.2.3.10, a catch basin must be provided where the drainage easement ties-in to the nearest public right-of-way.

3.2.3.6 Catch Basin Leads

.1 Catch basin leads shall be designed to accommodate, without surcharge, the anticipated design flow for a 1:5 year storm event.

.2 Pipe Diameter:

a) Minimum 250 mm.

.3 Flow Velocity:

a) Minimum 0.6 m/s.

b) Maximum 3.0 m/s.

.4 Manning's "n":

a) n = 0.013

.5 Slope:

a) Minimum 1.0%

.6 Catch basin leads shall be a maximum of 30 m in length unless a catch basin manhole is provided at the upstream end of the catch basin lead.

.7 Catch basin leads shall be installed to provide a minimum depth of cover of 1.50 m, as measured from the top of the pipe to the final finished grade at the surface.

.8 Catch basin leads must be connected to a catch basin manhole or to a manhole on the storm sewer main. Direct connections to storm sewer mains shall be permitted only upon prior approval by the City Engineer.

3.2.3.7 Stormwater Service Connections

Each lot shall have its own stormwater service connection designed in accordance with the following.

.1 Commercial, Industrial, Institutional and Multi-Family Developments

a) Service connections for commercial, industrial, institutional and multi-family developments shall be a minimum diameter of 300 mm and sized according to the anticipated site requirements and shall include sewer mains, catch basins, catch basin leads, catch basin manholes, and manholes as required to manage onsite drainage in accordance with the other articles of this section. The service connections shall be designed with consideration of the depth requirements for servicing of these lots and the potential impact on the depth requirement for the downstream sewer main.

b) For car wash facilities, wastewater from the facility must drain to the wastewater collection system and shall not be permitted to be connected to the stormwater management system.

.2 Detached Residential Developments

a) Stormwater service connections for detached residential (single family) developments shall be adequate to convey discharge flows into the stormwater collection system.

b) Service connection pipe diameter shall be a minimum of 100 mm.

c) The minimum continuous slope of storm service connections shall be 2.0% from the connection to the main to the service termination at 0.15m inside the lot easement boundary.

d) Service connections shall have a minimum depth of cover of 2.20 m throughout the length of the service, as measured from the top of the pipe to the final finished grade. Service connections shall be supported throughout their entire length.

e) Service connections shall be located such that they do not conflict with driveway locations. (except in cul de sacs)

f) Service connections shall be extended beyond the gas line into the lot to terminate at 0.15 m inside the easement boundary. Services must be capped at install.

g) Lot services shall be located as shown on the Engineering Standard Drawings in Appendix A, as applicable.

h) Sump pump discharge connections at the building shall be in accordance with the Engineering Standard Drawings.

i) If the connection is more than 5m deep, then servicing must be accomplished through use of a conveyance main qualified upon acceptance by the City Engineer. Secondary mains must abide to a 0.3m offset.

j) Maintain a minimum 0.6m horizontal spacing between services;

k) Up to four (4) services may be tied directly into a precast manhole along the main line;

3.2.3.8 Oil and Grit Interceptors (OGI)

.1 The City will require OGIs be installed in a new residential subdivision where the site discharges to a natural drainage course without prior treatment, and upstream of all storm water management facilities.

.2 The City will require OGIs be installed on new or redeveloped commercial, institutional and industrial sites larger then 0.4 Ha. The City Engineer reserves the right to enforce OGIs on any site at their discretion.

.3 Even in the presence of a storm water management facility prior to release to the natural drainage course, the City may require OGIs to be installed within a development at the discretion of the City Engineer. Development scenarios are evaluated on a case by case basis and consider site specific factors including, but not necessarily limited to, upstream drainage contributions from collector or arterial roadways, business types, presence or storage of hydrocarbons, hours of operation, total parking area, and location within the overall storm water infrastructure system.

.4 OGIs shall use the hydraulic energy of the conveyed stormwater to separate, trap, and store stormwater pollutants.

.5 OGIs must be capable of trapping fine sand, silt, clay and organic particles in addition to larger sand and gravel particles, and small floatables.

.6 OGIs shall be capable of removing 85% of the average annual total suspended solids (TSS) load and 95% of the floatable free oil without scouring previously captured pollutants.

.7 The Design shall provide calculations substantiating removal efficiencies and shall include correlation to field monitoring results for the proposed OGI system.

.8 OGIs shall be installed in a location that is accessible for maintenance vehicles. Where remote OGI locations are proposed the City will require a pathway with sufficient width and structural integrity to provide maintenance equipment access. The current maintenance equipment utilized by the City weighs 60,000 pounds, is 11.5m long and 2.5m wide.

3.2.3.9 Lift Stations and Stormwater Force Mains

.1 Wherever possible, every reasonable effort should be made in the design to provide a drainage system for the Development that relies solely on gravity for conveyance in order to minimize the overall operation and maintenance requirements and life cycle costs of the system.

.2 Where absolutely necessary, the City may accept design proposals which include lift stations and force mains to convey wastewater and/or stormwater out of the Development.

.3 The Consultant shall consult with the City while conducting the Design to obtain the City's preliminary comments and input regarding any proposed lift station and force main. The City may have additional requirements of the Design in this respect.

.4 Please refer to Appendix I for all design and construction standards / specifications regarding lift stations.

.5 The Design shall fully describe the details regarding any proposed lift station and force main system. The City may request additional details regarding the design in order to ascertain its acceptability.

3.2.3.10 Major System General Design Criteria

The following *minimum* criteria shall apply to the Design for the major system, as applicable to the proposed development:

.1 General

a) The major system shall be designed to accommodate runoff generated by a 1:100 year rainfall event.

b) The maximum depth of peak flows and ponding shall not exceed 150 mm on arterial roadways.

c) Apply computer simulation modeling or the Rational Method in accordance with Article 3.2.3.2.

d) The Design must include an analysis of the capacity and characteristics of the downstream receiving drainage course and identification of any measures to be completed to prevent downstream flooding and/or for erosion and sediment control.

.2 Conveyance Components

a) Major system conveyance components must provide continuous overland flow routes to a designated receiving watercourse.

b) Overland flow routes shall accommodate design flows plus anticipated overflows from stormwater management facilities.

c) The depth of peak flows and ponding for major system conveyance components (i.e. roadways, channels, etc.) shall be limited to prevent significant hazard to the public, property damage, and erosion.

d) The maximum depth of peak flows and ponding along major system conveyance components shall be a minimum of 350 mm below the lowest anticipated landscape grade or opening along adjacent lots and buildings.

e) Manning's n:

i) n = 0.013 for roadways.

ii) n = 0.050 for grassed boulevards.

f) Arterial roadways shall not form a part of the major system conveyance system. Where the nature of the terrain imposes unreasonable difficulty in achieving this objective, the City may authorize the use of an arterial roadway as part of the major system conveyance system provided the all other applicable conditions are met. Such situations shall be reviewed by the City on a case-by-case basis.

g) Concrete Swales

i) Within public right-of-ways and easements, swales may be employed for the collection and conveyance of runoff to appropriate points of interception or release. Minimum width of such right-of-ways or easements to be 3 m.

ii) Swales shall be in accordance with the Engineering Standard Drawings in Appendix A.

h) Culverts

i) Culverts may be provided to connect swales and drainage channels across roadways and other surface improvements.

ii) Culverts shall be IPEX Ultra-Rib PVC, or an approved equivalent.

iii) Refer to the Engineering Standard Drawings in Appendix A.

iv) Energy dissipation and sediment and erosion control must be considered in culvert design.

v) Culverts must include gratings for public safety. Gratings shall have a maximum clear bar spacing of 150 mm and shall be suitably anchored to the outfall structure. Grated outlet structures must be designed with twice the required hydraulic capacity in order to prevent plugging and designed for a maximum flow velocity of 1.0 m/s through the grating. Gratings must be designed to allow maintenance access.

.3 Lot Grading

a) Please refer to *article 3.1.3* for information on lot grading.

.4 Storage Components

a) Major system storage components, also referred to as stormwater management facilities, which are to be owned and operated by the City, shall be designed based on the critical volume determined for each stormwater management facility from the 1:100 year rainfall event, and as prescribed by applicable Alberta Environment standards and guidelines. The design of these facilities must incorporate calculations for a range of rainfall durations to assess which will result in the critical volume for the catchment area.

b) Commercial, institutional, and high-density residential developments (including apartment and high-density multi-family sites) require onsite stormwater management facilities or onsite stormwater storage. These stormwater management facilities and/or storage facilities shall be designed based on the critical volume determined from the 1:25 year rainfall event. Suitable overland flow routes shall be provided from the facility to accommodate overflows for more significant rainfall events. Storm calculations must be provided to the City for review. **The Design must limit post-development peak runoff flows from the Development to the following:**

i) Carrot Creek = 1.8 l/s/ha

ii) Sturgeon River = 2.5 l/s/ha

c) Where one or more stormwater management facilities are proposed in an Area Structure Plan, the Developer shall consult with the City regarding site-specific requirements for each facility. Such may include special landscaping, fencing, lighting, recreational, and operation and maintenance requirements. The City may also have specific requirements for stormwater quantity or quality control, which must be adequately addressed by the Design.

d) The geotechnical report shall be integral to the design of stormwater management facilities.

e) Suitable warning signage shall be provided around all stormwater management facilities for public safety. Signage shall conform to The City of St. Albert Sign Guidelines, latest edition.

f) Where stormwater management facilities will be constructed in phases, the Design shall fully detail how such phasing shall be achieved and how the interim system shall operate.

g) Landscaping in and around stormwater management facilities shall incorporate bark chips or other floatable decorative landscaping materials only above the 1:100 year flood line and have a maximum of 75 mm of wood chip mulch. Biodegradable erosion blankets shall be used below the 1:100 year flood line.

h) Detailed operation and maintenance manuals shall be provided for all stormwater management facilities in accordance with Article 2.7.3.2.

i) Underground Storage Facilities

  i) Underground storage facilities include various proprietary systems for storing surface runoff in buried storage vaults. Such facilities are not preferred and shall only be allowed upon the discretion and written acceptance of the City.

3.2.3.10.1 Stormwater Management Facilities

The City of St. Albert has preference for wet ponds over dry ponds wherever possible. The City is also looking to develop more constructed wetlands in lieu of wet ponds with a naturalized edge and will collaborate with Developers who bring forth innovative low impact designs.

.1 Wet Ponds

Wet ponds temporarily store stormwater runoff to restrict post-development peak discharge rates and promote settling of solid particles. Where storage is required for residential subdivisions, wet ponds or constructed wetlands are recommended and should be incorporated into the Area Structure Plan.

Wet ponds, which are to be owned and operated by the City, shall be located within a designated PUL. Lands subject to inundation under the design rainfall event shall be included within the PUL. Refer to Appendix A for more detail.

Minimum surface area of the pond at normal water level is recommended to be 2 ha pending design constraints.

Minimum depth of the pond at normal water level shall be 2.5 m.

Minimum width of the water surface at the normal water level shall be 25 m.

Algae mitigation is paramount. Good practices such as aeration, sediment runoff controls and ‘short circuiting flow’ mitigation should be integrated into the design to control algae.

Inlets and Outlets

i) Inlets and outlets must be located as far from each other as possible in order to avoid hydraulic short-circuiting and maximize detention time and circulation through the facility.

ii) Inlets and outlets shall be fully submerged with pipe obverts a minimum of 1.0 m below the normal water level and inverts a minimum of 150 mm above the lake bottom.

iii) The facility’s normal operating level shall be at or below the pipe invert at the nearest manhole on the inlet storm sewer main.

iv) The facility’s anticipated high water level during a 1:5 year rainfall event shall be at or below the pipe obvert at the nearest manhole on the inlet storm sewer main.

This will typically require the installation of a drop structure on the inlet storm sewer main.

v) Sediment basins shall be provided at inlets for control of heavy solids.

vi) An emergency overflow must be provided to redirect flows in excess of the design peak flow for the facility. The overflow shall tie-in to a suitable overland flow route.

vii) Grates will not be required for fully submerged structures to allow free flow of water and mitigate obstructions.

Pond design shall provide for semi-annual turnover under average annual precipitation conditions.

The facility's normal water level shall be a minimum of 300 mm below the lowest basement weeping tile of the buildings located adjacent to the facility.

Sideslopes must meet recommendations of the geotechnical report and shall be a maximum of 3:1 on the pond exterior and 5:1 on the pond interior.

Refer to the Engineering Standard Drawings in Appendix A for a typical wet pond cross-section.

The pond bottom and sideslopes shall be constructed of materials and to slope angles as recommended by the geotechnical report.

A manhole shall be provided adjacent to the pond that is hydraulically connected to the wet pond to allow direct measurement of the water level of the pond.

Alberta Environment stormwater quality best management practices must be addressed by the design for the facility.

Erosion control must be provided around the perimetre of wet ponds. Such shall be compatible with adjacent land use and provide for low maintenance and public safety.

All-weather vehicle access must be provided to all inlet, outlet, and control structures, and other works in or around the facility which may require maintenance, with suitable provision for launching boats into the pond. A single boat launch/access point is acceptable as long as a minimum access width and depth of 5m and 2m respectively is maintained between the boat launch and all inlet, outlet, control structures/ other works to facilitate access of City personnel.

Control manholes, fountain gates or alternatives to be provided

Walkways and paths should be located at or above the 1:25 year storm event level to mitigate inundation during storm events.

.2 Dry Ponds

Dry ponds temporarily store stormwater runoff to restrict post-development peak discharge rates and only contain standing water during design rainfall events. The city will only allow the use of dry ponds based on the approval of the City Engineer. Where storage is required for commercial or high-density residential developments, the City may accept dry ponds if the use of wet ponds or constructed wetlands are impractical.

Dry ponds, which are to be owned and operated by the City, shall be located within a designated PUL. Lands subject to inundation under the design rainfall event shall be included within the PUL.

Maximum active storage depth of the pond shall be 1.5 m.

Inlets and Outlets

i) Inlets and outlets must be located as far from each other as possible in order to avoid hydraulic short-circuiting and maximize detention time and circulation through the facility.

ii) Inlets and outlets to dry ponds must include gratings over openings for public safety. Gratings shall have a maximum clear bar spacing of 150 mm and shall be suitably anchored to the inlet/outlet. Grated outlet structures must be designed with twice the required hydraulic capacity in order to prevent plugging, and designed for a maximum flow velocity of 1.0 m/s through the grating. Gratings must be designed to allow maintenance access.

iii) Inlet and outlets structures must be protected with suitable fencing and guardrails.

iv) The facility's anticipated high water level during a 1:5 year rainfall event shall be at or below the pipe obvert at the nearest manhole on the inlet storm sewer main. This will typically require the installation of a drop structure on the inlet storm sewer main.

v) Sediment basins shall be provided at inlets for control of heavy solids.

vi) Outlets shall include a slide gate or other suitable feature to control outflow from the facility.

vii) Outlet capacity shall be sufficient to drain dry pond in a reasonable amount of time following a storm event as approved by City Engineer.

viii) An emergency overflow must be provided to redirect flows in excess of the design peak flow for the facility. The overflow shall tie-in to a suitable overland flow route.

Pond design shall include provisions for maintenance of the dry pond between rainfall events.

The pond shall be graded to promote proper drainage of the facility between rainfall events. Minimum slope of the pond bottom shall be 2%.

Sideslopes must meet recommendations of the geotechnical report and shall be in accordance with the Engineering Standard Drawing.

The pond bottom and sideslopes shall be constructed of materials as recommended by the geotechnical report.

Landscaping of the pond shall be compatible with adjacent land use and provide for low maintenance. The minimum requirement is to have trees, shrubs and native grass seed mix that is drought tolerant and capable of withstanding wet conditions.

Stormwater quality best management practices must be addressed by the design for the facility.

All-weather vehicle access must be provided to all inlet, outlet, and control structures, and other works in or around the facility which may require maintenance.

.3 Constructed Wetlands

Constructed wetlands store stormwater runoff for extended periods of time to restrict post-development peak discharge rates and improve stormwater quality. Constructed wetlands are specifically recommended for any storage facilities that are located immediately upstream of a receiving watercourse, at the end of a storm sewer main.

Requirements for the design of constructed wetlands for stormwater management shall be reviewed on a case-by-case basis in order to address site-specific stormwater quantity and quality requirements within existing environmental factors.

Minimum requirements of current Alberta Environment standards and guidelines pertaining to the design of constructed wetlands shall expressly apply.

Wetland Drainage Area

A minimum drainage area of 5 ha is required to generate constant or periodic flow to the constructed wetland.

i) The smallest practical drainage area is considered to be 20 ha. For drainage areas between 5 and 20 ha in size, the City may approve the use of constructed wetlands on a site-specific basis.

ii) To determine that a permanent pool can be maintained in a constructed wetland, hydrological studies are to be conducted using the size and characteristic of the drainage area.

iii) The City prefers that fewer, larger wetlands be constructed rather than a series of smaller constructed wetlands.

iv) The Developer is required to implement the ESC Plan during development in the drainage area to minimize sediment loading to the forebay and wetland during the construction phase of the project and during the staged construction of the SWMF.

Wetland Soil Characteristics

v) For wetland deep water areas, low soil permeability of 10-7 m/s is recommended to maintain a permanent pool of water and minimize exfiltration. Compacted sandy clays and silty clay loams may be suitable provided that documented geotechnical testing demonstrates low soil permeability.

vi) Wetland vegetative zones can be constructed using soils from recently displaced wetlands, sterilized topsoil, or peat from within the drainage basin or region. A layer of 10 cm to 30 cm of soil shall be spread over the vegetation zones of the constructed wetland. Planting should be done in this soil over the 2 years following construction.

Summary Guide for Design of Constructed Wetlands			
Design Element	**Design Objective**	**Minimum Criteria**	**Recommended Criteria**
Drainage Area	Maintain the sustainability of the wetlands, provide constant and or periodic flows and prevent stagnant and long periods of dry conditions.	Min. 5 Hectares	20 Hectares
Wetland Surface Area		Min 1 Hectare at NWL	
Wetland Vegetation Upland Vegetation	Stormwater quality treatment. For public safety. To act as safety bench and also weed barrier to prevent root invasion of adjacent properties by Poplar and Aspen species.	Plant diverse species within one year after construction; use soils from displaced wetlands or topsoil or peat to a depth of 10-30 cm of the bottom of the wetland. A 2 m wide shallow marsh area around the wetland at NWL. Screening requirements between NWL and the most critical design storm event to be agreed between the Developer and City.	
Active Storage Detention Time	To enhance treatment and suspended solids settling.	Drawdown time: ≥ 24 hrs for volume equivalent to runoff from a 1:2 storm; 48 hrs for volume equivalent to runoff from a 1:5 storm; ≤ 96 hours for 90% of total active storage volume above NWL. Dead storage: 80 m3of storage volume/ha for a drainage area 35% impervious. 140 m3 storage volume/ha for a drainage area 85% impervious.	

Length to Width Ratio	To maximize flow path and minimize short-circuiting. Provide longer contact time ver the surface area of the marsh. Optimize treatment capability.	Effective flow path length to be 3 times the relative wetland width. Incoming water should be well distributed throughout the land and conveyed as sheet flow after the forebay.	
Wetland Depth	To encourage emergent vegetation.	Variety of water depths: 0.1 m - 0.6 m. Average depth: 0.3 m. Deep water areas, >2 m, only in forebay and permanent pool. Water fluctuation in excess of 1m above NWL should be infrequent.	
Recreational Uses	Public amenity and safety.	A trail may be provided beside the mow strip between NWL and the private property boundary. Planting strategies should deter direct access of public to wetlands.	
Side Slopes	To provide drainage and ensure safety along deep open water. To provide erosion control and accessibility for maintenance.	5H:1V along all edges except at accessible deep water areas in forebay and permanent pool areas where shall be 7H:1V. Terraced slopes are acceptable. The 2 m wide shallow marsh area at the NWL boundary shall be 10H:1V slope.	
Inlet	Safety and maintenance.	Maximum depth: 3 m. Distanced far away from outlet to avoid short-circuiting of flow. Fully submerged: crown 1.0 m below NWL; invert 100 mm above bottom.	
Outlet	Safety, maintenance and assistance in plant species management.	Use variable water level control structures to regulate water levels between 0.5 m below NWL and 0.5 m above NWL. Maximum depth: 3 m.	

		Distanced far away from inlet to avoid short-circuiting of flow. Fully submerged: crown 1.0 m below normal water level; invert 100 mm above bottom.	
Fencing	Safety	Use natural solutions such as grading and planting strategies. Developer should provide fencing around the PUL with openings for maintenance and public access to trails.	

3.2.3.11 Stormwater Management System Design for Infill and Redevelopment Projects

.1 Refer to Article 2.6.2 for submission requirements.

.2 The Design shall provide for the interception, conveyance, and storage of all overland drainage which enters the Development from surrounding areas for the indefinite future or interim period until infill or redevelopment of such areas occurs. Furthermore, the stormwater management system shall be designed to ensure the Development does not adversely affect the existing drainage pattern of surrounding areas, whether during or following construction.

.3 Peak allowable outflow rate from the onsite collection system to the receiving storm sewer system shall be 35 L/s/ha or equal to the available conveyance capacity of the receiving sewer during a 1:5 year rainfall event, whichever is less.

.4 Sewers

a) Pipe Diameter:

i) Minimum 150 mm.

.5 Flow Velocity:

a) Minimum 0.6 m/s.

b) Maximum 3.0 m/s.

.6 Manning's "n":

a) n = 0.013

.7 Slope:

a) Minimum slope shall be in accordance with the table provided in Article 3.2.3.3.

.8 Pipe Design

a) Strength design shall be integral to the pipe selection process.

.9 Depth of Cover

a) Sewer mains shall be installed to provide a minimum depth of cover of 1.80 m, as measured from the top of the pipe to the final finished grade at the surface.

.10 Where conditions are favourable, sump pump discharge should be connected to the stormwater main.

.11 Lot and landscape grading shall be designed such that the maximum depth of peak flows and ponding shall be a minimum of 300 mm below the lowest anticipated opening elevation at buildings. A suitable overflow route or sufficient ponding volume must be provided from or at all ponding areas to achieve this minimum freeboard and limit ponding to a maximum depth of 350 mm.

3.2.3.12 Storm Outfalls

.1 Outfall pipe obvert shall be above the high water level of the receiving channel under the 1:5 year rainfall event. Outfall pipe invert shall be above the normal ice level of the receiving channel under average annual precipitation conditions. Where these requirements cannot be reasonably achieved, the outfall pipe obvert shall be 1.0 m below the normal water level of the receiving channel under average annual precipitation conditions.

.2 Drop structures and energy dissipation works shall be included where necessary to prevent erosion. Further erosion protection works including, but not necessarily limited to, rip rap and filter fabric treatment, shall be required at the end of storm outfalls into the downstream channel.

.3 For concrete sewer pipe, pipe joints shall be grouted inside and out, or otherwise sealed with a suitable product or method to improve joint integrity, for at least 10 pipe lengths upstream from the outfall.

.4 Storm outfalls must include gratings over outlets for public safety. Gratings shall have a maximum clear bar spacing of 150 mm and shall be suitably anchored to the outfall structure. Grated outlet structures must be designed with twice the required hydraulic capacity in order to prevent plugging, and designed for a maximum flow velocity of 1.0 m/s through the grating. Gratings must be designed to allow maintenance access.

.5 Storm outfall structures must be protected with suitable fencing and guardrails.

.6 Storm outfalls shall be located such that there is minimal impact to adjacent property. Landscaping around outfalls shall be compatible with adjacent land use and provide for low maintenance, using native plant material and a grass seed mix.

.7 All-weather vehicle access must be provided to all storm outfalls for maintenance purposes.

3.2.4 Liftstation/SCADA

.1 Wherever possible, every reasonable effort should be made in the design to provide a drainage system for the Development that relies solely on gravity for conveyance in order to minimize the overall operation and maintenance requirements and life cycle costs of the system.

.2 Where absolutely necessary, the City may accept design proposals which include lift stations and force mains to convey wastewater and/or stormwater out of the Development.

.3 The Consultant shall consult with the City while conducting the Design to obtain the City's preliminary comments and input regarding any proposed lift station and force main. The City may have additional requirements of the Design in this respect.

.4 Please refer to Appendix I for all design and construction standards / specifications regarding lift stations and SCADA development.

.5 The Design shall fully describe the details regarding any proposed lift station and force main system. The City may request additional details regarding the design in order to ascertain its acceptability.

3.2.5 Franchise Utilities

3.2.5.1 General

.1 All franchise utilities must be installed as per the alignment outlined in the cross sections within Appendix A.

.2 All franchise utilities are to be designed to the specifications outlined by Fortis Alberta and ATCO.

3.3 Surface

3.3.1 Roadways

3.3.1.1 General

.1 All roadway design in St. Albert will be in accordance with the *Complete Streets Guidelines and Implementation Strategy*, latest edition, which aims to make road rights-of-way more accommodating for all modes of transportation.

.2 Complete Streets represents a shift in roadway design paradigm to view roadways as more than just space for the movement of vehicles. Urban streets provide many vital functions to residents of their cities such as serving as public spaces, providing safe options for active transportation, and facilitating the shopping needs of residents. In St. Albert, this philosophy is being applied to the roadway design standards and processes and how these are used to create communities.

.3 Complete Streets are intended to increase the attractiveness, convenience, and safety for all modes of transportation at the multiple levels of the roadway network. The objective is to create a public right-of-way that ensures land uses are integrated and contribute to a people-oriented street environment that works for everyone.

.4 Within the Area Structure Plan process, all roadway, walkway, and utility corridor requirements will be established through cooperation between the Developer and the City's Planning and Development, and Engineering Departments.

.5 Roadway design shall conform to the requirements of the Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC), latest edition. Other references for roadway design include TAC's Metric Curve Tables and Design Vehicle Dimensions for Use in Geometric Design, latest editions.

.6 Design of traffic calming measures for roadways shall be in accordance with TAC's Canadian Guide to Neighbourhood Traffic Calming, latest edition. Traffic calming measures include vertical changes in the road (speed humps, speed bumps, speed tables, raised intersections), lateral changes in the road (chicanes, offset intersections, lateral shifts), constrictions (narrowings, pinch points, islands, parking), entrance features (gates, signs, surface treatments), and other measures intended alter driver behaviour, improve conditions for non-motorized road users, and improve the quality of life for residents on traffic calmed streets.

a) To help communicate the difference between roadway function and St. Albert's Complete Streets, a new set of roadway descriptions has been developed:

b) Highways/Expressways (Boulevards) – regional streets that support the Edmonton Metropolitan Area, serving local and regional travel, typically used for public transit services, and often providing commercial / large load movement. Examples of this would be St. Albert Trail (Highway 2), and Ray Gibbon Drive.

c) Divided Arterials (Crosstowns) – major streets that allow users to travel across the City, without changing corridors. These streets provide connectivity for public transit buses and may provide for commercial / large load movements.

d) Undivided Arterials (Connectors) – major streets that connect Crosstowns together. Connectors provide connectivity for transit buses and may provide for commercial / large load movement.

e) Collectors (Neighbourhoods) – minor streets that provide direct access to, and around a neighbourhood. Capable of accommodating public transit buses.

f) Locals – minor streets that provide direct access to the front of a properties, do not accommodate public transit buses transit or large load movement, and typically connect to Neighbourhood roadways.

g) Laneways – minor roads that provide access to the rear of a property and do not provide for public transit buses or commercial / large load movement.

.7 Each of these roadway functions was then combined with the following land use form options to create unique streets that reflect their local surroundings:

a) Commercial: land use that provides goods and services to the community, including mixed use development.

b) Residential: land use that provides a variety of housing types for the community.

c) Employment: land use that provides business and industrial services to the community.

3.3.1.2 Road Classification

.1 Classification and designation shall be in accordance with TAC's *Geometric Design Guide for Canadian Roads* and the City of St. Albert's *Complete Streets Guidelines and Implementation Strategy*.

.2 Roadways and walkways shall be classified during the subdivision planning stage.

.3 Traffic calming measures are required on all collector (neighbourhood) roadways.

.4 Table 3.3.1 below provides guidance using the roadway function and land use form to equate to a Complete Street typology that will effectively serve the network and users of St. Albert.

Table 3.3.1: St. Albert Complete Streets Typologies

TAC	LAND USE FORM		
Roadway Function	Commercial	Residential	Employment
Highways/Expressways	Boulevards		
Divided Arterials	Crosstown Commercial	Crosstown Residential	Crosstown Employment
Undivided Arterials	Connector Commercial	Connector Residential	Connector Employment
Collectors	Neighbourhood Commercial	Neighbourhood Residential	Neighbourhood Employment
Locals	-	Local Residential	Local Employment
Laneways	Laneway Commercial	Laneway Residential	Laneway Employment

.5 Table 3.3.2 lists the required road cross-section and maximum operating speed for each road classification along with reference to the applicable Standard Drawing in Appendix A.

Table 3.3.2 – Road Cross-Section and Maximum Operating by Classification

Road Classification	Roadway Curb-to-Curb Width (m)	Right-of-Way Width (m)	Maximum Operating Speed (km/h)
Laneway (Residential)	4.0m	7.0m	<20km/h
Laneway (Commercial/Employment)	6.0m	6.0m	<20km/h
Local (Residential)	9.0m	18.0m	50km/h
Local (Commercial/Employment)	9.0m	18.0m	50km/h
Collector (Neighbourhood Residential)	12.0m	22.0m	50km/h
Collector (Neighbourhood Commercial)	12.0m	22.0m	50km/h
Collector (Neighbourhood Employment)	12.0m	22.0m	50km/h
Undivided Arterial (Connector Residential)	11.0m	27.0m	60km/h
Undivided Arterial (Connector Commercial)	15.0m	31.0m	60km/h
Undivided Arterial (Connector Employment)	11.0m	25.0m	60km/h
Divided Arterial (Crosstown Residential)	7.0m	38.0m	60km/h
Divided Arterial (Crosstown Commercial)	9.4m	38.0m	60km/h
Divided Arterial (Crosstown Employment)	7.0m	38.0m	60km/h

3.3.1.3 Roadway Geometric Design

.1 Vertical Geometrics

a) Grade

i) Maximum grade shall be 6.0%. As per TAC Geometric Design Guide for Canadian Roads, latest edition.

ii) Minimum grade shall be 0.6% along gutters and 1.0% around curb returns and cul-de-sac bulbs. As per TAC Geometric Design Guide for Canadian Roads, latest edition.

iii) For roadways connecting to an intersection, maximum grade shall be 2% over 30 m from the curb return.

iv) All roadways shall be crowned or shall have a cross fall for positive drainage. Refer to the applicable Engineering Standard Drawings in Appendix A.

.2 Vertical Alignment

a) Vertical curves shall meet the requirements in Table 3.3.3

Table 3.3.3: Vertical Curve Design Criteria (From TAC latest edition)

Design Speed (km/h)	K Value	
	Crest K Value	Sag K Value
20	1	3
30	2	6
40	4	9
50	7	13
60	11	18
70	17	23

Note: K=L/A, where L equals length of vertical curve in metres (m) and A equals the algebraic difference in grade percentage.

b) Vertical curves are not required where the algebraic difference in grade is less than 1.5%.

c) For inverted vertical curves, a minimum grade of 0.5% shall be maintained along the gutter line.

d) The City may stipulate additional requirements where collector or arterial roads require super elevation.

e) The City may stipulate additional requirements where collector or arterial roads require super elevation.

.3 Horizontal Alignment

a) Roadway alignment shall be centered within the right-of-way.

b) Straight or near-straight residential roadways shall have a maximum unimpeded length of 200 m, unless traffic calming measures are provided.

c) Horizontal curves shall meet the requirements in Table 3.3.

Table 3.3.4 – Horizontal Curve Design Criteria (from TAC latest edition)

Road Classification	Minimum Curve Radius (m)	Maximum Grade (%)	Minimum Tengent Length (m)	Minimum Intersection Spacing (m)
Residential Roads:				
Local	100	6	30	60
Cul-de-sac	100	6	30	60
Minor Collector	100	6	60	60
Major Collector	150	6	60	60
Commercial Roads:				
Minor Collector	100	6	60	60
Major Collector	150	6	60	60
Arterial Roads:				
Undivided	450	5	60	400
Divided	450	5	60	400

3.3.1.4 Intersections

.1 The City of St. Albert prefers the use of roundabouts in design on the basis of improved efficiency, safety and traffic calming wherever possible. Reference the Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC), latest edition, for design of roundabouts.

.2 Where roundabouts are not feasible, the angle of intersection of two roadways is as follows: Ideal = 90 degrees; Minimum = 70 degrees; Maximum = 110 degrees.

.3 Intersection design must incorporate good design practice with respect to sight distances and other safety considerations.

.4 Refer to Table 3.3.5. Intersections for local and collector roadways shall be spaced at least 60 m apart, as measured along the road centreline. The City shall review the appropriate location of intersections for arterial roadways.

.5 Intersection spacing different from Table 3.3.5 shall be subject to the review and acceptance of the City.

.6 Where the projected traffic volume on arterial roadways necessitates the provision of acceleration/deceleration turning lanes at an intersection, the Developer shall provide for the widening of the arterial road right-of-way, as required. Reference the Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC), latest edition, for the conditions necessitating the use of acceleration/deceleration lanes.

.7 Minimum corner cuts for intersections are based upon the roadway types and are summarized in Table 3.3.5 below:

Table 3.3.5: Minimum Corner Cuts for Intersections

Minimum Corner Cuts for Intersections	Local	Collector	Arterial
Local	6m	9m	N/A
Collector	9m	15m	15m
Arterial	N/A	15m	15m

3.3.1.5 Cul-de-sac

.1 Culs-de-sac are a maximum of 120 m in length, as measured from the adjoining roadway's nearest curb line to the start of the cul-de-sac's bulb. Culs-de-sac which exceed this may be approved at the discretion of the City. Culs-de-sac which exceed 120 m but that are less than 170 m in length require an additional hydrant and looping of the water main to the cul-de-sac. Cul-de-sacs which exceed 170 m in length require a minimum 6 m wide public utility lot (PUL) for emergency vehicle access and looping of the water main. Any PUL which is required for emergency vehicle access shall be developed to a standard acceptable to the City and shall include provisions for limiting public vehicle access. Refer to the Engineering Standard Drawings in Appendix A.

.2 In the case where the cul-de-sac cannot be graded to drain towards the adjoining road, a PUL must be included to provide an outlet for overland flow.

.3 Cul-de-sac bulbs shall have a minimum radius of 12 m from the centre to the curb face. Bulb road surfaces may be crowned or cross fall sloped for drainage, at a minimum grade of 1.0% and maximum grade of 3.0% outward from the centre of the bulb. A longitudinal grade of 1.0% must be maintained along the lip of gutter within the bulb. Refer to roadway geometric design for more information.

.4 The use of culs-de-sac is dictated by the most current St. Albert Land Use Bylaw.

3.3.1.6 Laneways

.1 Commercial and Residential laneways shall be designed to the specifications as outlined in the detailed drawings in Appendix A.

.2 Laneways have a full lighting requirement as mandated by City council. Refer to Article 3.3.1.11.

.3 Horizontal alignment:

a) The length of a laneway shall not exceed 180m from the nearest street measured from the adjoining roadway's nearest curb line.

b) A 3m corner cut is required at the intersection of two laneways.

.4 Vertical alignment:

a) The vertical alignment of alleys adjacent and parallel to collector or arterial roadways shall be designed in conjunction with the grades on the adjacent roadways. The minimum longitudinal grade for alleys is 0.7%.

3.3.1.7 Driveways

.1 Lot layouts shall be such that driveways do not connect directly to any arterial roadways or major collector roadways with an estimated ultimate traffic volume of more than 6000 vehicles per day in residential areas. Commercial driveways connecting to arterial roadways or major collector roadways shall be dependent upon justification within the TIA. Trip generation used to estimate this traffic volume shall be assessed within the most current TIA.

.2 A minimum clearance of 1.25 m shall be provided between the edge of the driveway and the outside edge of adjacent street furniture to either side. Street furniture placement shall be carefully considered to allow optimum driveway and apron width. A Minimum clearance of 1.50 m shall be provided between the edge of driveway and any boulevard tree.

.3 Driveways shall be in accordance with the Engineering Standard Drawings in Appendix A.

.4 Driveways shall not be constructed in the alignment of a captured anticipated pedestrian crossing such as across from a trail connection or the curb return of a T-intersection.

.5 Driveways shall not be permitted to connect to an abutting road through a curb return area.

.6 Driveways on corner lots shall connect to the adjacent roadway with less estimated traffic volume, located a minimum of 9 m from the front of curb of the adjacent roadway. Variances for reduced clearances must be approved by the City.

.7 Any replacement of concrete (including for boulevards and driveways) due to road repairs, and/or otherwise, shall be built to the current engineering standards.

3.3.1.8 Pavement Structure

.1 See Appendix A for minimum pavement structures.

.2 When tying new pavement into existing pavement, a minimum 0.75 m wide strip shall be milled out of the existing pavement along the joint of the tie-in to the new pavement, and the joint paved to tie the two pavement surfaces together and prevent separation and differential settling.

3.3.1.9 Noise Attenuation

.1 A Noise Impact Assessment, signed and sealed by a professional engineer, must be provided in cases where a major arterial roadway and/or railway runs through or adjacent to a proposed residential development. The assessment must list the current noise levels, estimate future noise levels, and identify and implement noise attenuation measures required to achieve a maximum noise level of 65 dBA Leq over a 24-hour period, and in accordance with the City's current Noise Bylaw.

3.3.1.10 Transit Stops

.1 The City's Transit Department will aid with locating transit stops for the Development during the Area Structure Plan process.

.2 Transit bays must be provided at the locations determined by the Transit Department and in accordance with the Engineering Standard Drawings in Appendix A.

.3 Developers will be required to install bus shelters and pads on arterials roads and bus stops that are adjacent to any multi-family sites. Developers will be required to install bus bench pads in all other locations as identified by the City.

.4 The standard width for bus stop pads (for pedestrians within boulevard) with a bench or a shelter is 2.5m in St. Albert. A bus pad with a connection to the sidewalk shall be provided at all bus stops.

.5 In commercial cross-sections where the furnishing zone is not wide enough for a 2.5m bus pad, a curb bulb-out shall be used in place of curb parking for the length of the bus stop. This also allows transit vehicles to use the travel lane as a transit zone, avoiding having to pull into and out of parking spaces.

.6 The location of transit stops should align with potential traffic calming (such as curb extensions) to allow safer and easier access / exits from public transit. All transit stops must abide by accessibility standards.

3.3.1.11 Roadway Lighting

.1 Roadway lighting shall be designed in accordance with the following:

.2 Lighting for local roadways shall conform to Roadway Lighting, Illuminating Engineering Society of North America, RP-8-00;

.3 Lighting for collector and arterial roadways shall conform to Guide for the Design of Roadway Lighting, Transportation Association of Canada, latest edition.

.4 Lighting at intersections shall conform to the design criteria for the higher classified road.

3.3.1.12 Travel Lanes

.1 Travel lanes must accommodate the anticipated vehicles using them and designing travel lanes for the use of cars, buses, and trucks requires consideration of accommodation for necessary width and turning movements. Traditional lane width design has also taken into account space required to correct potential erratic vehicle behaviour. This has resulted in wider lane widths which allow drivers to correct movements within lanes and the spaces adjacent to roadways have been designed to be clear of obstructions. While this is a strong consideration for safety in certain road functions that focus on higher volumes and speeds for vehicles; wider travel lanes may influence driver behaviour towards increased travel speeds and should not be considered a benefit for urban areas where frequent vehicle interactions are expected with vulnerable road users such as pedestrians and cyclists. Such design and resulting higher speeds may lead to increased chances of fatality and serious injury in the event of motor collisions occurring.

.2 Narrower lane widths in urban areas mitigate higher vehicle speeds and help to keep pedestrians, cyclists, and any other vulnerable road user safe. Table 3.3.6 from the Transportation Association of Canada specifies the recommended lane widths for urban streets.

Table 3.3.6: Travel Lane Widths

Design Speed (km/h)	Recommended Lower Limit	Recommended Upper Limit
60 and less	3.0m	3.7m

Note: These dimensions do not include curb and gutter widths.

.3 Streets, such as Locals, that are anticipated to service largely passenger vehicles and not accommodate transit or large loads, may be considered for the lower limit of 3.0 metre lane widths. Streets anticipated to accommodate transit or large loads, should be designed with a minimum limit of 3.3m, but should be evaluated through investigation of necessary design to accommodate turning radius and vehicle widths. This does not take into account the width of the curb and gutter.

3.3.1.13 Turning Lanes

.1 Turning lanes should be used on higher volume streets to allow for queueing of vehicles not travelling through an intersection. Turning lanes can be provided in the same space as the median landscaping. In areas with frequent accesses, a centre two-way turn lane can be provided. Dimensions for turning lanes are provided in Table 3.3.7.

Table 3.3.7: Turning Lane Widths

Type	Recommended	Recommended Lower Limit	Recommended Upper Limit
Left-turn	3.2m	3.1m	3.3m
Right-turn	3.2m	3.1m	3.3m
Two-Way Turn Lane	3.5m	3.0m	4.0m

Note: These dimensions do not include curb and gutter widths.

3.3.1.14 On-Street Parking Lanes

.1 Parking lanes that accommodate on-street parking, are considered part of the interstitial area in between the vehicle realm and the public realm. It is not common to accommodate on-street parking along roadways such as Crosstowns and Connectors. Exceptions may be considered in commercial land use forms where the adjacent development may benefit from on-street vehicle parking. At Neighbourhood and Local roadway functions, vehicle parking is typically provided, with the possible exception being local employment streets.

Table 3.3.8: Parking Lane Widths

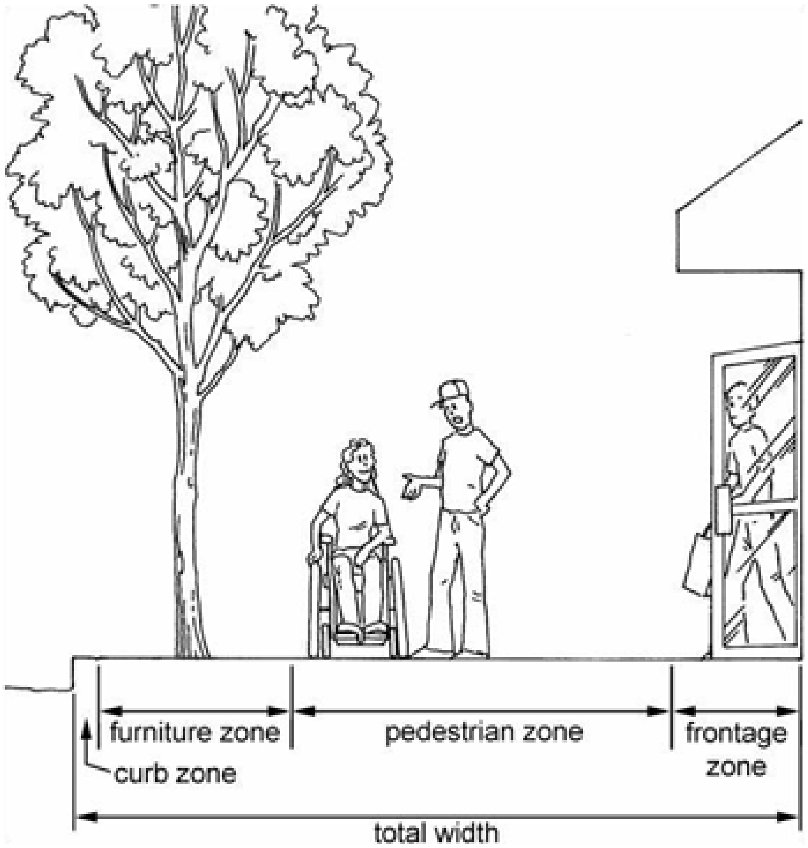
Type	Recommended	Recommended Lower Limit	Recommended Upper Limit
Parallel	2.4m	2.3m	2.6m

Note: The dimensions include the curb and gutter.

3.3.1.15 Pedestrian Realm

.1 The pedestrian realm consists of the space in between the interstitial area and the property line of developments. This space has the potential to serve the most amount of uses out of the three major areas in streets. The space within the pedestrian realm is further divided into three zones: the **frontage zone**, the **through zone**, and the **furnishing zone**.

Figure 3.3.1: Pedestrian Realm Zones



Reference:US Department of Transportation Federal Highway Administration

Frontage Zone

.2 The frontage zone may serve multiple purposes:

a) Space for building doors.

b) Business Signage and Landscaping

c) Café or restaurant seating.

.3 Table 3.3.9 shows the recommended lower and upper limit for the frontage zone.

Table 3.3.9: Frontage Zone Widths

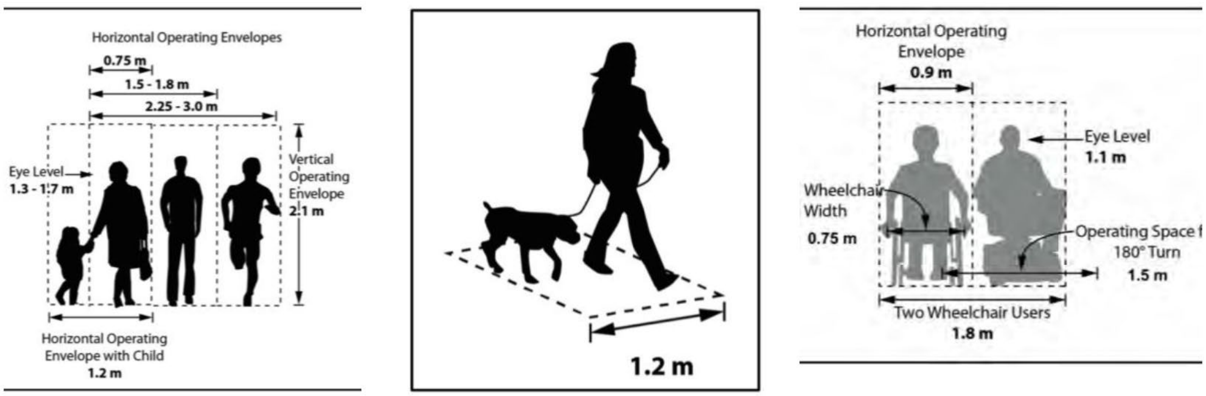
Land Use Form	Recommended Lower Limit	Recommended Upper Limit
Commercial Areas	0.5m	3.0m
Residential/Employment Areas	0.3m	2.0m

.4 Door zones, signage, and landscaping can be accommodated by the lower limit. However, for seating in the frontage zone, at least 1.0m is required. The use of the frontage zone depends on the land use form. In commercial land use forms, the space is able to serve multiple purposes.

Through/Pedestrian Zone

.5 Through zone space is intended to be a clear space used for pedestrian travel. The following figures display common dimensions to accommodate different types of pedestrians. Special consideration in safety and space must be made to this zone to acknowledge that St. Albert bylaws support cyclists using the sidewalk.

Figure 3.3.2: Typical Pedestrian Dimensions



Typical Pedestrian Dimensions

Horizontal Operating Envelope for a Person with a Service Animal

Wheelchair User Dimensions

Table 3.3.10: Through Zone Widths

Land Use Form	Recommended Lower Limit	Recommended Upper Limit
Commercial	2.2m	n/a
Residential	1.8m	n/a
Employment	1.8m	n/a

Furnishing Zone

.6 The furnishing zone exists between the through zone and the curb and gutter and is needed for placement of light posts, seating, signage, waste receptacles, bicycle parking, utility furniture, bus stop amenities, and landscaping.

Table 3.3.11: Furnishing Zone Widths

Land Use Form	Recommended Lower Limit	Recommended Upper Limit
Commercial	1.8m	3.0m
Residential	2.2m	3.5m
Employment	2.2m	3.5m

3.3.2 Curbs, Gutters and Sidewalks

3.3.2.1 General

.1 Through the Area Structure Plan process, all sidewalk and walkway requirements will be established through cooperation between the Developer and the City's Planning and Development, and Engineering Departments.

3.3.2.2 Sidewalks and Walkways

.1 Sidewalks and walkways through residential areas, commercial areas, and parks shall form an integrated pedestrian circulation system through the Development.

.2 For all roadways, unless otherwise authorized or directed by the City, road-separated sidewalks will be located in accordance with the Engineering Standard Drawings in Appendix A.

.3 Sidewalks shall be provided on both sides of the roadway. Consult the City for the site-specific sidewalk requirements commercial areas.

.4 For cul-de-sacs, sidewalks are required as follows:

.5 Cul-de-sacs with a walkway connection through a public utility lot require a sidewalk on one side of the roadway. (The connection from the PUL to the curb ramp may be monolithic.)

.6 The Design should consider pedestrian access and allow for walkways through cul-de-sacs and other locations, as appropriate.

.7 Sidewalks and concrete walkways shall conform to the dimensions shown on the Engineering Standard Drawings in Appendix A with a maximum grade of 6% longitudinally, 2.5% in the crossfall direction. For Local roads sidewalks may be accepted at 1.5m width at the City’s discretion if there are no major concerns with pedestrian traffic in the neighbourhood.

.8 All trails, shall be constructed of asphalt concrete in accordance with the Engineering Standard Drawings in Appendix A. Asphalt concrete shall meet the applicable articles of Section 3.0.

.9 All trails are to be constructed to a minimum width of 3.0 metres.

.10 The horizontal alignment of sidewalks along roads shall be parallel to the centreline of the right-of-way wherever possible.

.11 Sidewalk and walkway grading shall be done in accordance with the lot grading plan and shall be done in such a way as to avoid conflicts with the drainage pattern within the right-of-way. Walkway landings shall be provided in accordance with the following table. It is recognized that the gradient and building layout on some streets may make the provision of landings impractical.

Slope (%)	Maximum Length (m)	Maximum Height (mm)	Landing Required
≤ 5.00	N/A	N/A	N/A
5.00 to 6.0	12.0	750	Every 12 m

.12 Changes in grade shall be gradual.

.13 No sidewalk or walkway shall be used as a drainage swale.

.14 Curb ramps shall be provided at all intersections with walkway access in accordance with the Engineering Standard Drawings in Appendix A.

.15 Pedestrian protection (i.e. trees, shrubs, bollards, etc.) may be required at the intersection of primary walkways/trails and roadways, as directed by the City. Pedestrian curb extensions should be considered and accommodated at known or anticipated high use crossings (such as trail links, parks / school sites, or neighbourhood-neighbourhood intersections).

.16 The City may require that benches, waste receptacles, and other street furniture be strategically placed along certain sidewalks or walkways. Refer to the City's Landscape Standards in Appendix D for further details regarding street furniture.

3.3.2.3 Curb and Gutter

.1 For all roadways, concrete curb and gutter shall be provided in accordance with the Engineering Standard Drawings in Appendix A.

.2 Vertical face curb and gutter shall be provided along all roadways fronting parks and public utility lots (except for emergency accesses) unless other means of protecting vehicular access into these lands is provided. Curb access for City maintenance equipment must be provided, complete with staggered T-Bollards.

.3 Where a transition section is required between differing types or sizes of curbs and gutters, the engineering drawings must include a detail showing how the transition is to be constructed.

.4 Curb Returns

a) For local and collector roadway intersection curb returns, the minimum curb radius shall be based upon the vertical turning movement for the anticipated traffic, vehicle capacity analysis, and speed reduction. Typically, this will require a minimum radius 10 m for local roadway intersections where the road will not be a bus or truck route, and 15 m for all other collector and arterial roadway intersections.

b) If required the transition should occur at the curb ramps from straight face to rolled face.

c) Curb returns on local commercial roadways, collector roadways, and arterial roadways shall be constructed with a minimum radius of 15.0 m to accommodate truck turning movements.

d) Catch basins located within curb returns shall be situated to provide 0.5m clearance from the end of the curb ramp flare to the end of the catch basin/concrete transition.

3.3.3 Trails

3.3.3.1 Objectives

.1 The following guidelines are intended to assist in the development of a high-quality and fully integrated trail system. The guidelines include legal requirements, official policies, established standards and practices and desirable standards and is a local supplement to the existing standards in "Guidelines for Design of Bikeways" by the Roads and Transportation Association of Canada.

.2 The objective of the planning guidelines is to lay out a pathway network which links together parks, natural areas, riverbanks, and public recreation facilities.

3.3.3.2 Pathway Classifications

Pathway Classification						
Location	**Max. Width (m)**	**Min. Width (m)**	**Surface**	**Crossfall (%)**	**Min. Horizontal Setback (m)**	**Min. Vertical Setback (m)**
Multi-Use Trail	6	3	Asphalt	2%	1.0m 2.5m from water services	3.0m
Trail Connectors	2	1.5	Match connecting trails	2%	1.0m 2.5m from water services	3.0m
Naturalized Trails	2	1	Gravel, recycled road mulch	2%	0.5m 2.5m from water services	2.1m

.1 Multi-Use Trail

The Multi-Use Trail system is a citywide linear network that facilitates non-motorized movements for recreation and transportation purposes. The Multi-Use Trail is hard-surfaced, typically asphalt. It is a multi-use facility and no one user or type of user is to be given preference. The spine of the system parallels the major physical features of the river valley park system, including waterways, escarpments and ravines. It should be designed as a continuous facility that connects individual communities to:

a) Citywide parks and recreation facilities;

b) Natural features, including water courses, escarpments, ravines, river valley parks and associated open space;

c) Regional joint use sites, commercial districts, employment centers, adjacent communities and key cultural attractions;

d) Local pathway, bikeways and trail systems; and

e) LRT stations and transit routes.

.2 Naturalized Trails

a) Naturalized Trails are low impact alternatives to Multi-Use Trails. Naturalized trails are typically surfaced with gravel, wood mulch or recycled road mulch. These trails are best suited for naturalized areas, parks, and Environmental Reserves.

b) Naturalized trails are classified as multi-use facilities and are pedestrian access only (unless designated otherwise, such as mountain bike trails).

.3 Trail Connectors

a) Trail Connectors provide secondary routes within communities, linking residential areas to facilities such as neighborhood parks, schools and other local community designation. Local pathway may also serve as links to the Multi-Use and Naturalized Trail system.

Reference Appendix A for details on pathway structure and cross section.

3.3.3.3 Planning Guidelines

.1 Alignments

a) Trails shall be shown schematically in an Area Structure Plan.

b) Trails, where desirable should be routed along the edges of environmentally significant areas or into locations with less sensitivity in natural environmental parks in order to minimize the impact on the park or natural area and reduce future damage and desire lines.

.2 Street Crossings

a) Route pathway to street intersections where possible.

b) Mid-block crossing are discouraged and permitted on local streets only. If mid-block crossings are to be provided, appropriate line markings must be provided, and signage is to be installed by the City.

c) Avoid necessity for building mid-block pedestrian overpasses on major streets.

d) Adjust subdivision layout to minimize quantity of crossings.

e) Line up pathway entrances to ensure visual continuity.

.3 Play Equipment Sites

a) Trails should be at least 5 m from play area surfaces.

b) Provide a minimum 2 m wide asphalt link from the play equipment site to multi-use trail.

.4 Parking Lots

a) Route pathway to facilitate pedestrian access to buildings on site.

b) Provide asphalt links from parking lots to pathway.

c) Locate pathway entrance at street.

.5 Natural Areas

a) Align trails around significant areas and sites; never through.

b) Avoid damage to natural features, vegetation and wildlife habitat.

c) Increase back sloping gradient to 2:1 to minimize fill coverage.

d) Send proposed design plans for all natural areas and Environmental Reserve parcels to the City for approval.

3.3.3.4 Design Guidelines

The objective of the design guidelines is to produce a safe and enjoyable pathway incorporating the needs of multiple users (i.e. walkers, child strollers, runners/joggers, people with disabilities, cyclists, in-line skaters and skateboarders), and therefore, stringent attention must be given to design details. Where location and design considerations prevent transportation and recreation functions from being accommodated together, the recreation function should be given a higher priority.

.1 Safety Clearance and Setback requirements

a) Multi-Use Trails and Trail Connectors:

i) Provide 1.0 m clear of all obstacles on both sides.

ii) Provide 3.0 m clear of all obstacles overhead.

iii) Avoid locating pathway over manholes.

iv) Ensure a 2.5 m minimum clearance from park water services.

v) Set back pathway a minimum of 1.0 m form face of curb.

b) Naturalized Trails:

i) Provide minimum 0.5 m clear of all obstacles on both sides (i.e. trees, signs, light poles etc.).

ii) Provide minimum 2.1 m clear of all obstacles overhead (i.e. tree branches, bridges, etc.).

.2 Safety Railings

a) Multi-Use Trails and Trail Connectors:

i) Safety railings shall be installed when pathway is within 2.0 metres of the top of a 2:1 slope or steeper, and the slope is greater than or equal to 1.0 metre in depth.

ii) Under exceptional circumstances, and subject to approval by the City after an appropriate risk assessment, safety railing may not be required.

iii) Minimum railing height and design to be in accordance with the City's Engineering Standard Drawings in Appendix A, or equivalent as approved by City.

iv) Chain link fence is only acceptable when the fabric is attached to, but not protruding, above the top rail. Attachment shall be with a knuckle finish.

b) Naturalized Trails:

i) Minimum railing height and design to be in accordance with the City's Engineering Standard Drawings in Appendix A, or equivalent as approved by City.

ii) Typically constructed of galvanized steel or wood (wood is preferred)

iii) Install where a trail is within 1 m of the top of a 2:1 slope or steeper, and the slope is greater than or equal to 1 m in depth.

iv) Chain link fence is not preferred, and is only acceptable when the fabric is attached to, but not protruding above, the top rail. Attachment shall be with a knuckle finish.

.3 Pathway Entrances/Wheelchair Ramps

a) For pathway entrances and wheelchair ramps, extend pathway to street curb in all cases.

b) Ensure pathway joins streets at right angles.

c) Provide bollards where the entrance to a pathway is on a street. Provide a T-Bollard layout as per the details in *Appendix A* that deters motor vehicle access from the street but allow convenient access for cyclists, pedestrians, and wheelchairs. Staggered T-Bollards shall be provided where required for maintenance equipment access.

d) Line up entrances for visual continuity where pathway route crosses street.

e) Ensure catch basins or manholes are not located at pathway entrances or wheelchair ramps.

.4 Sight-Lines

a) Where possible, ensure no obstructions to visibility within 5.0 m of pathway-pathway intersections. Refer to the latest edition of the Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC), for requirements to provide adequate stopping sight distance.

.5 Maximum Grades

a) Over 8%: re-route.

b) 5% to 8%: not longer than 50 m (keep bicycles and pedestrians separate and avoid curves and constrictions). Where such portion of a pathway network meets a roadway, provide staggered T-Bollards at the pathway entrance to prevent bikers from accidentally entering the roadway.

c) 3% to 5%: no longer than 200 m.

d) Under 3%: acceptable (required if wheelchair accessible).

e) If the longitudinal grade of a pathway exceeds 3% over the 20 m approaching a connecting roadway, then staggered T-Bollards are required.

.6 Design Speed

a) Flat terrain: do not exceed 35 km/hr.

b) Downgrades: do not exceed 50 km/hr.

.7 Super-elevation

a) On curves 2%.

b) Maximum 5%.

.8 Stopping Sight Distances

a) Stopping sight distance is described below:

Minimum SSD – v2/{225 (f+g)} – 0.695v

Where: SSD = Stopping sight distance
v = bicycle design speed (typically 30 km/hr)
f = coefficient of friction = 0.25
g – grade m/m (rise or decent/run)

The following table may also be used to obtain appropriate stopping sight distances:

NOTE: A stopping site distance of 35.0 m is considered standard guideline.

	Level	Ascending		Descending	
Gradient	0%	2.5%	5%	2.5%	5%
SSD	35 m	33.5 m	32.5 m	36.5 m	38 m

.9 Minimum Design Curve Radii

Minimum design curve radii is as follows:

Minimum r – v2/[127 (e+f)]

Where: r = minimum radius
f = coefficient of friction
e = super elevation
v = bicycle design speed (typically 30 km/hr)

The following table may also be used to obtain appropriate minimum radius for asphalt pathway with 2% banking.

NOTE: A minimum design curve radii of 5.0m is considered standard guideline.

Speed	10 km/hr	15 km/h	20 km/h
Radius	2 m	9.5 m	5%

.10 Stairs

a) Stairs are not acceptable within a pathway or trail network.

.11 Lighting

a) Provide on trails as requested by the City on a case by case basis.

.12 Pedestrian Bridges and Overpasses

a) Railing height as per Transportation Alberta approved specifications.

b) Minimum deck width 3.0 m between railings.

c) Submit concept drawings to the City, however, final approval will come from appropriate bridge engineer. Ensure all drawings are signed by a Professional Engineer.

.13 Vehicular Bridges and Overpasses

a) In general, ensure sidewalks for pedestrians and widened shoulder lanes for cyclists are provided along both sides of structure.

b) Where bridge is part of pathway system, ensure combined pathway as sidewalk is provided along both sides of structure.

c) Railing height as per Transportation Alberta approved specifications.

d) Minimum pathway width to be 3.0 m.

e) Submit concept drawings to the City, however, final approval will come from appropriate bridge engineer. Ensure all drawings are signed by a Professional Engineer. The developer is to ensure that the proposed structure conforms to all applicable City Bylaws and provincial Building Codes.

.14 Pedestrian Underpasses

a) Minimum height 3.0 m and minimum width 3.0 m.

b) Ensure drainage is kept in concrete swale along on one side.

c) Ensure area is lighted well.

d) Desirable maximum length 50 m; provide break in underpass within median of divided roadways.

.15 Bridges

a) Railing height as per Transportation Alberta approved specifications.

b) Minimum deck width: 1.5 m between railings.

c) Material examples: log stringers, laminated wooden beams, prefabricated steel and pre-cast concrete.

d) Submit concept drawings to the City. Ensure all drawings are stamped by a Professional Engineer.

.16 Amenities

a) In general, provide one trail entrance every 150 m or as needed.

b) One park bench every 400 m; one trash receptacle every 400 m. Environmentally sensitive and accessible areas should be assessed on an individual basis.

c) Trash receptacles as identified by the City Engineer.

.17 Signage

a) Provide signage as per The City of St. Albert Sign Guidelines, latest edition.

.18 Pavement Markings

a) Refer to Article 3.3.4.2.

.19 Recommended References

a) “Guidelines for Design of Bikeways,” Roads and Transportation Association of Canada.

b) “Recreational Pathway,” National Capital Commission, Ottawa.

c) “Technical Handbook of Bikeway Design,” Velo, Quebec.

d) “Planning & Design Criteria for Bikeways in California,” California Department of Transportation.

e) "Trail Manual" Parks Canada, 1978.

f) "Recreation Trails," Alberta Recreation and Parks, 1989.

g) "Trail Design, Construction and Maintenance Manual," Ontario.

h) "Trail Building & Maintenance," Appalachian Mountain Club.

i) "Sentiers Quebec," Comite Quebecois des Sentiers de Randonnee. 1979.

j) "Cross Country Ski Trail Development," Alberta Recreation and Parks, 1979.

k) The City of Burlington Accessibility Design Standards, 2016.

3.3.4 Traffic/Streets Signs and Pavement Markings

3.3.4.1 Roadway Signage

.1 The Developer shall be responsible to organize, order, install, and maintain all signs necessary to provide safe vehicle/pedestrian navigation through the Subdivision including, but not necessarily limited to, regulatory signage, street name signage, transit signage, construction warning signage, and construction development signage, whether temporarily and permanently installed for the time period as dictated within the development agreement/permit.

.2 Roadway signage layout and design shall conform to TAC's Manual of Uniform Traffic Control Devices for Canada, latest edition.

.3 Refer to the Appendix for detailed requirements for signage.

.4 Barrier post requirements are provided in the Engineering Standard Drawings in Appendix A.

3.3.4.2 Pavement Markings

.1 Introduction

a) The principles and standards governing pavement marking application are set out in "Part C; Divisions 1 through 4" of the *Canadian Manual of Uniform Traffic Control Devices.* The guidelines in this document incorporates specific City standards to meet local needs and conditions.

b) Please refer to the City of St. Albert Permanent Road Marking Guidelines, latest edition. The Guidelines shall supplement these Municipal Engineering Standards as requirements and considerations as per the document.

c) Four categories of pavement marking are discussed:

i) Longitudinal

ii) Transverse

iii) Symbols and Letters

iv) Parking

d) Additional types and styles of line marking have been proven through best practices in the industry, however at the time of revision of this document, the City utilizes the types of markings included in these standards on a consistent basis. Additional markings may be performed and added to the guidelines in later revisions.

e) It is important to note that these standards may be altered for unusual traffic conditions. However, such special situations should be considered exceptions to the rule. Engineering judgment and practical experience are necessary supplements to the use of these standards. Any changes to the written standards requires review and approval from City Engineer.

f) Users of the following standards are assumed to have a basic understanding of traffic engineering terms and be able to recognize the related traffic movements. These standards should be used as a first reference. Where no specific guidelines are provided, the *Canadian Manual of Uniform Traffic Control Devices* standards are to be used.

.2 Longitudinal Markings

a) Longitudinal markings are lines along the length of the roadway indicating to the driver proper position on the roadway (delineated travel lanes) and may indicate proper direction of travel (yellow centre line to the left).

b) Directional Dividing Lines

i) Directional Dividing Lines are used to designate the separation between the portions of the pavement of a two-way road which are available for travel in opposing directions.

ii) The Directional Dividing Line shall be a solid 10 cm in width and yellow in color.

iii) Directional Dividing Lines shall be applied in St. Albert:

- For the entire length of roadway for a Boulevard, Crosstown or Connector where no concrete divider is present.
- A minimum of 30 m back along a Neighbourhood Roadway, where it meets a Boulevard, Crosstown or Connector Roadway.
- On Neighbourhood roads where geometric conditions and/ or specific transit requirements warrant increased guidance to the motorist including, but not limited to, locations with existing:
  - Pavement width transitions;
  - Horizontal or vertical curves where sight line distances are of a concern.
- At locations where a penalty box or extended stop bar is distant from an existing concrete divider. The Directional Dividing Line will extend from the concrete divider to the front stop bar.
- A minimum of 30 m in advance of any Railway Crossing.

iv) On most roadways, the Directional Dividing Line will coincide with the geometric centre of the pavement surface. In some cases, however, the Directional Dividing Line may be located in an off-center position to make more efficient use of the roadway space. Typical examples of this exception include:

- Pavement width transitions.
- Added turning lanes at intersections.
- An uneven number of lanes in each travel direction.

- Zones with parking on one side of the roadway.
- Lane Lines

c) Lane Lines delineate the edge of travel lanes where there are 2 or more travel lanes on the same side of the Directional Dividing Line (same direction of flow). They are utilized to direct traffic into designated travel lanes as required.

i) Lane Lines shall be used where more than one travel lane in the same direction is present and shall be placed:

ii) Throughout the entire length of pavement on all Boulevards, Crosstowns and Connectors, as well as any divided Neighbourhood roads, where parking is not permitted.

- On Neighbourhood roads at approaches to signalized intersections where the pavement surface width allows for more than one travel lane and/ or directional guidance is required for traffic movement.
- Lane Lines should extend back from a stop line for a minimum of 30 m.
- Minimum Lane Width = 3.2 m measured from face of curb.
- Maximum Lane Width = 4.2 m measured from face of curb.

iii) Lane Lines shall be:

- Used to designate lane movements in the same direction of flow of traffic that carry on continually straight down the roadway.
- 10 cm in width
- White in color.
- 3 m long lane line segments with 6 m long gaps between the lane lines where lane changes are allowed.
- Solid throughout, where lane changes are not allowed (example: Free Flow Lanes) Minimum distance of these solid sections shall be 60 m.
- Terminated at the stop bar, or 4.65 m back from the perpendicular face of curb at an intersection.
- Start from the back side of a crosswalk at an intersection or 3.65 m back from the perpendicular face of curb at an intersection.
- When approaching an intersection, the last 3 m lane line shall be placed coming off of the stop bar and the next 2 to 3 lanes lines fitted as best possible to maintain the 3:6 line marking to gap ratio.

d) Continuity Lines

i) Continuity Lines indicate the continuation of the through-travel lane from dedicated turning lanes and from merging/diverging lanes.

ii) Continuity Lines shall be:

- 20 cm in width
- White in color.
- Used at all turning lanes, acceleration and deceleration lanes
- Used to separate auxiliary turn lanes from through lanes at intersections.
- 3 m long line segments with 3 m long gaps between the Lane Lines where lane changes are allowed.

- Solid throughout, where lane changes are not allowed (example: Penalty Box).

iii) Continuity Lines are not required for right turn cut off lanes, where no auxiliary turning lane exists.

iv) For turning lanes or merging lanes that are created through pavement width transitions (the lanes are created through widening of the road), the 20 cm Lane Lines will run parallel with the 10 cm Lane Lines and shall start where the concrete face of curb falls away, keeping the minimum width of the straight thru lane.

v) For turning lanes that are created from a previous straight thru lane (where 10 cm Lane Lines must turn into 20 cm Lane Lines) the 20 cm Lane Lines shall start a minimum of 12 seconds of travel time prior to the gore line of the turning movement (or from the stop bar if there is no island at the intersection).

- On a 60 km/hr roadway this distance = 192 m
- On a 50 km/hr roadway this distance = 168 m

vi) When approaching an intersection, the last 3.0 m lane line shall be placed coming off of the stop bar and the next 2 to 3 lane lines fitted as best possible to maintain the 3:3 line marking to gap ratio.

e) Pavement Edge Lines (Shoulder Lines)

i) Edge Lines or Shoulder Lines are used to indicate the limits of the travel lane, such as to separate the travel lane from a paved shoulder.

ii) Edge Lines shall be:

- Continuous 10 cm solid White line when placed to the right of the travel lane, when not used at a merging or diverging zone.
- Continuous 20 cm solid White line when placed to the right of the travel lane when used for merging or diverging zones.
- Continuous 10 cm solid Yellow line when placed to the left of the travel lane.

iii) Typical use of Edge Line markings include:

- Where paved shoulders are present
- In merge and diverge zones
- At pavement width transitions
- At V-gutters
- Where obstructions on the shoulder may be considered to constitute a hazard to the motorist in that lane.

f) Guide Lines

i) Guide Lines provide travel path guidance to drivers as they proceed through an intersection or merge into proper travel lanes.

ii) Guide Lines shall be 10 cm in width, 0.5 m in length with 0.5 m gaps, and:

- White when on the driver’s right-hand side; or

- Yellow when on the inside lanes' driver's left-hand side (i.e. centreline of roadway to centreline of roadway).

iii) Guide Lines shall be used at the following locations:

- Where a multi-lane turn is present.
- Where the uphill/downhill roadway grade requires Guide Lines for improved safety of traffic flow.
- Where the roadway grade changes inside the intersection.
- At intersections where approaches are not at 90 degrees to each other and driver error may occur.

.3 Transverse Markings

a) Transverse line markings are aligned crossing the roadway to indicate zones of pedestrian crossings or stop locations for vehicles.

b) Pedestrian Crosswalk Lines

i) Pedestrian Crosswalk Lines indicate a specific zone of pedestrian travel, and are used where there is a conflict between vehicular movement and pedestrian movement. Any intersection is a permissalbe pedestrian crossing, unless otherwise signed as such through traffic control devices.

ii) The City follows the guidelines expressed in the Transportation Association of Canada; *Pedestrian Crossing Control Manual*, latest edition, for the placement of all pedestrian crosswalks.

iii) Parallel Line Pedestrian Crossings

- Parallel Line Pedestrian Crossings utilize two parallel lines running across the roadway to signify the safe crossing area for the pedestrian.
- Standard Pedestrian Crossings:
    - Consist of 2 parallel lines running across the complete width of the roadway.
    - Shall be White in color.
    - Shall consist of 2, 20 cm wide lines.
    - Shall be a minimum of 3.0 m wide from centerline to centerline. The width may be increased based on location and pedestrian demand, as requested through the City.
    - Are to be located such that the crosswalk line (nearest to the centre of the intersection) must be a minimum of 0.65 m back from the extended line of the perpendicular roadway curb face.
- Locations where Standard Pedestrian Crossings shall be used are:
    - Any pedestrian crossing that has been deemed through the planning or design process to be a desire path, or that has been warranted through completion of a Pedestrian Crossing Warrant Review and where there is

a stop control for the driver – stop sign, traffic signal, pedestrian activated traffic signal.

iv) Zebra Bar Pedestrian Crossings

- A Zebra Bar Pedestrian Crossing utilize multiple "bars" that flow parallel with the direction of traffic flow, but are placed crossing the width of the roadway to signify the safe crossing area for the pedestrian at locations where a motorist may not normally expect a pedestrian.
- Zebra Bar Pedestrian Crossings shall be placed at:
  - Any pedestrian crossing that has been deemed through the planning or design process to be a desire path, or that has been warranted through completion of a Pedestrian Crossing Warrant Review and where there is not a stop control for the driver (no stop sign or traffic signal), but is a yield condition or uncontrolled for the driver.
  - Where Standard Pedestrian Crossings may be upgraded to a Zebra Bar Crossing if Engineering deems it feasible and beneficial at locations where special circumstances may exist.
- Zebra Bar Pedestrian Crossings shall be:
  - Placed with each bar running parallel with the roadway.
  - 60 cm in width
  - Minimum 3.0 m in length, unless otherwise directed by the City
  - White in color
  - Placed in an effort to minimize vehicle tire exposure to the material.

c) Stop Bar Lines

i) Stop Bar Lines are used to indicate the point at where a vehicle must stop in compliance with a traffic signal, stop sign or other specific requirement to stop.

ii) Standard Stop Bar Lines

- Standard Stop Bar Lines are used at all locations other than Railway Crossing locations, where a Stop Bar Line is deemed necessary.
- Standard Stop Bar Lines shall be used:
  - At all signalized and multi-way stop controlled intersections.
  - At intersections of Boulevards, Crosstowns and Connectors; inclusive of these roadways intersecting with each other or Neighbourhood roads
- Standard Stop Lines shall be:
  - 30 cm in width
  - White in color
  - Applied to the complete distance (width of road) for all travel paths entering into the intersection.

- Installed a minimum of 1.0 m back, from the nearest point (if the crosswalk runs at an angle) of the closest crosswalk line.
- Applied perpendicular to the travel lanes of the roadway
- If no crosswalk exists, the Stop Bar Line shall be placed a minimum of 4.65 m back from the extended line of the perpendicular roadway curb face, unless otherwise specified by the City.
- The Stop Bar Line on the same side of the intersection where the actual pedestrian crossing markings are located at all Pedestrian Activated Signal Crossings shall be placed 16.0 m back from the pedestrian push button pole.

iii) Railway Crossing Stop Bar Lines

- Stop Bar Lines used at all Railway Crossings.
- Railway Crossing Stop Bar Lines:
  - Consist of two solid 30 cm wide lines, 30 cm spacing between them.
  - Shall be White in color.
  - Shall be placed a minimum of 2.0 m back from the nearest warning arm of the railway tracks to the nearest Stop Bar Line.
  - Placed perpendicular to the flow of traffic and roadway for the complete lane width of all lanes approaching the Railway Crossing.

d) Gore Areas

i) Gore Area markings are used to define the beginning and the end of merging and diverging area zones and the approaches to structures in the roadway.

ii) Gore Area marking shall:

- Be solid 10cm wide Yellow Centre Line where traffic passes the Gore Area in opposing directions.
- Extend from a point 10 m past the point of the physical barrier to a point where the lane widths in opposing travel directions are a constant width.
- Be solid 10 cm wide White Lines where traffic passes by the Gore Area in the same direction on roadways with a speed limit of 70km/h or less.
- Be unmarked inside the Gore Area Lines unless safety concerns warrant interior markings.
- Extend from the point of the physical obstruction to a point where the lane width of the ramp and through lane reach 5.5 m and 3.7 m (or designed lane width), respectively, when in the same direction of flow.

iii) For left turn slab-on islands, the pavement markings shall be:

- 10 cm in width
- White in color

e) Diagonal Lines

i) Diagonal markings indicate roadway areas that are not to be used as part of the travel lane, or stopping area.

ii) Chevron Lines

- The interior of Gore Areas may be marked with Diagonal Lines to guide traffic away from the object.
- Where traffic is required to pass to the right of the area, the lines must be Yellow.
- Where traffic is required to pass to the left of the area, the lines must be White.
- Chevron Lines shall:
    - Be placed at an angle of 2:1 in the direction of travel (2 units along the direction of travel to 1 unit per perpendicular to the direction of travel).
    - 45 cm wide, unless otherwise specified by the City (where it they be requested to be 60 cm wide).
    - Have a minimum of 2.0 m distance between Chevron bars.

iii) Stop Box Lines

- Stop boxes may be applied on approaches to signalized intersections where the potential for vehicle movement conflicts exist.
- Stop Bar Lines shall be:
    - 10cm in width (the inside diagonal lines).
    - White in color (the inside diagonal lines).
    - Laterally defined by the curb and the roadway centerline. Alternatively, in instances of only a single lane Stop Box, defined by the Continuity Lines (which shall run as a solid 20 cm line from the Stop Line to the back line of the cross walk) and the centerline.
    - Longitudinally defined by the near side of the crosswalk and the stop line.
    - 2 intersecting diagonal lines inside the stop box, centered.
    - A minimum length of 6.0 m. This is the distance from back line of the crosswalk to the Stop Box Stop Line.
- Some multi-lane roads may require staggered Stop Boxes or a Stop Box for the inside lane only, rather than one, single, Stop Box across all lanes. Traffic movement conditions at the intersection should be considered in determining the appropriate Stop Box arrangement.

.4 Symbols and Letters

a) The goal of the use of symbols is to obtain uniformity and to prevent confusion by utilizing symbols that have restrictive messages that are clearly evident to the driver.

b) Arrows

i) Arrows are used to indicate necessary vehicle movement that is permitted in a travel lane. Use and placement of the arrows are dependent upon lane design and roadway speed. They shall be used in conjunction with other traffic control devices such as lane designation signs mounted overhead or to the side of the road.

ii) For Pavement Arrows please use standard City of Edmonton style of arrows as shown in St Albert's guidelines and referenced from the City of Edmonton, *Pavement Marking Guidelines* most up to date.

iii) Left or Right Turn Arrows

- Turn arrows indicate a mandatory turn is necessary and the lane it is located in will end.
- Turn arrows shall be used:
  - At intersections where a lane that was a through-only lane before the intersection is required to make a forced left or right turn.
  - At "unprotected" left turn lanes; i.e. where no curb is present between the left-turn lane and the traffic travelling in the opposing direction.

iv) Through-Left or Through-Right (Double) Arrows

- Double Arrows indicate optional movements of continuing straight thru or making a turn at the intersection.
- Double Arrows shall only be used when necessary in the lane parallel with a forced left / right turn lane.
- The tail of the parallel arrows (the turning movement and the double arrow) shall be aligned in the lane ways.

c) Railway Crossing "X"

i) The Railway Crossing "X" is used to provide warning of an upcoming railway crossing.

ii) The Railway Crossing symbol shall be:

- White in Color
- Have a 30 cm line width
- 6.0 m in length
- 2.5 m in symbol width (from outside edge to outside edge at the top and bottom of the "X")
- Located 10 m past the Railway Crossing Warning Sign (closer to the RR tracks).

d) Disabled Parking Symbol

i) The disabled parking symbol is utilized to provide notification of a designated parking stall associated with required shown permitting.

ii) Are installed according to Standard Drawing 3.55

iii) Symbol shall be white in colour.

iv) Background shall be blue in colour.

.5 Parking Line Markings

a) Parking Lines may be used to delineate parking stalls.

b) Standard Parking Lines (including Angle Parking) shall be:

i) 10 cm wide, solid line (Yellow in colour).

ii) Minimum 5.8 m in length.

iii) Minimum 2.6 m in stall width (spacing between lines)

iv) Placed to leave a minimum drive aisle of 7.3 m in width.

v) A Parallel Parking Stall must be marked as a minimum of 2.6 m wide and 7.0 m in length.

c) Disabled Parking Stalls shall be:

d) 10 cm wide, solid line (Yellow in colour).

i) Minimum 7.0 m in length.

ii) Minimum 3.7 m in stall width.

iii) Clearly marked with the standard Disabled Parking Symbol.

iv) Clearly marked with Traffic Control Devices showing the specific parking location or zone for the disabled.

3.4 Landscaping

3.4.1 Landscaping Objectives

.1 The landscape design and construction standards should provide the Consultants, Developers and Contractors with an outline of the minimum acceptable standards for the implementation of landscape requirements within the City. The City of St. Albert places a high value on landscaping and greenery in both natural and developed areas. Landscaping provides many aesthetic, ecological, economic, health and safety benefits.

.2 The City's landscaping objectives are as follows:

a) Create functional and aesthetically pleasing landscapes that take into consideration existing and proposed utilities, land uses, flood and drainage patterns, cultural needs, recreational needs, and vehicular and pedestrian circulation systems;

b) Provide landscaping which is contiguous with surrounding natural areas, enhancing the natural character of the region;

c) Provide a safe environment and maximize reasonable accessibility for all residents, by considering Universally Accessible Design and Crime Prevention through Environmental Design (CPTED) principles as part of the design formulation;

d) Incorporate hardy and suitable plant material, specifically with respect to level of maintenance, durability, survivability, availability of replacements, refurbishment, and reclamation potential; and

e) Serve ecological functions through environmental design strategies such as: water conservation and ground water recharge, increasing the amount of permeable surface area to minimize drainage concerns, conserve energy through strategic shading and the use of wind breaks, protect and improve air quality, and create or maintain habitat for wildlife.

3.4.2 Design Principles

.1 The following design principles shall be considered by Landscape Architects when designing landscape, open space and recreation infrastructure in the City of St. Albert. Designs shall:

a) aim to ensure the security, safety, and accessibility of the public;

b) consider the protection of valuable cultural features;

c) ensure the preservation of significant natural landscapes;

d) aim to introduce unique and decorative design features within the landscape; and

e) employ sustainable design practices in all aspects of the project.

3.4.2.1 Leadership in Energy & Environmental Design (LEED) – LEED for Neighborhood Development

.1 Sustainable landscape and urban design practices are outlined in the LEED design assessment criteria. Specific landscape related LEED topics include:

a) Heat Island Reduction - the urban heat island effect can be reduced with increased tree planting and solid surfacing with a high reflectivity or open grid pavement.

b) Water Efficiency - the collection and reuse of rainwater onsite to water plants and turf is a sustainable practice that is covered under the LEED criteria.

The LEED rating system is a valuable guide for the design of sustainable development. (See 2019 draft MDP objectives regarding climate change).

3.4.2.2 Universally Accessible Design

The mobility needs of people of all abilities shall be incorporated into the design, construction, alteration, and renovation of City facilities and municipal infrastructure. Where specific standards related to universally accessible elements are not provided within the Engineering Standards, the City of Burlington Ontario Accessibility Design Standards shall be used as a reference document.

3.4.2.3 CPTED (Crime Prevention Through Environmental Design)

Safety and security must be a high priority for any public space. CPTED guidelines have gained wide international acceptance as design criteria for the built environment with a goal of reducing the potential for crime.

3.4.2.4 Alberta Building Code for Structures

This building code is relevant for buildings and structures such as recreational facilities and public washrooms. The current Alberta Building Code (ABC), in it's latest edition, sets out technical provisions for the design and construction of new buildings. It also applies to the alteration, change of use and demolition of existing buildings. The ABC complements the current Alberta Fire Code in its latest edition, and both are indispensable for building officials, educators and professionals in the construction industry.

3.4.2.5 Design for Winter Cities

.1 Wind: Incorporate landscape design strategies to block wind, particularly prevailing winds and downdrafts.

.2 Sunshine: For gathering or seating areas maximize exposure to sunshine through orientation and design.

.3 Colour: Use colour on site features and amenities to enliven the winterscape.

.4 Lighting: Create visual interest with lighting, while being mindful of obtrusive or unsafe intensity, spread, contrast and colours.

.5 Winter Infrastructure: Design and incorporate infrastructure and amenities that supports desirable outdoor winter activities and improves comfort and access in cold weather.

3.4.3 Landscape Architect's Responsibilities

The Landscape Architect shall also be responsible for the co-ordination of all base plan preparation with other consultants to ensure all utilities, survey and base plan detailing is consistent with other engineering and architectural drawings forming part of the engineering drawing submission. At all times the Landscape Architect will ensure all standards, specifications and procedures herein contained are strictly enforced. The Landscape Architect must be a member in good standing of the AALA (Alberta Association of Landscape Architects) and currently licensed to practice in Alberta.

3.4.4 Landscaping Standards

.1 General

Section 2.7.6, 3.4, and 4.4 presents the minimum acceptable requirements for the design and construction of some typical, key landscaping components. These minimum requirements must be met or exceeded by the detailed design drawings developed by the Consultant.

.2 Minimum Landscape Requirements Summary Table (See also, Parks & Open Space Standards & Guidelines (POSSG):

		Landscape Requirement			
		Planting	Topsoil & Turf	Fencing	Site Furnishings
Roadways	Local Roads	1 tree per lot.	Sod	n/a	n/a
	Collector Roads	1 tree per 10 linear meters.	Sod	Min. 1.8m height uniform fence along all boundaries between public & private property.	
	Arterial Roads	1 tree per 10 linear meters.	Sod		
Municipal Open Space	Walkway	No trees or shrubs.	Sod	Min. 1.8m height uniform fence along all side yards	n/a
	PUL	70 trees per ha	Seed &/or Sod	Uniform fence along all boundaries between public & private property, min. 1.8m ht. (along side yards) & 1.2m ht. (along back of lots)	Required at the discretion of the City of St. Albert
	Stormwater Management Facility	70 trees per ha	Seed &/or Sod	Min. 1.2m height uniform fence along all boundaries between public & private property.	Trash Receptacles, Bench
	Major Utility Right-of-way	Preserve existing trees	Seed &/or Sod		n/a
Parks & Open Space	Conservation Park	n/a	n/a	At the discretion of COSA	n/a
	City Park	70 trees per ha	Seed &/or Sod	Uniform fence along all boundaries between public & private property, min. 1.8m ht. (at side yards) & 1.2m ht. (at back of lots).	Required at the discretion of the City of St. Albert – See Table 2 for minimum requirements
	Community Park	70 trees per ha	Seed &/or Sod		
	Neighbourhood Park	70 trees per ha	Seed &/or Sod		
	Urban Square / Park	At the discretion of the City of St. Albert.	Sod		
	Special Use Area		At the discretion of COSA		
	Connector Park	Min. 4 trees per 35 lm.of Multi-Use Trail	Seed &/or Sod		

	Community Park with School Site	Min. 55 trees per ha	Seed &/or Sod	No rear gate access.	
	Environmental Reserve	If damaged – rehabilitated to the satisfaction of the City. Preserve existing vegetation.	If damaged – rehabilitated to the satisfaction of the City	Temporarily fenced to protect from construction. Construction setback may be required at discretion of the City	n/a

**The minimum standards outlined in the table above may be altered at the discretion of The City of St. Albert to enact landscaping objectives, such as naturalization, or to address design constraints on a case by case basis.*

3.4.5 Landscaping General

3.4.5.1 Tree & Shrub Minimum Sizes

.1 Shrubs will be massed within planting beds and planted appropriate to species. Shrubs shall meet the following minimum sizes at the time of CCC inspection:

a) Deciduous: minimum 450 mm height.

b) Coniferous: minimum 300 mm spread, subject to availability.

.2 Trees shall meet the requirements specified in Section 4.4.6.

.3 Shrubs must meet the requirements of Section 4.4.6.

3.4.5.2 Landscape Restoration

.1 Existing natural and naturalized landscaped areas that are disturbed as a result of development, shall be restored with native plant materials consistent with the surrounding environment, drainage patterns, soil conditions, and ecological rehabilitation. In such cases, the City shall be consulted during the design to assist in planning, the selection of appropriate replacement plant materials, and the retention of wildlife habitat.

.2 The Developer's landscape architect shall design an appropriate mix of native trees, shrubs, ground covers, and native seed mixes, consistent with these Design Standards, to rehabilitate affected areas.

.3 The landscape architect shall, when required, coordinate this restoration with other consultants to implement geotechnical, structural, and bioengineering principles and recommendations.

.4 The City shall require a Natural Area Assessment for any proposed development which would adversely affect any natural area, as per the City's Natural Areas Inventory Map. Other environmental studies may be requested at the discretion of the City.

3.4.5.3 Naturalization Design

.1 Landscape drawings shall identify all existing plant communities to be established and all other information necessary to implement the proposed landscape improvements.

.2 The landscape architect shall specify all tree, shrub, and ground cover sizes. No minimum or maximum sizes are specified.

.3 To create aesthetic diversity, 10% of all plant materials shall be of minimum tree whip size at the discretion of the City based on site specific conditions.

.4 Forestry stock, seedlings, deciduous tree whips, propagated cuttings, and rooted cuttings are acceptable for use, subject to City inspection and acceptance prior to installation.

.5 All plant material to be nursery stock or obtained from the City or Provincial Government sources. Appropriate certification shall be provided.

.6 Appropriate plant installation specifications and details shall be included on landscape drawings.

.7 Suitable herbicides may be used to eradicate non-native vegetation on natural slopes prior to planting of trees and shrubs, subject to the review and acceptance of the City. No chemical treatment shall be permitted within 30 m of any body of water. (Refer to landscape restoration section).

.8 Natural areas disturbed by construction shall be restored by removal of contaminated soils, re-seeded with appropriate native seed mix, and where appropriate planted with naturalized trees and shrubs. In accordance with these standards and maintained during a 2-year maintenance period.

.9 Provide a mow strip of 1.0m on either side of trails and a mow strip 3.0m next to private property in between naturalized area and fence lines.

3.4.6 Roadway Landscape

.1 Boulevard areas are to be graded, top-soiled, and sodded.

.2 Local road tree planting shall have a minimum of one tree per lot unless utilities or other infrastructure do not allow. Boulevards adjacent to each side yard lots shall have at least 3 trees per side yard.

.3 Collector road tree planting requires a row of boulevard trees the equivalent of one tree per 10 linear meters of the plantable area on both sides of the roadway.

.4 Arterial road tree planting requires a row of boulevard trees the equivalent of one tree per 10 linear meters of the plantable area on both sides of the roadway.

.5 .Coordinate boulevard landscaping with the location of street furniture to avoid conflicts.

3.4.6.1 Entrance Feature, Roadway Island, and Roadway Median Development

.1 Landscape design for special entrance features, islands, and medians shall be subject to the review and acceptance of the City. Entrance features shall be low maintenance.

.2 Trees shall be positioned within planting beds or tree wells.

.3 All manicured planting beds shall incorporate a minimum of 100 mm organic mulch (i.e. wood chip mulch). Mulch shall be pulled away from the bases of tree trunks and shrub stems as per landscape detailed drawing.

.4 Roadway islands and medians shall not be grassed unless specifically directed or authorized by the City.

.5 Free-standing architectural features (i.e. signs, sculptures, entry gates, etc.) shall not be located within grassed areas.

.6 All paving stones, paving stone headers, concrete, or other special hard surfaced verge or walkways shall be subject to the review and acceptance of the City.

.7 Typical cross-section details for island and median planting plans shall show all underground infrastructures.

.8 Retaining walls shall be engineered.

.9 Center median verge to be a minimum of 0.5m wide concrete.

.10 Plantings that have thorns are not permitted in medians. Maintenance has difficulty collecting garbage and pruning.

3.4.7 Public Utility Lot

.1 PULs shall be graded, top-soiled, and seeded or sodded.

.2 Provide a minimum of 70 trees per hectare within the PUL. Shrubs may be substituted at the rate of seven shrubs for every one tree. For smaller PUL’s no trees or shrubs are acceptable pending City review and discretion.

.3 Healthy, vigorous trees within or abutting private property within a PUL shall be preserved. Any trees that are requested to be removed are subject to City approval.

.4 Pedestrian access may be required to be provided within a PUL to ensure connectivity for trail users.

3.4.8 Walkways

.1 Areas adjacent to walkways and trails must be graded, top-soiled, and seeded or sodded.

.2 No trees or shrubs are allowed in walkways to the discretion of the city. For example, a 6m wide walkway is to only have turf grass on both sides of the paved pathway.

3.4.9 Major Utility Right-Of-Way

.1 Major utility rights-of-way shall include landscape improvements. Where the utility authority does not approve of planting within their right-of-way’s, the requirement for all or a portion of the planting may be waived, subject to the authorization of the City.

.2 Right-of-way landscape improvements may range from low maintenance naturalization to more formal landscape designs, depending on the existing landscape character established within the right-of-way.

.3 Healthy, vigorous trees within or abutting the right-of-way-shall be preserved. Any trees that are requested to be removed are subject to City approval.

.4 Landscape improvements for major utility right-of-ways shall be in accordance with the applicable articles of these Design Standards and subject to the review and acceptance of the City and the applicable utility authorities.

3.4.10 Stormwater Management Facilities

.1 Storm water management facilities shall be graded, topsoiled, seeded or sodded. Benches and waste receptacles along trails as per engineering standards.

.2 Dry ponds and areas surrounding new stormwater management facilities must be graded, topsoiled, and seeded or sodded.

.3 Provide a minimum of 70 trees per hectare, above normal water level. Shrubs may be substituted for trees at a rate of seven shrubs for one tree to a maximum of 10% of the total required trees per hectare.

.4 Plant materials will be selected with consideration to hydrological characteristics, soil characteristics, facility side slopes, and storm water function use.

.5 Inlets and outlets above normal water level shall be landscaped with mass planting and large rocks, or acceptable alternative concrete revetment, to provide visual screening and security buffering for the public. No weed fabric shall be used.

.6 Special or unique park features (i.e.: artificially pumped dry streams, special play courts, bridges, and other architectural or structural features) are not permitted to be constructed within a SWMF area.

.7 No trails to be constructed below 1 in 25 year flood lines.

.8 All planting below the 1 in 25 year flood line shall be naturalized, in support of the MDP.

.9 Any information signs to be installed shall adhere to the current City of St. Albert Sign Guidelines. Any deviation from these guidelines must be reviewed by and accepted by the City prior to construction.

.10 Stocking of fish of any kind into Stormwater Management Facilities is prohibited.

3.4.11 Environmental Reserve

.1 Environmental reserves shall be temporarily fenced and otherwise protected from adjacent construction. At no time shall encroachment into any natural area or designated buffer area occur without express written consent from the City.

.2 In order to protect the roots, and therefore the health of the trees, no activates, including grading or placement of soil storage of materials or equipment, shall occur over the roots of any tree designated for protection.

.3 Any environmental reserve areas damaged during construction must be rehabilitated to the satisfaction of the City.

.4 For water courses and associated floodplains, steep-sided ravines and development parcels with interest in supporting wetlands, the City of St. Albert Natural Area Conservation and Management Plan is to be followed.

.5 Existing natural and restored areas affected by any proposed improvements, which cannot be protected during construction, must be restored with native plant materials having regard for the surrounding environment, new drainage patterns, soil conditions and ecological rehabilitation. Generally, but not limited to, restoration would apply to ravine lands, major utility and road R.O.W's.

.6 A conservation easement may be established between a private landowner and the City of St. Albert.

a) To protect the environment,

b) natural scenic or aesthetic values, or

c) agricultural land or land for agricultural purposes. Under a conservation easement, the landowner retains title to the land, but certain land use rights are extinguished in the interest of conserving and protecting the land. The land use restrictions that apply to the property are negotiated and agreed to at the outset (for example, a restriction on subdivision), and the conservation easement (and the land use restrictions) are registered on title and are transferred to a new land owner if the land is sold.

3.4.12 Park Development

.1 See the Parks and Open Space Standards and Guidelines (POSSG) for the purpose, primary function, size, location, street frontage access and connectivity, and universal design for the following park classifications:

a) Conservation Park

b) City Park

c) Community Park

d) Neighborhood Park

e) Urban Square/ Plaza

f) Special Use Area

g) Connector

.2 Park sites shall be graded, topsoiled, seeded or sodded.

.3 Refer to section 3.4.4 for minimum number of trees required. Shrubs may be substituted at the rate of seven shrubs for every one tree to a maximum of 10% of the total required trees per hectare.

.4 Developer may provide recreation amenities (playgrounds, outdoor rinks, sports fields) as in Appendix F. See 3.4.14 for required amenities.

3.4.12.1 Community Park with School Site

.1 At a minimum school Park sites are to be topsoiled and seeded (sodded depending on the site at the discretion of the City of St. Albert) and 55 trees per hectare depending on the timing of the school site development in relation to the subdivision development timing.

.2 Joint Use Site Guidelines:

a) School building envelope to have same grades as sports field envelope (i.e. 2%).

b) School building envelopes and adjacent road grades must be at the same elevation

c) School building envelope is to have topsoil applied to a minimum depth of 250 mm.

d) For every one metre in elevation in excess of 2% slope, a minimum increase of three meters will be required on site.

e) If non-engineered fill is to be incorporated in a community park with school site, the non-engineered fill drawing (see detail Sheet No. 28a), documenting the limit and depth of the fill area and confirming the fill area is outside the building envelope, shall be provided at CCC.

.3 Refer to section 3.4.15 for site furniture guidelines.

3.4.13 Amenities

.1 Site Furniture shall be provided by the Developer and placed at strategic locations through the Subdivision as outlined in the table below. Refer to Section 4.4.2. The City shall maintain the right to stipulate specific requirements for furniture.

.2 Any site amenities that are not standard to City of St. Albert must be approved by the City prior to installation and require a Home Owners Association (HOA) to maintain the non-standard amenities or a maintenance agreement with the City.

.3 For information on amenities as they relate to park classification please reference the City of St. Albert Parks and Open Space Standards and Guidelines, latest edition.

3.4.13.1 Benches, Trash Receptacles and Picnic Tables

.1 All bench, trash receptacle and picnic table styles and materials are subject to the approval of the City prior to installation.

.2 See specification 4.4.3; Site Furnishings (32 33 00), for City standard bench, trash receptacle and picnic table standard supplier, style, standard options, and standard colours.

.3 One (1) wheelchair accessible picnic table is required at all picnic areas.

.4 All benches require concrete “wing” for accessibility purposes.

3.4.13.2 Bollards

.1 All bollard styles and material are subject to the approval of the City prior to installation.

.2 Bollards shall be installed by developer in open spaces to ensure that Public Parks, PUL’s, MR’s or SWMF’s are protected from unauthorized public access by vehicles.

.3 Landscape design should consider opportunities to supplement or even replace bollards as a deterrent to unauthorized public access by vehicles to open spaces.

3.4.13.3 Optional Amenities

.1 Optional amenities are non-standard infrastructure development (i.e. ornamental fencing, water features, gazebos, sculptures, entrance features / signs, decorative fixtures etc.) in a public park or road right-of-way. Refer to The City of St. Albert Parks and Open Space Standards and Guidelines in it’s latest edition for options that may be considered.

.2 All optional amenities are subject to the approval of the City prior to installation.

.3 For more detail on optional amenities, refer to Appendix F.

3.4.13.4 Minimum Setback Requirements

.1 Site amenities shall be spaced from infrastructure in accordance with the minimum setbacks provided in the following table:

Infrastructure Designation	Setback Distance
Benches	1.0 m from back of walkway
Trash Receptacles	250 mm from back of walkway, & minimum 3.0m from benches.

3.4.14 Fencing

.1 Uniform fencing shall be provided and installed by the developer adjacent to the following locations:

i) Arterial roadways;

ii) Parks and playfields

iii) Public walkways and public utility lots;

iv) School sites;

v) City owned lands (ie. Firehall sites, etc)

vi) Multiple family sites

vii) Neighborhood commercial sites;

viii) Institutional sites; and

ix) Other areas as required by the city

.2 Screen, uniform and solid fences are to be designed to compliment other proposed architectural and urban amenities, and meet the following objectives:

a) Safety and security;

b) Delineation of private and public lands;

c) Pedestrian barrier; and

d) Visual continuity.

.3 Screen, uniform, and solid fences are to be structurally designed to achieve a minimum life expectancy of 20 years.

.4 Gates shall not be provided on residential lots that back onto MR, ER, PUL or any Municipal Park land.

3.4.15 Plant Material

3.4.15.1 Minimum Setback Requirements

.1 Trees shall be spaced from infrastructure in accordance with the minimum setbacks provided in the following table measured from closest edge of the infrastructure to closest edge of the tree:

Infrastructure Designation	* Setback Distance for Trees
Fence Lines	2.5m
Median and Road Curb Face (Arterial)	2.0m
Median (Collector and Local Roadways)	1.5m
Bull nose of Median on Primary Street	4.5m
Driveways	1.5m (2.0m preferred)
Fire Hydrants	3.5m
Street Lights (Arterial Roadways)	3.5m
Street Lights (Collector and Local Roads)	3.5m
Buried Utilities (power, cable, telephone, traffic signals)	1.0m
Power Hardware	3.5m
Telephone Pedestals	1.5m
Water Valves	1.8m
Buried Gas Mains and Services	1.5m
Street corners (distance from intersecting curb)	12.0m
Yield and Stop Signs (Arterial Roadways)	7.5m
Yield and Stop Signs (Collector and Local Roadways)	3.5m
Bus Stop Signs and other signs	3.5m
Other signs	2.0m
Sidewalks ~~and trails~~	1.0m
Trails	3.0m
Buried Storm / Wastewater / Water Services	1.8m
* Minimum tree setbacks can be adjusted by the City based upon the species and placement.	

.2 Trees shall not be planted in any location from which the tip of any branch will grow closer to overhead power lines than 2.4 m laterally or 4.5 m vertically.

.3 No trees at 75% growth projection shall have branches overhanging the fence line of private property.

.4 The mix of boulevard and open space trees species shall be diversified to minimize the risk of pests and disease. There shall be no more than three of the same species placed in succession. Boulevard/open space trees shall be planted with a spacing that is at equal intervals, which may vary depending on their ultimate size, in accordance with the following:

a) Large and medium size trees: 10 to 13 m spacing.

b) Small size trees: 7 to 10 m spacing.

3.4.15.2 Tree Selection

Tree selection shall be consistent with the following requirements:

Adequate, year-round sightlines shall be maintained for pedestrian and vehicular safety.

Minimum 1.8 m branching height for all trees adjacent to roadways and walkways.

The following tree species are acceptable for landscaping within public areas. Proposed alternates shall be subject to the review and acceptance of the City.

Due to climate change and the increasing risks of new pests, the City recommends planting a variety of species on any residential block (i.e. larger species for larger boulevards, and smaller species for a smaller boulevard, alternating species along a block, patterned plantings etc.).

No fruit-bearing species are permitted without City approval adjacent to sidewalks or trails.

For naturalized areas and Environmental Reserves, a list of tree species must be provided to St. Albert for review and must be approved prior to development.

Refer to the following chart for recommended deciduous trees

Large Trees				
Botanical Name	Common Name	Approx. Height at Planting	Min. Caliper at Planting	Acceptable Locations
Acer saccharimum	Silver Maple	3.7-4.6 m	60mm	Boulevards
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Maple	3.7-4.6 m	60mm	Boulevards
Betula papyrifera	Paper Birch	3.7-4.6 m	60mm	Open Spaces (Moist)
Fraxinus pennsylvanica (Seedless)	Green Ash	3.7-4.6 m	60mm	Boulevards
Fraxinus pennsylvanica 'Bergeson', 'Patmore', 'Prairie Spire', and 'Summit'	Bergeson, Patmore, Prairie Spire, and Summit-Ash	3.7-4.6 m	60mm	Boulevards
Fraxinus mandshurica**	Manchurian Ash	3.7-4.6 m	60mm	Boulevards
Fraxinus Americana	White Ash	3.7-4.6 m	60mm	Open Spaces
Fraxinus 'Northern Gem' and 'Northern Treasure'	Northern Gem & Northern Treasure Hybrid Ash	3.7-4.6 m	60mm	Boulevards
Tilia americana	Basswood	3.7-4.6 m	60mm	Open Spaces
Ulmus americana	American Elm	3.7-4.6 m	60mm	Boulevards/Medians
Ulmus americana 'Brandon'	Brandon Elm	3.7-4.6 m	60mm	Boulevards/Medians
Salix pentrandra	Laurel-Leaf Willow	3.7-4.6 m	60mm	Open Spaces (Moist)
Salix alba	White Willow	3.7-4.6 m	60mm	Open Spaces (Moist)

Salix alba 'Vitellina'	Golden Willow	3.7-4.6 m	60mm	Open Spaces (Moist)
Medium Trees				
Botanical Name	Common Name	Approx. Height at Planting	Min. Caliper at Planting	Acceptable Locations
Aesculus sp	Buckeye	3.7-4.6 m	60mm	Open Spaces
Aesculus glabra	Ohio Buckeye	3.7-4.6 m	60mm	Open Spaces
Aesculus hippocastanum	Horse Chestnust	3.7-4.6 m	60mm	Open Spaces
Juglans cinerea	Butternut	3.7-4.6 m	60mm	Open Spaces
Populus tremula 'Erecta'	Swedish Aspen	3.7-4.6 m	60mm	Medians
Populus x canescens 'Tower'**	Tower Poplar	3.7-4.6 m	60mm	Open Spaces
Prunus padus commutate* **	Mayday Tree	3.7-4.6 m	60mm	Open Spaces
Malus 'Spring Snow'	Spring Snow Flowering Crab	3.7-4.6 m	60mm	Open Spaces
Prunus maacki* **	Amur Cherry	3.7-4.6 m	60mm	Open Spaces
Prunus pennsylvanica	Pincherry	3.7-4.6 m	60mm	Open Spaces
Quercus macrocarpa*	Burr Oak	3.7-4.6 m	60mm	Boulevards
Acer ginnala	Amur Maple	3.7-4.6 m	60mm	Open Spaces
Tillia cordata	Little Leaf Linden	3.7-4.6 m	60mm	Open Spaces
Tillia x flavescens	Dropmore Linden	3.7-4.6 m	60mm	Open Spaces
Ulmus davidiana	Discovery Elm	3.7-4.6 m	60mm	Boulevards
Small Trees				
Botanical Name	Common Name	Approx. Height at Planting	Min. Caliper at Planting	Acceptable Locations
Crataegus x mordensis 'Snowbird' *	Snowbird Hawthorn	3.0-3.7m	60mm	Open Spaces
Malus x astringens Cultivars *	Rosybloom Crabapple	3.0-3.7m	60mm	Open Spaces
Maackia amurensis*	Amur Maacki	3.0-3.7m	60mm	Open Spaces
Sorbus decora*	Showy Mountain Ash	3.0-3.7m	60mm	Open Spaces

Prunus virginiana var. melanocarpa Cultivars*	Chokecherry	3.0-3.7m	60mm	Open Spaces
Prunus virginiana 'Schubert'**	Schubert Chokecherry	3.0-3.7m	60mm	Boulevard
Syringa rectuculata	Japanese Tree Lilac	3.0-3.7m	60mm	Islands
*Fruit or nut bearing trees are not permitted near sidewalks or trails. These trees should be planted in beds to reduce maintenance. Only selective use Chokecherry trees will be permitted. Alternate trees in Boulevard)				
** Prone to disease (Cottony Psyllid, Bronze Leaf, Black Knot)				

Refer to the following chart for recommended coniferous trees:

Note: This list is acceptable for buffers and open spaces only.

Botanical Name	Common Name	Min. Height at Planting	Mature height
Abies sp.	Fir	2.4m	8-10m
Picea spp.	Engleman, Norway, White & Colorado Spruce	2.4m	15m
Pinus sp.	Scot, White, Lodgepole, Ponderosa Oine	2.4m	15m
Larix sp.	Siberian Larch, Tamarack	2.4m	3-10m

Refer to the following chart for recommended deciduous shrubs:

Botanical Name	Common Name	Min. Height at Planting	Mature height
Cornus spp.	Dogwood	400mm	0.4-3m/ 1.2-3m
Euonymus spp.	Winged and Dwarf Narrow-leaved Burning Bush	400mm	0.6-1.5m/ 0.6-1.5m
Hydreangea spp.	Hydrangea	400mm	0.6-2.4m/ 0.6-2.4m
Loniceria spp.	Honeysuckle	400mm	0.6-3.7m/ 1-3m
Philadelphus spp.	Mock Orange	400mm	0.6-1.5m/ 0.3-1.5m
Physocarpus sp.	Ninebark	400mm	0.4-3m/ 0.6-3m
Potentilla sp.	Potentilla	400mm	0.6-1m/ 1m
Ribes spp.	Currant	400mm	1.2-2.1m/ 1.2-2.1m
Rosa spp.	Rose	400mm	0.6-3m/ 0.6-1.8m
Spirea spp.	Spirea	400mm	0.4-1m/ 0.6-2.4m
Syringea spp.	Lilac	400mm	0.9-3m/ 1.5-5m
Corylus cornata	Beaked Hazelnut	400mm	0.4-3m/ 1.2-3m

Viburnum spp.	Cranberry	400mm	0.6-3m/ 1-3m

Refer to the following chart for recommended coniferous shrubs:

Botanical Name	Common Name	Min. Spread at Planting	Mature Size
Juniperus spp.	Common, Horizontal, Pfitzer, Savin Juniper	300mm	0.3-1m
Juniperus spp.	Rocky Mountain Juniper	300mm	Up to 5m
Picea abies var.	Compact, Gregoryana, Nest Spruce	300mm	1.5m
Picea pungens var.	Globe, Hoopsii, Koster Spruce	300mm	Up to 3m
Pinus sylvestris var.	Sentinal, Green Compact Pine	300mm	Up to 2m
Pinus mugo var.	Mugo Pine var.	300mm	0.6-3m

3.4.15.3 Planting Season

.1 Planting must be done between May 1 and September 15 and during the normal planting season for the type of plant being installed.

3.4.15.4 Planting Beds

.1 Where possible, shrub beds should be designed with tapered or flowing edges to allow for east of mowing with machines, leaving no uncut grass

.2 The use of filter fabric and edging within planting beds is not allowed due to long term maintenance.

3.5 Commercial, Institutional, Industrial and Multi-Family

3.5.1 General

.1 All private site development design shall conform to all relevant zoning bylaws.

a) Commercial, Institutional, Industrial and Multi-Family development design will be reviewed and approved during the development permitting process.

3.5.2 Grading

.1 All private site design shall conform to grading standards outlined in *Article: 3.1.*

3.5.3 Underground

.1 All private site design shall conform to underground standards outlined in *Article: 3.2.*

3.5.4 Surface

.1 All private site design shall conform to surface standards outlined in *Article: 3.3.*

i) Parking lots/structures must abide by the current St. Albert Land Use Bylaw.

ii) Asphalt parking lots shall have a minimum grade of 0.6%

3.5.5 Landscaping

.1 All private site design shall conform to landscaping standards outlined in *Article: 3.4.*

4 Construction Specifications

4.1 General

4.1.1 Construction

.1 Construction projects that include major ground disturbance including, but not limited to, demolition and piling require noise and vibration monitoring for the duration or as specified by the City Engineer. It is the responsibility of the Consulting Engineer to contract the services of a noise and vibration specialist on behalf of the Owner. To protect the public interest, noise and vibration monitoring is to be conducted at key locations based upon the proximity to adjacent properties, the findings of the geotechnical report and the sub-surface topography.

Any request for an exemption to noise and vibration monitoring must be submitted in writing to the City Engineer for consideration. No exemption to noise and vibration monitoring will be permitted without written authorization from the City Engineer. A copy of the noise and vibration monitoring results shall be made available to the City Engineer and to any adjacent property owner who requests the monitoring results.

.2 A copy of all construction drawings, construction specifications, and applicable supporting documentation shall be maintained at the construction site during construction.

.3 Underground utilities shall not be permitted to operate as part of their respective existing utility systems until such utilities have been inspected and tested by the Contractor under witness of the Consultant and accepted by the City in writing. Only the City may operate existing utility systems.

.4 The Consultant, or designated representative, shall be available at all times to visit the site during the installation of municipal infrastructure.

.5 In addition to construction observation carried out by the Consultant, the City will periodically review the work. Should the City note any method or material being employed that is contrary to the accepted Design, the City shall bring such to the attention of the Consultant. If remedial action is not taken to the satisfaction of the City, the City will issue a stop work order in accordance with the Development Agreement.

.6 It shall be the responsibility of the Developer and Consultant to ensure that the Contractor successfully completes all necessary testing, to the satisfaction of the City. The Consultant shall provide the City with a written report acknowledging that all required testing has been successfully completed.

.7 Where the work of the Contractor fails to meet the specifications of the accepted Design, the Developer and Consultant shall be responsible to ensure such work is rectified and retested accordingly.

.8 Following construction completion, record drawings must be prepared and submitted to the City in accordance with Article 2.7.5 of these Standards.

4.1.2 Materials

.1 Only new materials shall be used in the construction of municipal infrastructure.

.2 Any materials which are defective in manufacture or which are damaged prior to installation and acceptance by the City shall be replaced by the Developer, at the Developer's sole expense.

.3 Where specific materials are specified in these Municipal Engineering Standards, the City shall consider applications for substitute products which can be considered comparable in terms of these Municipal Engineering Standards. Written acceptance of such must be obtained from the City before any substitution can be made.

4.2 Earthworks and Grading

4.2.1 Site Preparation

.1 Maintain slopes and adequate drainage during grading.

.2 The mixing of fill material may be allowed if reviewed and approved by geotechnical engineer and the City Engineer.

.3 Locate, mark, and protect all utilities and appurtenances (i.e. manholes, catch basins, valves, and hydrants).

.4 Do not stockpile materials on municipal reserve (MR) or environmental reserve (ER) designated land unless written authorization of such has been provided by the City.

4.2.2 Clearing and Grubbing (31 11 00)

.1 Excavate, remove and dispose of all roots, stumps, submerged logs, corduroy and similar objectionable matter to a depth as determined by the geotechnical report.

.2 Fill holes and level areas disturbed by grubbing.

.3 It is paramount that clearing does not disturb nesting birds and other wildlife. Development shall abide by all Alberta Environment standards and guidelines and carry out all mandates as set forth such as performance and documentation of nesting checks.

.4 Cut, dig, remove, and dispose of all timber, brush, windfall, stumps, and rubbish except such trees and shrubs that are designated for preservation.

.5 Preserve such designated trees and shrubs from scarring, barking, or other injury during construction operations. Conduct root pruning as necessary as prescribed by a Certified Arborist.

.6 Leave ground surface in a condition suitable for stripping of topsoil.

4.2.3 Topsoil Stripping and Stockpiling (31 14 13)

.1 Strip all areas to be excavated for structures, pipes, or roadways to the limits shown on the construction drawings.

.2 Strip the full depth of topsoil or organic material.

.3 Frozen topsoil may be stripped by ripping provided a minimum of 2 passes are made, the first of which shall not exceed 50% of the topsoil depth.

.4 Stockpile and windrow topsoil temporarily and dispose of stripped material that is unsuitable for replacement. Stockpile in a manner that will not endanger persons, the work, or adjacent property.

.5 Do not stockpile material on municipal reserve (MR) or environmental reserve (ER) designated land unless written authorization has been issued by the City.

.6 Ensure stockpiles of topsoil, common excavation, and borrow materials are sufficiently separated. Maintain a minimum of 1.0 m separation between topsoil and common excavation material when stockpiling.

.7 Provide erosion and sediment control measures around stockpiles as required.

.8 If the topsoil and subsoil are mixed and the topsoil is adversely affected, engage a soils specialist to determine the necessary remedial work and complete the required remedial work.

.9 Protect completed portions of the work from damage. Repair damaged areas as required.

.10 The City reserves the right to impose a time limit on the duration which a stockpile may be left in place. Upon expiry of the time limit, the stockpile must be removed and the underlying surface reinstated to the satisfaction of the City.

4.2.4 Fill and Grade (31 23 00)

.1 Place and spread fill material in successive horizontal lifts.

.2 Compact each lift to a minimum 98% Standard Proctor Density, unless otherwise specified or directed by the City.

.3 Each lift shall not exceed 150 mm in compacted thickness

.4 Trim side slopes from top down, and finish true to the required alignment, grade, and shape.

.5 Grades shall be within 30 mm of design grades.

.6 Trim high areas, scarify low areas, compact, and re-grade as required to achieve specified grades and compaction.

.7 Ensure cross falls and ditch bottoms are graded to promote positive drainage flow.

.8 All fill material must undergo at a minimum, chemical analytical testing conducted by a provincially registered engineering or geoscience company. Soil analytical results should be compared to site-specific Alberta Tier 1 parameters and analytical testing must be completed by an accredited laboratory. Results must be submitted as a technical memorandum signed off by a professional engineer or geoscientist and submitted to St. Albert.

4.2.4.1 Trench and Uniform Backfill (31 23 00)

.1 Trench backfill is defined as backfill above the pipe zone.

.2 Place backfill in a dry trench.

.3 Place backfill by rolling down a slope in the trench or lower by machine. Prevent backfill from dropping vertically.

.4 Backfill as close as possible to pipe laying operations so that trenches are left open no longer than absolutely necessary.

.5 Protect all open excavations when construction is not ongoing with fencing, barricades, flashing lights, etc., and provide watchmen for site security and public safety if required by the City.

.6 Plan the backfilling operation so that exposure of the backfill material to frost is kept to a minimum. Use no large frozen chunks of soil as backfill.

4.2.4.1.1 Classes of Trench Backfill

.1 Type 1: Backfill with native or imported fill material over bedding up to the designated subgrade or existing ground elevation, whichever is lower, in lifts not exceeding 300 mm when compacted. Compact each lift compacted to 98% of the maximum density as determined by the Standard Proctor Compaction Test.

.2 Type 2: Backfill with specified granular fill over bedding up to existing ground elevation if lower than the designated subgrade depth, in lifts not exceeding 300 mm when compacted and compact each lift to 95% of the maximum density as determined by the Standard Proctor Compaction Test. If designated subgrade elevation is level with or lower than the existing ground, place native or imported fill material as the topmost 300 mm lift compacted to 98% of the maximum density as determined by the Standard Proctor Compaction Test.

.3 Type 3: Cut trench sides above bedding to slopes flat enough to allow road compaction equipment to operate transversely across the trench. Backfill with native or imported fill material over bedding up to the designated subgrade or existing ground elevation, whichever is lower, in lifts not exceeding 150 mm when compacted and compact each lift to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

.4 Type 4: Fillcrete over bedding to designated subgrade elevation. Uniformly place fillcrete from the top of bedding to the designated or pre-existing sub-grade elevation. Protect fillcrete from freezing or other adverse weather conditions for a minimum of 24 hours following placement. Fillcrete that is exposed to significant infiltration of water within 24 hours of placement must be removed and replaced. A minimum of 150 mm of granular base course must be placed on the fillcrete surface before allowing any vehicular traffic over the fillcrete. Granular base course may be placed 24 hours following the placement of the fillcrete.

Supply fillcrete in accordance with *Table 4.3.82* under *Section 4.3.3.1.11*.

4.2.5 Excavation (31 23 00)

.1 Excavate the area to the required cross-section and to the required sub-grade elevation.

.2 Where excavation exposes unsuitable materials below the sub-grade, excavate such materials using transition slopes no steeper than 10% along the alignment profile. Make the bottom of the cut level, with no loose material.

.3 Where over-excavation occurs, reinstate grades by backfilling, compacting, and re-grading as required.

.4 Excavate rock and haul to disposal areas.

.5 Excavate unsuitable material and haul to disposal areas.

.6 Location plans and remediation procedures for borrow pits must be in place and reviewed by the City prior to borrow activities being undertaken. Borrow pits must be identified on record drawings.

4.2.5.1 Trench Excavation (31 23 00)

.1 Refer to the Engineering Standard Drawings in Appendix A.

.2 Where applicable, any recommendations of the geotechnical report regarding trenching methods shall be duly incorporated into the construction specifications and drawings, and observed by the Contractor.

.3 Where required, temporary protective structures, bracing, shoring, and sheeting are the responsibility of the Contractor and shall be designed by a Professional Engineer registered in Alberta.

.4 Observe safety regulations of the Occupational Health and Safety Act with regard to protection of the work, property, and structures adjacent to the Work and maintenance of the trench widths.

.5 Existing pipelines shall be exposed by hand digging or hydro-vacuuming. No mechanical excavation shall be undertaken within 1.0 m of the anticipated location of an existing pipeline. Hydro-vacuuming is the preferred method of confirming the location of existing utilities near the surface.

4.2.5.1.1 Density Requirements

.1 Reference Density:

.2 **Standard Proctor:** the maximum dry density obtained from a plot of the dry densities of multiple specimens at various moisture contents, moulded and compacted in the laboratory according to ASTM D698 Method A.

.3 Required Compaction

.4 Required trench backfill compaction, expressed as a minimum percent of standard Proctor density or of one-mould Proctor density, is defined in Table 4.2.1

Table 4.2.1: Required Compaction

Required Compaction	Backfill Zone
A. Under existing or proposed road, alley, walk, street light or similar structure and within a distance from such structure equal to trench depth:	
98.0% of standard	From designated subgrade elevation or existing ground level, whichever is lower, to 1.5 m below.
95.0% of standard	More than 1.5 m below.
B. Adjacent to existing improved road, alley, walk, street light or similar structure and within a distance from the improvement equal to trench depth:	
92.0% of standard	Through full depth of trench.
C. Outside defined areas:	
95.0% of Standard	Through full depth of trench.
D. Trench and backfill Type 2:	
95.0% of standard	Through full depth of trench.
E. Trench and backfill Type 3:	
98.0% of standard or 100.0% of one-mould	From designated subgrade elevation or existing ground level, whichever is lower, to 1.5 m below.
95.0% of standard or 97.0% of one-mould	More than 1.5 m below.

Moisture Content Requirements

The uniform backfill moisture requirements shall apply where the upper 1.5 m of the subgrade is excavated beyond the limits of the trench to include any roadway structures, including monolithic or boulevard walk. The excavated material, if acceptable to the Engineer, shall be replaced and re-compacted in lifts not exceeding 300 mm compacted thickness, to the requirements of Table 4.2.1.

4.3 Surface

4.3.1 General Pavement Design Requirements

It is the objective of this section to ensure a degree of consistency in Designs provided by Engineering Consultants by following specific structural design methodologies within a general framework. At the same time the design process provides sufficient flexibility to allow for the judgement and innovation by experienced pavement design engineers to address the specific conditions of each project.

The City of St. Albert will continue to be the custodian of all pavement evaluation, management and inventory data. These data will be available for use by engineering consultants. The City of

St. Albert's role in the design process will be to review pavement designs provided by consultants for completeness, conformance to the design philosophies and methodologies outlined below and to ensure that the design is supported by appropriate Engineering investigation and evaluation.

The methodologies detailed apply to the design of flexible (granular Base course) pavement structures on all classes of roadway in the City of St. Albert. This section reflects the most appropriate design methodologies, adapted for St. Albert's conditions and experience that are available at the present time. Changes in technology related to non-destructive pavement evaluation testing, laboratory testing and analysis, mechanistic pavement design and new paving materials; new maintenance practices; and changing traffic conditions and loadings will all influence the future performance of pavements and will result in necessary changes to this section in the future.

This section is not all encompassing in terms of addressing all factors that may influence the design and performance of a pavement. Pavement designers will need to address these factors on a project by project basis and, where necessary, will have to carry out additional research to ensure appropriate and cost-effective design solutions are provided.

It is important that the design engineer have ready access to background publications and the research of others (e.g. Asphalt Institute [AI], American Association of State Highway and Transportation Officials [AASHTO], Federal Highway Administration [FHWA], Transportation Research Board [TRB], Transportation Association of Canada [TAC], Association of Asphalt Paving Technologists [AAPT], Canadian Technical Asphalt Association [CTAA], etc.) that form the technical background to the design and performance of flexible pavement structures.

It is intended that this section be utilized in conjunction with the AASHTO Guide [AASHTO 93], which will be supplemented with information from the currently available AASHTOWare Pavement ME Design software once local calibration has been undertaken and completed.

The following Tables indicate the range of inputs for use in the AASHTO 93 Design guide for City of St. Albert Projects:

Table 4.3.1: Recommended Subgrade Modulus

Soil Type (As determined through Investigation)	Subgrade Modulus M_R (MPa)
High Plastic Clay (Ci, CH)	30
Low Plastic Clay (CL, MH)	40

Table 4.3.2: Recommended Reliability

Design ESALS (x10^{6})	Reliability %
< 0.1	75
0.1 – 5.0	85
5.0 to 10.0	90
>10.0	95

Table 4.3.3: Recommended Layer Coefficients

Material	Layer Coefficient
Asphalt Concrete (Surface and Base Course)	0.40
Asphalt Stabilized Base Course (Foamed Asphalt)	0.28
Granular Base Course	0.14
Granular Subbase Course	0.10

Table 4.3.4: Recommended Drainage Coefficient

Drainage Coefficient (Granular Base)	1.0

Table 4.3.5: Recommended ESAL Values for Road Classifications

Roadway Design	Design ESAL Value*
Residential Local Roadway	3.6×10^4
Residential Minor Collector (Truck Route with No Bus)	1.8×10^5
Residential Major Collector (Truck and Bus Route)	3.6×10^5
Light Industrial & Commercial	1.0×10^6
Arterial	Requires Traffic Evaluation
Major Arterial	Requires Traffic Evaluation

**Note: ESAL values should always be verified before design*

Table 4.3.6: Recommended Serviceability

	Serviceability Index
Initial	4.2
Terminal	2.5

Table 4.3.7: Recommended Standard Deviation

Pavement Type	Overall Standard Deviation
Asphalt	0.45 (new Construction) 0.49 (Overlays)
Concrete	0.35 (new Construction) 0.39 (Overlays)

The City of St. Albert is working on Calibration of the new AASHTOWare Pavement ME Design software for use as a pavement structural design tool. Currently the City of Edmonton in conjunction with Alberta Transportation has identified the following as level 3 inputs into the AASHTOWare Pavement ME Design Software. These can be found published in the document "Canadian Guide: Default Parameters for AASHTOWare Pavement ME Design" latest version.

Table 4.3.8: Recommended Initial IRI (m/km) Inputs

Treatments	Initial IRI
Mill & Inlay	1.0
Mill & Hot mix Overlay	1.0
FDR with Stabilization & overlay	1.0
New or Reconstruction	0.9

Table 4.3.9: Recommended Terminal IRI (m/km) based on Road Classification

Road Classification	Terminal IRI (m/km)
Residential Local Roadway	3.0
Residential Minor Collector (Truck Route with No Bus)	2.6
Residential Major Collector (Truck and Bus Route)	2.3
Arterial	2.1
Major Arterial	1.9

Table 4.3.10: AASHTOWare Pavement ME Design Performance Criteria Default Values

Performance Criteria	Default Target Values
Flexible Pavements:	
AC top-down fatigue Cracking (m/km)	380 Note 1
AC bottom-up fatigue Cracking (percent)	Freeway:10 Arterial 20 Collector/Local 35
AC thermal fracture (m/km)	250 Note 2
Permanent deformation – total pavement (mm)	20
Permanent deformation – AC only (mm)	20
Total Cracking (reflective + Alligator) (percent)	50 Note 3
Rigid Pavements: Note 4	
JCPC transverse Cracking (Percent slabs)	Freeway:10 Arterial 15 Collector/Local: 20
Mean joint faulting (mm)	3

Note 1: Design failure criterion is not well understood; value to be used for information only and not for acceptance or rejection of a design.
Note 2: Thermal cracking allowed in a municipal environment is higher than typically allowed in a highway scenario as a result of utilizing binders that are stiffer due to the signalized intersections (slow moving traffic with stopping and starting)
Note 3: Reflective cracks derived from empirical equation of MEPDG and require further calibration for local conditions; value to be used for information only and not for acceptance or rejection of a design. (Edmonton currently does not trigger on cracking)
Note 4: City of Edmonton currently only has two small rigid pavement sections, so at this time we would tend to follow the guidelines presented by Ontario

.

Table 4.3.11: AASHTOWare Pavement ME Design Recommended Design Reliability Levels

Roadway Functional Class	Recommended Range of Reliability Levels (%)
Freeway	95
Arterial	90
Collector	85
Local	80

Table 4.3.12: Edmonton Average AADTT and Truck Distribution by Functional Road Class

Road Classification	Ave. AADTT for Road Class	FHWA Classification 4	5	6	7	8	9	10	11	12	13
		Truck Distribution									
Local	12	0.0	45.1	14.1	1.0	7.5	24.1	7.9	0.1	0.1	0.1
Minor Collector	101	0.0	43.1	13.9	1.0	8.2	22.5	10.4	0.7	0.1	0.1
Major Collector	1611	20.5	33.8	9.2	1.5	8.9	22.0	1.8	0.7	0.2	1.4
Industrial	354	1.0	36.6	6.8	1.9	9.7	16.4	18.9	0.3	0.5	7.9
Arterial	3410	13.0	27.1	6.0	0.4	2.7	19.1	15.5	0.5	0.5	15.2
Major Arterial	9552	9.4	22.6	4.5	0.4	1.5	18.0	25.0	0.1	0.4	18.1

Table 4.3.13: St. Albert Recommended Superpave and SMA Asphalt Concrete Properties

Asphalt Layers		10mm-LT	10mm-HT	20mm-B	16.0mm SMA
Thickness (mm)	Project Specific				
Mixture Volumetrics					
Unit Weight (kg/m^3)		2335	2357	2371	2350
Effective Binder Content (by Volume%)		11.8	11.2	10.1	14.6
Air voids(%)[1]		3.0			
Poisson's Ratio[2]		0.35			
Mechanical Properties					
Dynamic Modulus		"Input Level 3" Selected			
Aggregate Gradation	% Passing 19mm Sieve	100	100	100	100
	%Passing 9.5 mm Sieve	83.2	82.5	79.0	73.1
	% Passing 4.75 mm Sieve	54	52.8	58.5	29.7

	% Passing 80 µm Sieve	4.0	3.9	5.8	11.0
G*Predictive Model		"Use viscosity based model (nationally calibrated)" selected			
Reference Temperature		21.1°C			
Asphalt Binder3		PG 58-28	PG 58-28	PG 58-28	PG 70-28
Indirect Tensile Strength @10 °C (MPa)		Calculated			
Creep Compliance		"Input Level 3" Selected			
Thermal					
Thermal Conductivity (Watt/meter-Kelvin)		1.16			
Heat Capacity (Joule/kg-Kelvin)		963			
Thermal Contraction		Calculated			

Note 1: For existing HMA layers, should use measured in-situ air voids.
Note 2: For new HMA mixtures, use calculated Poisson's ratio by expanding the row on 'Poisson's ratio' and set to 'true' for the row on 'Is Poisson's Ratio calculated?' Refer to Mechanistic-Empirical Pavement Design Guide Table 11-3 for other reference temperatures and open-graded HMA Poisson ratios.
Note 3: PGAC varies based on locations and traffic loading conditions. Individual Projects will either specify PG 70-28 or PG 76-28.

Table 4.3.14: Recommended Climate Data Stations

Station code	Town/City Name	Province	Climate Station Name	Latitude	Longitude	Elevation	Beginning Date (YYMMDD)	End Date (YYMMDD)
25111	Edmonton	AB	City Center	53.573	-113.518	671	740401	940331
25142	Edmonton	AB	EIA	53.317	-113.583	723	870701	070630
25108	Edmonton	AB	Namao	53.667	-113.467	688	750201	950131

Table 4.3.15: Recommended Asphalt Materials Properties

Layer		FDR with Foamed Asphalt
Thickness (mm)		Project specific
Mixture Volumetric		
Unit Weight (kg/m^3)		See Note 1
Effective Binder Content - by Volume (%)		11.8
Air Voids (%)[2]		4.0
Poisson's Ratio[3]		
Mechanical Properties		
Dynamic Modulus		"Input level: 3" selected
Aggregate Gradation	% Passing 19 mm Sieve	100 %
	% Passing 9.5 mm Sieve	83.2 %
	% Passing 4.75 mm Sieve	54 %
	% Passing 75 µm Sieve	4 %

G Star Predictive Model	"Use viscosity based model (nationally calibrated)" selected
Reference Temperature	21.1°C
Asphalt Binder4	PG 58-28
Indirect Tensile Strength – 10 deg.C (MPa)	Calculated
Creep Compliance (1/GPa)	"Input level: 3" selected
Thermal	
Thermal Conductivity (watt/meter-Kelvin)	1.16
Heat Capacity (joule/kg-Kelvin)	963
Thermal Contraction	Calculated

Note 1: Varies based on the actual mix design and is dependent on the existing roadway cross section, typical range is between 1950 and 2100kg/m^3
Notes 2: PGAC follows the binder grade of the original asphalt

Table 4.3.16: Recommended Concrete Mix Properties and Design Parameters

PCC	
Layer Thickness (mm)	Project specific
Unit Weight (kg/m^3)	2400
Poisson's Ratio	0.2
Thermal	
PCC Coefficient of Thermal Expansion (mm/mm degC x 10-6)	7.8
PCC Thermal Conductivity (watt/meter-Kelvin)	2.16
PCC Heat Capacity (joule/kg-Kelvin)	1172
Mix	
Cement Type	GU
Cementious Material Content	335 kg/m^3
Water/Cement Ratio	0.45
Aggregate Type	Quartzite
PCC Set Temperature	Calculated
Ultimate Shrinkage (Microstrain)	Calculated
Reversible Shrinkage (% of Ultimate Shrinkage)	50 %
Time to Develop 50% of Ultimate Shrinkage	35 Days
Curing Method	Curing Compound
Strength	
PCC Strength and Modulus	"Level 3" selected
28 Day Compressive strength (MPa)	30
Elastic Modulus (MPa)	29,600
JPCP Design	
PCC Surface Shortwave Absorptivity	0.85
PCC Joint Spacing (m)	3.5, 4.5, 4, 4.3
Sealant Type	Other
Doweled Joints	Default
Widened slab	Widened
Slab width (m)	4.25
Tied Shoulders	Tied
Load efficiency (%)	70
Erodibility Index	Default
PCC-base Contact Friction	Default

Permanent Curl/Warp Effective Temperature Difference (deg C)	Default

Table 4.3.16: Recommended Typical Granular Material Properties

Unbound		3-20	3-25	3-40	3-63	3-80
Layer Thickness (mm)		Project specific				
Poisson's Ratio		0.35				
Coefficient of Lateral Pressure (k0)		0.5				
Modulus						
Resilient Modulus (MPa)		250	250	200	200	200
Sieve						
Gradation and other engineering properties						
Aggregate Gradation (percent passing)	80 mm					100
	63 mm			100	100	
	25 mm		100	82	65	65.5
	20 mm	100	89.5	75	60	60.5
	16 mm	89.5	81.5	70	54.5	54
	12.5 mm	75	73	65	49	50
	10.0 mm	67	65.5	59		
	6.3 mm				35	
	5.0 mm	49.5	49.5	47	32.5	37.5
	2.0 mm	38	37	35	26.5	30.5
	1.25 mm	31	31	30	23	26.5
	0.630 mm	24	24	23	19	21
	0.400 mm	19.5	18.5	19	16	17
	0.315 mm	17.5	16.5	16.5	14.5	15
	0.160 mm	12	12	11.5	10.5	10.5
	0.080 mm	6	6	5	5	5
Liquid Limit		6	6	5	5	10
Plasticity Index <400µm		6	6	6	6	0
Is layer compacted		Yes				
Maximum dry unit weight (kg/m3)		Calculated				
Saturated hydraulic conductivity (m/hr)		Calculated				
Specific gravity of solids		Calculated				
Optimum gravimetric water content (T)		Calculated				

Table 4.3.17: Recommended Typical Chemically Stabilized Base Material Properties

General	CTB
Layer Thickness (mm)	Project specific
Unit Weight (kg/m^3)	2051
Poisson's Ratio	0.2
Strength	
Backcalculated Resilient Modulus (MPa)[1]	See Note 2
Minimum Resilient Modulus (MPa)	690
Modulus of Rupture (MPa)	4.2

(Laboratory) Resilient Modulus (MPa)	6900
Thermal	
Thermal Conductivity (watt/meter-Kelvin)	2.16
Heat Capacity (joule/kg-Kelvin)	1172

Note 1: This parameter is for rehabilitation design type only.
Note 2: Enter back-calculated modulus from FWD testing if available; otherwise, enter the laboratory resilient modulus (multiplied with an appropriate conversion factor).

Table 4.3.18: Recommended Typical Subgrade Properties

		Subgrade Type	
		CL	CH
Unbound			
Layer Thickness (mm)		Semi-infinite	
Poisson's Ratio		0.48	
Coefficient of Lateral Pressure (k0)		Default	
Modulus			
Resilient Modulus (MPa)		30	40
Gradation and other engineering properties			
Aggregate Gradation (percent passing)	5 mm	100	100
	2.0 mm	97	100
	0.425 mm	95	100
	0.080 mm	92	97
	0.005 mm	75	45
Liquid Limit		75	49
Plasticity Index		42	26
Is layer compacted		Yes	
Maximum dry unit weight (kg/m^3)		Calculated	
Saturated hydraulic conductivity (m/hr)		Calculated	
Specific gravity of solids		Calculated	
Optimum gravimetric water content (T)		Calculated	

4.3.2 Roadways

4.3.2.1 Materials

4.3.2.1.1 Sub-grade Materials (32 11 13)

.1 Definition

a) **Prepared subgrade**: soil immediately below a pavement structure or slab, compacted to a depth of 150 mm, 300 mm or as specified.

.2 Quality Assurance

a) **Maximum Density:** the dry unit mass of a soil sample at optimum moistur content as determined in the laboratory according to ASTM D698 Method A.

b) **Required Density:** a minimum of 100.0% of the maximum density for each 150 mm lift of subgrade under pavement structures, concrete curb, concrete gutter private, commercial and alley crossings and asphalt walks/bikeways and a minimum of 98.0% of the maximum density for each 150 mm lift of subgrade under concrete separate walks, curb ramps, slabs, and walk made of concrete pavers, brick pavers, or granular materials.

c) **Testing Frequency:** the quality assurance laboratory will take a minimum of one field density test for each 1 000 m^2 of compacted subgrade lift according to ASTM D1556, ASTM D2167, or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A or as directed by the Engineer.

d) **Proof Rolling:** a proof roll of the finished subgrade will be required to confirm adequate bearing capacity of the subgrade soils. The proof roll shall be supervised by the City, and must be performed in accordance with Section 4.3.2.2.7 – Proof Rolling or the engineer's recommendations.

.3 Materials

a) Use only compacted clay subgrade soil with no deleterious (including a review of soil chemistry) material approved by the City.

.4 Equipment

a) Various pieces of equipment designed for and capable of disking, scarifying, spreading, spraying water, compacting and trimming soil to specified depth.

4.3.2.1.2 Cement Stabilized Subgrade

.1 Definition

a) soil immediately below a pavement structure or slab, mixed with Cement and compacted to a depth of 150 mm, 300 mm, or as specified.

.2 Quality Assurance

a) **Maximum Density**: the dry unit mass of a soil sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

b) **Required Density**: a minimum of 100.0% of the maximum density for each 150 mm lift of stabilized subgrade.

c) **Testing Frequency**: The quality assurance laboratory will take a minimum of one field density test for each 1000 m2 of compacted subgrade lift according to ASTM D2167 or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A or as directed by the Engineer.

d) **Proof Rolling**: a proof roll of the finished subgrade will be required to confirm adequate bearing capacity of the subgrade soils. The proof roll shall be supervised by the City and must be performed in accordance with Section 4.3.2.2.7 – Proof Rolling or the engineer's recommendations.

.3 Materials

a) Cement: to CSA-A3000, A3001-03, Type GU – General use hydraulic cement.

b) Water: may be obtained from City fire hydrants. Other water sources are subject to the City's approval.

.4 Equipment

a) **Cement Spreader**: capable of spreading cement uniformly.

b) **Mixing Equipment**: designed for and capable of mixing the full depth of the subgrade in one pass, subject to the City's approval.

4.3.2.1.3 Plant Mix Soil Cement

.1 Definition

a) **Soil cement**: Granular base or sub-base course stabilized with Cement and constructed to this Section.

b) **Maximum Density**: The dry unit mass of a sample at optimum moisture content as determined in the laboratory according to ASTM D558 Method B.

.2 Submittals

a) Mix Design

i) Submit a mix design based on the PCA Shortcut Method B, performed by a qualified laboratory, to the Development Engineering at least 7 days prior to commencing production.

ii) Submit the following information with the mix design:

1. a minimum of one sieve analysis for each 2 000 tonnes of aggregate in the stockpile and the overall average gradation of the stockpile,
2. the mass of cement per tonne of dry aggregate and
3. the mass of water per tonne of dry aggregate.

b) Job Mix Formula

i) Submit the proportions of materials and plant settings based on the approved mix design to the Engineering Services Section at least 7 days prior to production.

.3 Quality Assurance

a) **Thickness**: At the City's request, the quality assurance laboratory will take one or more sets of cores from suspect soil cement, each set comprising 3 cores whose average thickness represents not more than 1 000 m2 of soil cement per supplier per day.

b) **Required Density**: Minimum 98% of maximum density for each lift where soil cement is used under concrete curb and gutter in a rehabilitation scenario, or in front of the curb and gutter in a foamed asphalt scenario where no subgrade preparation is carried out. In all other cases a minimum of 100% of Maximum dry density for each lift of Soil Cement is required.

c) **Representative Tests**: The quality assurance laboratory will take a field density test, representing not more than 1 000 m2 of soil cement per supplier per day, according to ASTM D2167 or ASTM D2922 for comparison with a maximum density determined according to ASTM D558 Method B. If a tested density fails, 2 more tests will be taken from the same area and the average of the 3 tests will represent that area.

d) The City may request that a quality assurance laboratory conduct plant checks, sampling and testing.

e) **Plant Check**: Soil cement plant inspections will be conducted at random to check settings, operation, materials and mixture produced. The City will order the plant shut down if deficiencies are found, including deviation from the approved job-mix formula, segregation in the mix, or inconsistent plant operation.

f) **Compressive Strength Test:** Samples of soil cement will be taken at the plant or at the jobsite. Specimens will be moulded on site or in the laboratory into 101.6 mm diameter by 116.4 mm height cylinders using the compactive effort specified in ASTM D558 Method B. The specimens will be cured for 7 days to ASTM D1632:9.1. After 7 days curing, the specimens will be tested for compressive strength to ASTM D1633 Method A. At least one strength test will be taken per 500 tonnes of mix per supplier per day.

.4 Materials

a) Cement: to CSA-A3000, A3001-03 Type GU – General use hydraulic cement.

b) Aggregate: to Section 2.1 - Aggregate, Designation 2 Class 20.

c) Water: potable, approved by the City.

d) Curing Seal: liquid asphalt prime coat.

.5 Mixing Plant

a) Subject to the City's approval; capable of producing a uniform mixture; and equipped with synchronized metering devices and feeders to maintain correct proportions of aggregate, cement and water.

.6 Mix Design

a) The mix design shall meet the following criteria:

i) Minimum compressive strength: 3.0 MPa at 7 days.

.7 Mix Production

a) Job-Mix Formula

i) Display the approved job-mix formula in sight of the plant operator. Failure to display the job-mix formula will result in a shutdown order by City. Do not make changes to the formula without the City's approval.

b) Mixing

i) Mix aggregate, cement and water to obtain uniformity in cement content and moisture content without segregation of aggregate.

4.3.2.1.4 Geotextile

.1 Materials

a) Non-Woven Geotextile includes:

i) Continuous monofilaments or staple fibers;

ii) Random fibers that are physically entangled by punching with needles;

iii) Random fibers that are pressed together and melted together at the contact points.

The non-woven geotextile fabric shall meet the following requirements:

Table 4.3.19: Non-Woven Geotextile Fabric Requirements

Property	ASTM Test	Material Specification[1] Average Roll Value		
		Type A[2]	Type B[3]	Type C[4]
Grab Tensile Strength (N)	D4632	400 min	650 min	875 min
Grab Tensile Elongation (%)	D4632	50% min	50% min	50% min
Mullen Burst (MPa)	D3786	1.2 min	2.1 min	2.7 min
Puncture (N)	D4833	240 min	275 min	550 min
Trapezoidal Tear (N)	D4533	180 min	250 min	350 min
Ultraviolet Stability (% Retained Strength)	D4355	70 % @ 150 hr	70 % @ 150 hr	70 % @ 150 hr
Apparent Opening Size (mm)	D4751	0.2 max	0.2 max	0.2 max
Permittivity (per sec)	D4491	2.1 min	1.5 min	1.2 min
Flow Rate (L/sec/m2)	102 min	102 min	102 min	102 min
Minimum fabric lap shall be 300mm				

Note 1: All numeric values except A.O.S. represent minimum average roll value as measured in the weaker principal direction.
Note 2: Typically used with perforated pipe and similar applications;
Note 3: Typically used in medium duty situations such as under rip rap;
Note 4: Typically used in heavy duty situations such as large rip rap.

.2 Woven Geotextile

a) Woven Geotextiles consist of continuous monofilaments, staple fibers; multi-filament yearns, or slit films that are woven into a fabric.

Woven geotextiles shall have the following material properties:

Table 4.3.20: Woven Geotextile Fabric Requirements

Property	ASTM Test	Material Specification[1] Average Roll Value		
		Class 1	Class 2	Class 3
Elongation (%)	D4632	<50 min	<50 min	<50 min
Grab Strength (N)	D4632	1 400 min.	1 100 min.	800 min
Sewn seam strength (N)	D4632	1 260 min.	990 min.	720 min
Tear Strength (N)	D4533	500 min.[2]	400 min.[2]	250 min.
Puncture Strength (N)	D4833	500 min.	400 min.	300 min
Permittivity (per sec)	D4491	0.05 min.[3]	0.02 min.[3]	0.02 min.[3]
Apparent Opening Size (mm)	D4751	0.43 max.	0.60 max.	0.60 max.
Ultraviolet stability (% retained strength)	D355	50% after 500 hrs of exposure	50% after 500 hrs of exposure	50% after 500 hrs of exposure

Note 1: All numeric values except A.O.S. represent minimum average roll value as measured in the weaker principal direction.
Note 2: For woven monofilament geotextiles, the required minimum average roll value for tear strength is 250 N.
Note 3: Default value. Permittivity of the geotextile should be greater than that of the soil. The Consultant may also require the permeability of the geotextile to be greater than that of the soil.

4.3.2.1.5 Granular Base Course and Granular Sub-Base (32 11 16 / 32 11 23)

.1 Definition

a) Maximum Density: The dry unit mass of a sample at optimum moisture content as determined in the laboratory to ASTM D698 Method A.

.2 Quality Assurance

a) Testing Frequency

i) The quality assurance laboratory will take a minimum of one field density test on a compacted granular lift for each 1 000 m2 of road, 500 m2 of alley, or 250 m2 of walk, monolithic walk, curb ramp, alley crossing, commercial crossing, private crossing, or median or island strip, according to ASTM D1556, ASTM D2167, or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method C.

b) Required Density

i) The compacted lift thickness of a granular course shall not exceed 150 mm, or as directed by the City. The required density of granular base courses is shown in the following table.

Table 4.3.21: Granular Base Course Density Requirements

Compacted Granular Base Course	Required Percentage of Maximum Density
under roads, curb and gutter	100%
under commercial or alley crossings	100%
under asphalt or concrete walk, transit pads	97%
under walk portion of monolithic walk	100%
under curb ramps	100%
under private crossings	97%
under median or island strips	97%
as granular walkways	95%
under shared used paths	100%

.3 Materials

a) **Granular Materials**: to Section 4.3.2.1.7 Aggregate, Designation 3, classes as indicated on the Drawings.

.4 Equipment

a) Graders, rollers and other equipment of adequate design and capacity to produce a granular base or subbase as specified.

4.3.2.1.6 : Full Depth Reclaimed Base Course

.1 Content

a) This section includes: the pulverization of existing asphalt, soil cement and/or aggregate roadway structures, the addition and mixing of stabilizing agents into the reclaimed base, and the grading and compaction of the reclaimed base course.

.2 Definition

a) **Reclaimed Base Course**: pulverized and processed roadway structure to the depths shown on the drawings or defined by the Engineer.

.3 Quality Assurance

a) Maximum Density: the dry unit mass of a reclaimed base course sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

b) Required Density: a minimum of 100% of the maximum density for each 150 mm of reclaimed base course.

c) Testing Frequency: the quality assurance laboratory will take a minimum of one field density test for each 1 000 m2 of compacted reclaimed base course according to ASTM D2167 or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A.

.4 Materials

a) **Cement**: to CSA-A3000, A3001-03, Type GU – General use hydraulic cement

b) **In-Situ Materials**: the existing pavement structure to be pulverized has been investigated, and the results are included in the contract Special Provisions. If additional coring or sampling is desired, the coring or sampling shall be at the expense of the Contractor, upon approval of the Engineer.

c) **Stabilizing Agents**: fluid chemical or bituminous stabilizing agents as specified in the contract Special Provisions, and as directed by the Engineer

d) **Water**: may be obtained from City fire hydrants according to the General

e) Requirements. Other water sources are subject to the Engineer's approval.

.5 Equipment

a) Reclaimer/Stabilizer: a roadway structure pulverizing machine with the following characteristics, and subject to the Engineers approval:

i) The capability of pulverizing asphalt, soil cement and gravel roadway structures to depths of at least 400 mm in a single pass, and accurately maintaining a preset depth of cut.

ii) A milling drum that rotates upward into the direction of advance with a minimum cut width of 2.0 m.

iii) A system to apply and to regulate the addition of water or fluid stabilizing admixtures in relation to the depth of mixing and rate of advance of the machine.

b) Compaction Equipment: self-propelled vibratory steel drum or sheepsfoot/padfoot rollers capable of achieving the required compaction of the reclaimed base course and providing a surface suitable for the placement of hot-mix asphalt concrete.

4.3.2.1.7 Aggregate (32 12 16)

.1 Content

a) This section includes designated classes, gradation and physical requirements of aggregate, production and supply of aggregate, and quality assurance.

.2 Quality Assurance

a) The quality assurance laboratory will conduct sieve analyses to ASTM C136 and other tests to ensure that aggregate being produced and supplied meets the requirements of Tables 4.3.22, 4.3.23, and 4.3.24. The Contractor shall provide a daily estimate of production tonnage to the quality assurance laboratory.

b) A minimum of one sieve analysis per 500 tonnes of aggregate supplied to a jobsite is required. The aggregate may be sampled from a stockpile at the jobsite or at the gravel pit / crusher site.

c) If the aggregate fails to meet the specified gradation, the contractor shall suspend gravel placement until proof of compliance with the specification is provided to the Engineer. Alternatively, the contractor may elect to remove the suspect gravel from the jobsite and provide aggregate from a different source.

.3 Submittals

a) Provide copies of scale certificates to the Engineer prior to use.

b) Each truckload of aggregate weighed in shall have a ticket filled out and submitted to the Engineer.

c) Quality Control Plan:

i) Submit a minimum of one sieve analysis per 500 tonnes of aggregate for stockpile or 300 tonnes of aggregate shipped directly from the crusher to the jobsite to Development Engineering. Do not stockpile or ship aggregate to the jobsite until the City has accepted the applicable test results. Make the test results available weekly to the City for review.

ii) Evaluation of Tests: The average grading of the first 8 consecutive sieve tests shall conform to the specified grading band. If it does not, adjust the production process so that the average grading of material already produced and that produced in the next 8 consecutive tests will conform to specifications. Failing this, do not supply aggregate represented by the nonconforming average of 16 tests.

iii) The preceding evaluation will be repeated for subsequent series of 8 consecutive tests.

.4 Storage and Protection

a) Place aggregate in horizontal lifts of 750 mm maximum thickness. Avoid segregation of particle sizes. Do not dump aggregate over the edges or down the faces of the stockpile. On completion, peak the stockpile at a minimum 3% grade.

.5 Materials

a) Aggregates shall conform to the requirements in the following tables:

Table 4.3.22: Aggregate Gradation Specifications for Designations 1-3

Designation	1				2		3			
Class	10	10	20	16.0*	20	20	25	40	63	80
Application	10mm-HT	10mm-LT	20mm-B	SMA	Soil Cement	Granular Base	Granular Base	Granular Base	Granular Base	Granular Sub-Base
80 000										100
63 000								100	100	
25 000			100				100	70 -94	55 -75	46 -85
20 000			97 - 100	100	100	100	82-97	60 -90	50 -70	40 -81
16 000			83 – 97	97-100		84 -95	70-93	55 -85	44 -65	32 -76
12 500	100	100	70 – 92	88-100	60 -96	60-90	60-86	50 -80	38 -60	30 -70
10 000	97-100	97-100	61 - 84	30 -80		50–84	52-79	44 -74		
8 000	70-94	80-94	52 – 77							
6 300	45-85	65-85	44 – 70	22-45					23 -47	
5 000	32-75	50-75	38 – 65	20-35	36 -75	37- 62	35-64	32 -62	20 -45	25 -50
2 500	23-55	35-55	26 – 52	16-26						
2 000					24 -54	26- 50	24-50	20 -50	14 -38	19 -42
1 250	16-45	25-45	18 – 41	14-22	20–43	19- 43	19-43	17 -43	12 -34	15 -38
630	11-36	20-36	13 – 31	13-20	14–34	14- 34	14-34	12 -34	10 -28	10 -32
400					11 -29	11- 28	10-27	10 -28	8 -24	7 -27
315	8-26	14-26	9 – 22	12-18	9 –26	10- 25	9–24	8 -25	7 -22	6 -24
160	5-15	7-15	6 – 14	10-16	6 -20	6 -18	6–18	5 -18	4 -17	3 -18
80	3-8	4-8	3 - 7	10 -14	2 -10	2–10	2–10	0 -10	0 -10	0 -10

**Note SMA Combined Aggregate gradation includes the required mineral filler*

Table 4.3.23: Aggregate Gradation Specifications for Designations 4 – 7

Designation	4		5		6		7	
Class	2.5	10	5	80	20	25	10	80
Application	Unit Pavers Joint Sand	Unit Pavers Bedding	Grout Sand	Culvert Bedding	ub-Drain Rock	Sewer Rock	Sewer Backfill	Culvert Backfill
80 000				100				100
25 000						100		
20 000				85 - 100	100			
14 000					90 - 100			
10 000		100			45 - 75		100	
5000		75 - 950	100	70 - 90	0 - 15	10 max	70 - 100	30 - 60
2500	100	35 - 70			0 - 5			
1250	85 – 100	20 - 50						
800				40 - 80				
630	50 – 90	10 - 40						
315	25 – 60	5 – 20	50 – 95					
160	12 – 30	2- 8					5 - 20	
80	10 – 15	0 - 5	25 max	0 - 15		2 max	0 - 12	0 - 15

Table 4.3.24: Aggregate Properties

Designation	1			2	3			
Class	10	20	16	20	20 & 25	40	63	80
Application	10mm-HT & 10mm LT	20mm- B	SMA	Soil Cement	Granular Base	Granular Base	Granular Base	Granular Sub-Base
+5000 µm with ≥2 fractured faces (% mass)	*	*	**	60 min	60 min	75 min	75 min	
Plasticity Index <400 µm	*	*	**	6 max	6 max	6 max	6 max	
Liquid Limit	*	*	**	25 max	25 max	25 max	25 Max	
LA abrasion wear (% mass)	*	*	**					
Soundness loss (% mass)	*	*	**					
Lightweight Pieces (% mass)	*	*	**	2 max	2 max	2 max	2 max	2 max

** Note: See section 4.3.2.1.8 SGC HOT MIX ASPHALT CONCRETE for requirements*
*** Note: See section 4.3.2.1.9 STONE MASTIC ASPHALT CONCRETE for requirements*

.6 Equipment

a) **Crushers**: capable of producing aggregate as specified.

b) **Truck Weigh Scales**: are to be furnished by the Contractor. Have the scales inspected and certified by the Weights and Measures Branch of Canada Consumer and Corporate Affairs prior to start of every construction season and as requested by the City, to ensure their accuracy.

c) **Scale Tickets**: Supply truckers with scale ticket forms approved by the City.

d) **Metric Sieves**: CAN/CGSB-8.2-M sieve sizes shall replace ASTM E11 sieves as per Table 4.3.25.

Table 4.3.25: Metric Sieves

CAN/CGSB-8.2-M Sieves (m)	ASTM E11 Sieves (mm)
125 000	125.0
80 000	75.0
63 000	63.0
50 000	50.0
40 000	37.5
25 000	25.0
20 000	19.0
16 000	16.0
12 500	12.5
10 000	9.5
5 000	4.75
2 500	2.36
2 000	2.00
1 600	1.70
1 250	1.18
800	0.850
630	0.600
400	0.425
315	0.300
160	0.150
80	0.075

.7 Examination

a) Crushed aggregate shall consist of sound, hard and durable particles of sand, gravel and rock, free of elongated particles, injurious amounts of flaky particles, soft shale, coal, ironstone, clay lumps and organic and other deleterious material.

.8 Preparation

a) Adjust and modify aggregate as required to meet gradation requirements by aggregate splitting, elimination of fines, or blending with sand.

.9 Hauling Aggregate from Stockpiles

a) Upon request of The City, must provide haul tickets confirming material within stockpile and amount hauled.

b) Have loaded trucks weighed and provide weigh tickets to the City.

c) Deliver aggregate to the jobsite and discharge at the designated location.

4.3.2.1.8 SGC Hot-Mix Asphalt Concrete

.1 Content

a) This section includes: the production of a hot mixture of asphalt cement, aggregate, and/or other materials, for paving, and the requirements for submittals, materials, mix design, quality control, quality assurance, and mix production.

.2 Definitions

a) Asphalt Cement Content: the amount (percentage) of asphalt cement in the SGC hot-mix, as determined by ESS in Clause 6.1.1.4 Quality Assurance, and is the value upon which any unit price adjustments will be based.

b) 10mm – High Traffic (10mm - HT): mix used primarily for paving residential collector roadways and selected arterial roadways.

c) 10mm – Low Traffic (10mm - LT): mix used for paving local residential roadways and alleyways.

d) 20mm - Base (20mm-B): base course for freeways, arterials, industrial/commercial roadways and collector roadways.

e) Bailey CA-CUW: Coarse Aggregate (CA) Chosen Unit Weight (CUW) of combined aggregate as defined by the “Bailey Method”.

f) Bailey CA-LUW: Bailey method CA – Loose Unit Weight (LUW).

g) Bailey CA-RUW: Bailey method CA – Rodded Unit Weight (RUW).

h) Bailey FA-LUW: Bailey method Fine Aggregate (FA) – LUW.

i) Bailey FA-RUW: Bailey method FA – RUW.

j) Bailey Method: a method of selecting asphalt concrete aggregate proportions, indicated by the most recent edition of “Achieving Volumetrics and HMA Compactability”, as published by the Asphalt Institute and the Heritage Research Group.

k) Bailey Nominal Maximum Aggregate Size (BNMAS): the first sieve, in the standard sieve series (2.50 mm, 5.0 mm, 10.0 mm, 12.5 mm, 20.0 mm, and 25.0 mm), larger than the first standard sieve to retain more than 15 percent by weight.

l) Job Mix Formula: establishes the target combined aggregate gradation, plant settings, approved asphalt cement content to be used for production of the asphalt mix, and the associated production tolerances, based on the submitted SGC mix design and the results of the trial batch of SGC hot-mix.

m) SGC Specimens: Test specimens prepared using the Superpave Gyratory Compactor (SGC) at a specified number of design gyrations (Ndesign) of either 75 or 100. The SGC formed specimens are be used for the determination of volumetric properties on the laboratory produced SGC hot-mix as outlined in the Asphalt Institute SP-2 Manual.

.3 Submittals

a) Asphalt Cement Data

i) Submit written certification, with the SGC mix design that the asphalt cement complies with the specifications. This certification shall include, but not be limited to:

1. Name of the Supplier.
2. Source(s) of the base asphalt cement(s).
3. Type and source(s) of admixture(s).
4. Proportions of materials used in the asphalt cement.
5. Current laboratory test results of the asphalt cement.
6. Certification statement from the supplying agency that the asphalt cement is a straight run, non-air blown/oxidized, non-chemically modified asphalt cement and, if the asphalt cement is modified, it has been modified only with a SB-type copolymer and that it complies with the requirements of this specification. Certification shall be submitted (1) for the asphalt cement used in the mix design as part of a submittal, and, (2) at the start of mix production, utilizing the approved job mix formula.

b) SGC Mix Design

i) Submit a SGC mix design, carried out by an independent laboratory, to the City at least 10 days before the start of any SGC hot-mix production, and for each subsequent change in supplier or source of materials. No SGC hot-mix production can proceed until the applicable mix design and job mix formula is approved by the City. Submit all SGC hot-mix mix design characteristics, including but not limited to:

1. Legal description of all aggregate sources;
2. Source of RAP;
3. Individual aggregate, RAP and mineral filler gradations;
4. Individual aggregate one and two crushed face counts;
5. RAP aggregate one and two crushed face counts;
6. Water absorption of the individual aggregates and the combined aggregates;
7. Based on the individual aggregate results the calculated water absorption of the combined aggregates;
8. Aggregate blend;
9. Combined aggregate gradation;
10. Bulk specific gravity of individual aggregates and mineral filler;
11. Based on the individual aggregate results, the calculated bulk specific gravity of the combined aggregates;
12. Maximum Theoretical Density (MTD) of the RAP;
13. Binder content of the RAP, determined by total mix to two significant digits;

14. Bulk specific gravity of the RAP binder;
15. Bailey CA-RUW for each individual coarse aggregate Stockpile;
16. Bailey CA-LUW for each individual coarse aggregate stockpile;
17. Bailey FA-RUW for each individual fine aggregate stockpile;
18. Bailey FA-LUW for each individual fine aggregate stockpile;
19. Virgin asphalt cement bulk specific gravity;
20. Mixing and compaction temperature, as determined by the asphalt cement's temperature-viscosity curve, which is to be provided, or as recommended by the asphalt cement supplier;
21. Two hour, short-term oven aging temperature;
22. Anti-stripping agent supplier, product name, product specification sheet, and application rate;
23. Bailey CA-CUW
24. Comments on the other Bailey parameters (CA Ratio, FAc Ratio, and FAf Ratio);
25. A hard copy of the Bailey spreadsheet with an electronic copy of the Bailey spreadsheet to be e-mailed to the ESS;
26. Number of design gyrations (Ndesign) in the SGC;
27. Number of maximum gyrations (Nmaximum) in the SGC:
28. A minimum of five individual and separate asphalt cement contents must be used in the SGC mix design and each individual asphalt cement content must be separated by a minimum of 0.40 to a maximum of 0.60 percent (by dry weight of aggregate);
29. Graph of mix's Theoretical Maximum Density (MTD) versus asphalt cement content (by total mix) reported to two significant digits;
30. All other graphs used in the mix design (by total mix);
31. Individual mix property results are to be plotted and a second order polynomial graph drawn through the individual data points.
32. Recommended initial asphalt cement content and associated mix parameters;
33. Ratio of virgin asphalt cement content to total asphalt cement content;
34. Asphalt cement absorption of the combined aggregates;
35. Ignition oven asphalt cement content correction factor:
36. Asphalt Pavement Analyzer (APA) result;
37. Tensile Strength Ratio (TSR) including the optional freeze-thaw cycle.

c) The review of the submitted SGC mix design will not begin until all of the information has been provided.

d) A previously approved SGC hot-mix mix design, of the required mix type, may be accepted by the City, if the same materials for which the mix design was approved are used and provided that the previously approved job mix formula requirements are satisfied.

.4 Plant Scale Certificate

a) Provide a copy of the plant scale certificates to the City at least 10 days prior to any SGC hot-mix production.

.5 Job Mix Formula

a) Submit with the SGC hot-mix mix design the proportions of materials and plant settings to be used include the following:

i) For Batch Plant:

1. Sieve analysis of combined aggregate in the mix.
2. Sieve analysis of aggregate in each bin separation to be used.
3. Sieve analysis of RAP if used.
4. Mass of material from each bin for each batch of mix.
5. Mass of asphalt cement in each batch.
6. Mass of anti-stripping agent in each batch
7. Mixing temperature of asphalt cement determined from its temperature viscosity curve, or as recommended by the manufacturer.

b) For Continuous or Drum-Mix Plant:

1. Sieve analysis of each aggregate and mineral filler.
2. Sieve analysis of combined aggregate in the mix.
3. Sieve analysis of RAP if used.
4. Mass of asphalt cement per tonne of mix.
5. Mass of anti-stripping agent per tonne of mix.
6. Mixing temperature of asphalt cement determined from its temperature viscosity curve, or as recommended by the manufacturer.
7. Settings of aggregate and asphalt cement feed systems (blend).

.6 Quality Control Plan

a) Before commencing SGC hot-mix production, submit a quality control plan to the City for review and approval. The quality control plan is to including the following recommended tests and frequency, as a minimum.

b) Submit test results, as requested, to the City for review.

c) Tests per sample:

i) Mix bulk specific gravity, average of two SGC specimens;

ii) Asphalt cement content, Reported to two significant digits;

iii) MTD of loose mix;

iv) Gradation of the extracted mix;

v) Moisture content of the mix;

vi) Air voids by calculation and by MTD;

vii) Voids in the mineral aggregate (VMA);

viii) Voids filled with asphalt cement;

ix) Film thickness calculation;

x) Sample time and location;

xi) Plant discharge temperature;

xii) Asphalt storage temperature.

d) Frequency: Minimum of one sample for asphalt cement content and mix gradation per 500 tonnes of mix production, and minimum of two complete test samples per day of production exceeding 500 tonnes per mix type.

.7 Aggregates

a) Submit LA abrasion, soundness, detrimental matter and Plasticity index test results for each aggregate source for each SGC mix type at least once per year. Submit results of gradation and crushed face count(s) at the following frequencies:

i) For a stockpile existing at the time of contract award: a minimum of one gradation and crushed faces count(s) test per 500 tonnes of aggregate. In addition, submit the average gradation and crush faces count(s) for each entire stockpile when submitting a mix design using aggregate from the stockpile(s).

ii) For aggregate stockpiled during the contract: a minimum of one gradation and crushed face count(s) per 500 tonnes of aggregate, or each day's production, whichever is less.

iii) Submit results to the City within 72 hours of the completion of testing. Do not use aggregate until test results have been reviewed and accepted by the Engineer.

.8 Quality Assurance

a) Inspection and Testing

i) In addition to field inspections by the Engineer, the City will conduct plant inspection and materials sampling and testing described in the following paragraphs.

b) Asphalt Plant

i) Inspections will be conducted at least once a week during production to check plant calibrations, plant operation, production settings, temperatures, and materials handling. Samples of materials and mixture may be taken and tested.

c) Asphalt Cement

i) Quality assurance sampling and testing of the asphalt cement shall be performed by the City, to verify compliance to the specification. A sample shall be taken at random during paving operations on City projects from a load(s) delivered to the Contractor’s asphalt plant at least twice a month or as otherwise determined by the City Engineer. It is the contractor's responsibility to inform the City of the delivery of asphalt Cement to their facility for sampling.

d) If non-complying material is identified, the paving program may be suspended for 24 hours, as directed by the Engineer, during which time the Contractor, the Engineer, and the City will meet to determine the impact of the non-compliance, and specify the necessary remedial action to be taken by the Contractor. Remedial action shall be either acceptance, acceptance at a pay adjustment, or removal and replacement at no cost to the City. If suspended, the paving program shall only continue upon written authorization by the City.

e) Asphalt cement identified to be in non-compliance shall not be shipped to a project. SGC hot-mix mixed and placed with identified non-complying asphalt cement shall be removed and replaced, as directed by the Engineer with complying material by the Contractor at no cost to the City.

f) Asphalt cement substitution in an approved job mix formula shall not be allowed, without prior approval of the City.

g) Actual asphalt cement content, in which unit price adjustments will be based on, is defined as the amount of asphalt cement in the mix as determined through the Quality Assurance testing program.

.9 Production Mix Analysis

a) Full mix sample testing will be conducted at a minimum frequency of one test, for each 1,000 tonnes of SGC hot-mix, or a day's production, whichever is less.

b) The mix’s asphalt cement content and MTD will be determined at a minimum frequency of one test for every 250 tonnes of SGC hot-mix produced, or a day's production, whichever is less.

c) TSR testing, with the optional freeze-thaw cycle, and APA testing (if required), will be carried out at a minimum frequency of one set per weeks production.

d) The determination of the asphalt cement content will utilize the asphalt ignition oven correction factor, as determined for each SGC hot-mix, by the City.

.10 Job Mix Formula

a) The City will test a trial batch of the SGC hot-mix job mix formula to verify the mix design. The mix design and job mix formula will not be approved by the Engineer until successful results are obtained by the City.

.11 Quality Control

a) General

i) The Contractor is responsible for quality control throughout all stages of the SGC hot mix production and placement including the aggregates, asphalt cement, and any other materials used in the mix. The Contractor shall utilize a qualified testing laboratory to undertake the quality control sampling and testing to determine and monitor the properties of the materials being produced and used on the project.

ii) Sampling and Testing

iii) The Contractor shall follow the sampling and testing methods and frequencies indicated in their quality control plan and/or as accepted or modified by the City.

.12 Materials

a) Asphalt Cement: Performance Graded (PG) 58-28, PG 64-28, Polymer Modified PG 76-28 or Polymer Modified PG 70-28 to AASHTO M320, Table 2 which are included in these specification as Table 6.1.8 and Table 6.1.9. For Polymer Modified PG 76-28 and PG 70-28, a straight run, non-chemically modified asphalt cement shall be modified with SB-type copolymers to reach the specified performance grade. No other modifiers are allowed unless approved in writing by the ESS.

b) *Note: If using PG asphalt cement, PG 58-28 shall be used in 10mm–LT, 10mm–HT and in 20mm-B in all new construction applications and in residential applications, while 10mm-HT, used as overlay on arterial roadways, shall utilize a PG 64-28, or as specified in the contract documents. No modification of the asphalt cement is allowed for the PG58-28 or the 64-28 asphalt cement.

c) Aggregates: to Section 4.3.2.1.7 – Aggregate and as indicated below.

The SGC hot-mix combined aggregate gradation requirements shall be as follows:

Table 4.3.26: SGC Hot Mix Aggregate Gradation Requirements

Designation	1	1	1
Class	10.0	10.0	20
Application	10mm -HT	10mm - LT	20mm - B
Sieve Size (μm)	% Passing by Mass	% Passing by Mass	% Passing by Mass
25 000	100	100	100
20 000	100	100	97 - 100
16 000	100	100	83 – 97
12 500	100	100	70 – 92
10 000	97 - 100	97 - 100	61 - 84
8 000	70 – 94	80 – 94	52 – 77
6 300	45 – 85	65 – 85	44 – 70
5 000	32 – 75	50 – 75	38 – 65
2 500	23 – 55	35 – 55	26 – 52
1 250	16 – 45	25 – 45	18 – 41
630	11 – 36	20 – 36	13 – 31
315	8 – 26	14– 26	9 – 22
160	5 – 15	7 – 15	6 – 14
80	3 - 8	4 - 8	3 - 7

Additional SGC hot-mix aggregate properties shall be as follows:

Table 4.3.27: Virgin Coarse Aggregate Physical Properties (> 5.0 mm) at the mix design gradation

Property	Test Method	Requirement
LA Abrasion, % loss, Charge C	AASHTO T 96	30.0% Maximum
Soundness (5 Cycles), %loss $MgSO_4$	AASHTO T 104	16.0 Maximum
Detrimental Matter, %	Alberta Infrastructure TLT 107	2.0 Maximum

Table 4.3.28: Virgin Fine Aggregate Physical Properties (< 5.0 mm) at the mix design gradation

Property	Test Method	Requirement
Soundness (5 Cycles), % loss $MgSO_4$	AASHTO T 104	16.0% Maximum
Plasticity Index	AASHTO T 90	Non-Plastic

d) Fine Aggregate: that fraction of the total aggregate passing the 5 000 μm sieve. Fine aggregate shall contain a minimum 75 percent manufactured or crushed fines. The total percent of manufactured fines in a mix is taken as the percentage of manufactured fines in the minus 5 000 μm sieve fraction of the total combined aggregate. When the amount of manufactured fines in the RAP is unknown, it will be assumed that the amount of manufactured fines in the minus 5 000 m sieve portion is 55 percent for 12.5 mm and 10 mm maximum sized RAP aggregate.

e) Crushed-Face Count in Mix: For each mix type, the minimum percentage, by mass retained down to the 5 000 μm sieve, having at least 2 crushed faces shall be as follows, provided there is a minimum 50% crushed-face count in each individual sieve size greater than 5 000 μm.

Table 4.3.29: Crushed-Face Count in Mix

Mix Type:	10mm - HT		10 mm - LT		20mm - B	
Minimum 2 Crushed -Face	90%		85%		90%	
Sieve Fraction (μm)	1 Face	2 Face	1 Face	2 Face	1 Face	2 Face
- 25 000 to + 12 500	-	-	-	-	90	85
- 12 500 to + 10 000	95	90	90	85	95	90
- 10 000 to + 5 000	98	95	93	90	98	95

f) Mineral Filler: The mineral filler, if required, should consist of limestone dust or approved alternate meeting the requirements of AASHTO M-17 or ASTM D242. The mineral filler must be free from organic impurities and the portion passing the 80 µm sieve size shall have a Plasticity Index of zero.

g) The mineral filler shall meet the following gradation requirements:

Table 4.3.30: Mineral Filler Gradation Requirements

Sieve size (µm)	Percent Passing (by Mass)
600	100
300	92 - 100
80	60 - 100

.13 Equipment

a) Asphalt Plant

i) Asphalt Mixing Plant: conforming to ASTM D995, capable of consistently producing a homogeneous mixture in which all aggregate particles are uniformly and thoroughly coated with asphalt cement, heated to the mixing temperature for the grade of asphalt cement, and meeting the following supplementary requirements.

ii) Provide free and safe access for the Engineer to verify proportions, settings, and temperatures, and to take samples of asphalt, aggregate, and mixture.

iii) All asphalt mixing plants are required to be operated in accordance with the Alberta Environmental Protection Code of Practice. All Contractors operating asphalt plants shall provide proof of registration with Alberta Environmental Protection and agree that the asphalt plant shall be operated in accordance with the Code of Practice.

iv) SGC hot-mix production shall not proceed unless all plant scales have been certified by Weights and Measures, Canada Consumer and Corporate Affairs prior to start of construction season and as often as deemed necessary by the Engineer to ensure their accuracy. Plant production shall not proceed until plant calibrations and recalibrations have been reviewed by the Engineer on site. Notify the Engineer at least 24 hours before plant calibrations are made or altered.

.14 Mix Design

a) The mix design for the SGC hot-mix shall be performed by a qualified laboratory following the procedures indicated in “Superpave Mix Design”, as set out in the latest editions of the Asphalt Institute manuals “For Asphalt Concrete and Other Hot- Mix Types” Manual Series No. 2 (MS-2), “Superpave Mix Design” Superpave Series No. 2 (SP-2), Section 1.4.2 SGC Mix Design, and to the following criteria.

Table 4.3.31: Mix Design Requirements

	Requirement		
Mix Type	**10mm - HT**	**10 mm - LT**	**20mm - B**
Selected Parameters			
Number of Gyrations Gyrations Ndesign Gyrations Nmaximum	100 160	75 115	100 160
Density at Nmaximum (%Gmm)	98.0 Max	98.0 Max	98.0 Max
Bailey CA-CUW	60 to 105 Max.	60 to 85 Max.	60 to 85 Max.
Air Voids, % of total mix (virgin mix)1	4.0 +/- 0.4%	3.0 +/- 0.4%	3.5 +/- 0.4%
VMA, %	13 Minimum	14 Minimum	12 Minimum
Voids filled, %	70 - 80	73 - 85	65 - 75
Tensile Strength Ratio % (AASHTO T283)2	80 Minimum	80 Minimum	80 Minimum
Minimum Film Thickness3, mm	7.5 min.	7.5 min.	6.5 min.
APA (mm, 52□C, 8,000 cycles)	5.0 max.	7.0 max.	5.0 max.

Note 1: The mix design air voids shall be selected at the mid point of the specified range or the lowest value within the range in which all the other mix design criterion are met;
Note 2: Minimum Tensile Strength Ratio to be determined in accordance with AASHTO T283, with optional freeze-thaw, at air void content of 7.0+/- 0.5 percent;
Note 3: Minimum film thickness to be determined to Appendix 02066.A

b) Rutting Susceptibility Testing: SGC hot-mix mix shall be subjected to the APA procedure during the mix design process. APA testing may be carried out by an independent laboratory that is approved by The City. The APA device must meet the requirements of AASHTO T340-10 and must be equipped with an automatic rut measurement system. The APA device must be calibrated at least once per year according to the procedures in the test method. In addition, the load cell used for checking wheel loads shall be calibrated at least once per year. Each test shall have 6 cylindrical samples fabricated and tested with the interior temperature of the APA set at 52oC. The downward force shall be set at 45 Kg and the hoses shall be pressurized to 689 kPa. Each specimen shall be compacted so that 7.0+/- 0.5 percent air voids are achieved. The APA rut test results shall be provided to the nearest 0.1 mm.

c) Modifications to the SGC hot-mix mix design procedure or criteria are as follows:

i) Metric sieves in accordance with CGSB Specification 8-GP-2M shall be used.

ii) PG asphalt cement content shall be reported based on the total mass of the mix.

d) Job mix Formula

i) Do not make changes to the approved job mix formula without written authorization from the City. Display the currently approved job mix formula in clear sight of the plant operator.

4.3.2.1.9 Stone Mastic Asphalt Concrete

.1 Content

a) This section includes the production of a hot mixture of asphalt binder and aggregate for paving, and the requirements for mix design, quality control, and quality assurance.

.2 Definitions

a) SGC Specimens: Test specimens prepared using the SHRP Gyratory Compactor (SGC) at the specified number of NDesign gyrations of 100.

.3 Submittals

a) Submittal of Asphalt Cement Data

i) Submit certified test results in writing with the mix design that the asphalt cement complies with the specifications. This certification shall include, but not be limited to:

1. Name of the Supplier
2. Source(s) of the Base Asphalt Cement(s)
3. Type and Source(s) of admixture(s)
4. Proportions of materials
5. Laboratory test results of the Asphalt Cement
6. Certification statement that the Asphalt Cement complies with the requirements of this specification.
7. Certification shall be submitted (1) for a binder used in the design of a job mix formula as part of a submittal, and, (2) during the life of an approved job mix formula.

.4 Mix Design

a) Submit a mix design carried out by an independent laboratory to the City Engineer at least 10 days before the start of any SMA production, and for each subsequent change in supplier or source of materials. No hot-mix production can proceed until the applicable mix design and job-mix formula is approved by the Engineer.

b) Submit all SMA mix design characteristics, including graphs used in arriving at the final mix design; the bulk specific gravity of individual aggregates and the combined aggregates; individual aggregate and mineral filler gradations and combined aggregate gradations: the graph of maximum specific gravity versus asphalt content; Blends and Job Mix Formula; the asphalt absorption of the combined aggregates and the Tensile Strength Ratio (TSR) as well as results of Asphalt Pavement Analyzer (APA) testing.

c) Submit, with the mix design, six 4-litre containers of PMA asphalt binder, and a sufficient quantity of each aggregate component to result in a 100-kg sample of combined aggregate at the design proportions.

.5 Plant Scale Certificate

a) Provide a copy of the plant scale certificates to the City at least 10 days prior to any SMA production.

.6 Job Mix Formula

a) Submit with the SMA Mix design the proportions of materials and plant settings to include the following.

i) For Batch Plant:

1. Sieve analysis of combined aggregate in the mix.
2. Sieve analysis of aggregate in each bin separation to be used.
3. Mass of material from each bin for each batch of mix.
4. Mass of asphalt binder in each batch.
5. Mixing temperature of asphalt binder determined from its temperature/viscosity
6. curve, or as recommended by the manufacturer.

ii) For Continuous or Drum-Mix Plant:

1. Sieve analysis of each aggregate and mineral filler.
2. Sieve analysis of combined aggregate in the mix.
3. Mass of asphalt binder per tonne of mix.
4. Mixing temperature of asphalt binder determined from its temperature/viscosity curve, or as recommended by the manufacturer.
5. Settings of aggregate and asphalt binder feed systems (blend).

.7 Quality Control Plan

a) Before beginning hot-mix production, submit a quality control plan to the City Engineer including the following recommended tests and frequency. Submit test results daily to the Engineer for review.

b) Tests: 2 Superpave Gyratory Compactor (SGC) per test

i) Asphalt binder content

ii) Air voids

iii) Voids in the mineral aggregate (VMA)

iv) Voids filled with asphalt binder

v) Moisture content of the mix

vi) Gradation of the mix

vii) Plant discharge temperature

viii) Asphalt storage temperature

c) Frequency: A minimum of 2 tests per day of production.

.8 Aggregates

a) Submit abrasion, soundness, flat and elongated, detrimental matter and clay content test results for each aggregate source. Submit results of sieve analysis to ASTM C136, and crushed face count at the following frequencies:

b) For a stockpile existing at the time of contract award: a minimum of one sieve test and one crushed face count per 1 000 tonnes of aggregate. In addition, submit the average gradation of an entire stockpile when submitting a mix design using aggregate from the stockpile.

c) For aggregate stockpiled during the contract: a minimum of one sieve test and one crushed face count per 1 500 tonnes of aggregate, or each day's production, whichever is less.

d) Submit results to the City Engineer within 24 hours of testing. Do not use aggregate until test results have been reviewed and accepted by the Engineer.

.9 Quality Assurance

a) Inspection and Testing

i) In addition to field inspections by the Engineer, the quality assurance laboratory will conduct plant inspection and materials sampling and testing described in the following paragraphs.

b) Asphalt Concrete Plant

i) Inspections will be conducted at least once a week during production to check plant calibrations, plant operation, production settings, temperatures, and materials handling. Samples of materials and mixture will be taken and tested.

c) Asphalt Cement

i) Quality assurance sampling and testing of the asphalt cement shall be performed by the QA, to verify compliance to the specification. A sample shall be taken at random during paving operations on City projects from a load(s) delivered to the Contractor's asphalt plant at least twice a month or as otherwise determined by the City. It is the contractor's responsibility to inform the City Engineer of the delivery of asphalt Cement to their facility for sampling.

1. If non-complying material is identified, the paving program may be suspended for 24 hours, as directed by the Engineer, during which time the Contractor and the Engineer will meet to determine the impact of the non-compliance, and specify the necessary remedial action to be taken by the Contractor. Remedial action shall be either acceptance, or acceptance at a pay adjustment, or removal and replacement at no cost to the City of St. Albert. The paving program may continue upon written authorization by the Engineer.

2. Production binder identified to be in non-compliance shall not be shipped to a project. Asphalt concrete batched and placed with non-complying binder shall be removed and replaced, as directed by the Engineer with complying material by the Contractor at no cost to the City of St. Albert.
3. Binder substitution in an authorized job mix formula shall not be allowed, without prior approval of the Engineer.
4. Actual asphalt cement content, in which unit price adjustments will be based on, is defined as the amount of asphalt cement in the mix as determined through the Quality Assurance testing program.

d) Production Mix Analysis

i) Full SGC testing will be conducted at a minimum frequency of one test, with two SGC specimens per test, for each 500 tonnes of hot-mix, or a day's production, whichever is less. Determine the asphalt cement content and the Maximum Theoretical Density (MTD) of SMA at a minimum frequency of one test for every 250 tonnes of hot-mix produced, or a day's production, whichever is less

e) Job Mix Formula

i) The quality assurance laboratory will test a trial batch of the job-mix formula to verify the mix design. The mix design and job-mix formula will not be approved until successful results are obtained.

f) Aggregate Gradation Tolerance

The variation from the approved job-mix aggregate gradation shall not exceed the following limits:

Table 4.3.32: Aggregate Gradation Tolerance

Sieve Size (µm)	% Passing by Mass	
	Individual Sample	Average of Last 3 Samples
5 000	± 3.0	± 3.0
1 250	± 3.0	± 2.5
630	± 3.0	± 2.0
315	± 3.0	± 2.0
160	-1.0 to +3.0	-1.0 to +2.0
80	-1.0 to +2.5	-0.5 to +1.0

g) Asphalt Content Tolerance

i) The allowable variation from the approved design asphalt content shall be ± 0.2% by mass of mix.

h) Air Void Tolerance

i) The allowable variation from the design air voids in the mix shall be ± 0.5%.

i) Mixing Temperature Tolerance

i) The allowable variation from the design mixing temperature shall be ± 9□C.

.10 Materials

a) Polymer Modified Asphalt Cement: to AASHTO M320, Table 2, grade PMA PG 76-28, PG 70-28, or as otherwise set forth in the contract documents. For the Polymer Modified PG 76-28 and PG 70-28 Straight asphalt cement shall be modified with SB-type copolymers to reach the specified performance grade. No other modifiers are allowed unless approved in writing by the City of St. Albert

b) Aggregates: to Section – 4.3.2.1.7 – Aggregates and as shown below. The Stone Mastic combined aggregate gradation requirements, including the required mineral filler shall be as per the tables below.

Table 4.3.33: Stone Mastic Combined Aggregate Gradation Requirements

Sieve Size (□m)	Percent Passing by Mass
20 000	minimum 100
16 000	97 - 100
12 500	88 - 100
10 000	30 - 80
6 300	22 - 45
5 000	20 - 35
2 500	16 - 26
1 250	14 - 22
630	13 - 20
315	12 - 18
160	10 - 16
80	10 - 14

Additional Stone Mastic aggregate properties shall be as follows:

Table 4.3.34: Coarse Aggregate Physical Properties

Property	Test Method	Requirement
LA Abrasion, % loss	AASHTO T 96	18% Maximum
Flat & Elongated, % 3:1 5:1	ASTM D 4791	20% maximum. 5% Maximum
Absorption, %	AASHTO T 85	2% Maximum.
Soundness (5 Cycles), % Sodium sulfate Magnesium Sulfate	AASHTO T 104	15% Maximum 20% Maximum
Detrimental Matter, %	Alberta Infrastructure TLT 107	2% Maximum
Clay content %	AASHTO - T 176	40% minimum
Crushed Face Count, % One Face Two Faces	ASTM D 5821	100% with at least 1 100% with at least 2

Table 4.3.35: Fine Aggregate Physical Properties

Property	Test Method	Requirement
Soundness (5 Cycles), % Sodium sulfate Magnesium Sulfate	AASHTO T 104	15% Maximum 20% Maximum
Angularity, %	AASHTO TP 33	45% Minimum
Liquid Limit, %	AASHTO T 89	25% Maximum
Plasticity Index	AASHTO T 90	Non-Plastic

c) Fine Aggregate: that fraction of the total aggregate passing the 5 000 µm sieve. Fine aggregate shall contain 100% manufactured or crushed fines

d) Mineral Filler: The mineral filler should consist of Limestone dust or approved alternate meeting the requirements of AASHTO M-17 or ASTM D242. Filler should be free from organic impurities and the portion passing the 80 µm sieve size shall have a Plasticity Index of zero.

The mineral filler shall meet the following gradation requirements:

Table 4.3.36: Mineral Filler Gradation Requirements

Sieve size (μm)	Percent Passing (by Mass)
600	100
300	92-100
80	60-100

e) Stabilizing Agent: Cellulose fibers shall be added at a rate of approximately 0.3 percent by total mass of mix in order to prevent draindown. The exact cellulose fibre addition rate to be determined by the SMA mix design.

The cellulose fibers shall meet the following requirements:

Table 4.3.37: Cellulose Fibers Requirements

Property*	Requirement
Sieve Analysis: **Method A – Alpine Sieve Analysis** Fiber Length Passing 0.150 mm **Method B – Mesh Screen Analysis** Fiber Length Passing 0.850 mm Passing 0.425 mm Passing 0.160 mm	 6 mm Maximum 70 +/- 10 % 6 mm Maximum 85 +/- 10 % 65 +/- 10 % 30 +/- 10%
Ash Content	18 +/- 5% non-volatiles
pH	7.5 +/- 1.0
Oil Absorption	5.0 +/- 1.0 times fiber mass
Moisture Content	Less than 5% (by mass)

**Note: Test methods in accordance with those outlined in: Fiber Length "Designing Stone Matrix Asphalt Mixtures Volume IV – Mixture Design Method, Construction Guidelines and Quality Control Procedures" report dated July, 1998 and prepared by the National Center for Asphalt Technology (NCAT).*

.11 Equipment

a) Asphalt Plant

i) Asphalt Mixing Plant: conforming to ASTM D995, capable of consistently producing a homogeneous mixture in which all aggregate particles are uniformly and thoroughly coated with asphalt, and meeting the following supplementary requirements:

ii) Provide free and safe access for the Engineer to verify proportions, settings, and temperatures, and to take samples of asphalt, aggregate and mixture.

iii) All asphalt-paving plants are required to be operated in accordance with the Alberta Environmental Protection Code of Practice. All contractors operating asphalt plants shall provide proof of registration with Alberta Environmental Protection and agree that the asphalt plant shall be operated in accordance with the Code of Practice.

b) Mix Design

i) The SMA Mix design shall be performed by an independent laboratory according to the procedures outlined in NCHRP Report 425 “Designing Stone Matrix Asphalt Mixtures for Rut Resistant Pavements – Part 2 Mixture Design Methods, Construction Guidelines and Quality Control/Quality Assurance Procedures” subject to the following parameters:

Table 4.3.38: Mix Design Requirements

Selected Parameters	Requirement
Superpave Gyratory Compactor Design (100 Gyrations)	
Air Voids, %	3.5% +/- 0.5%
VMA, %	17 Minimum
VCA_{mix} , %	Less than VCA_{dry}
Tensile Strength Ratio % (AASHTO T283)	75 Minimum
Draindown @ production temperature, %	0.3 Maximum

Note 1: The mix design air voids shall be selected at the mid-point of the specified range or the lowest value within the range in which all the other mix design criterion are met;
Note 2: Minimum Tensile Strength Ratio to be determined in accordance with AASHTO T283, with optional freeze-thaw, at air voids content of 7.0+/- 0.5 percent;

ii) Rutting Susceptibility Testing: SMA shall be subjected to the Asphalt Pavement Analyzer (APA) procedure during the mix design process and will be subjected to testing during actual production of the mixture, as deemed necessary by the Engineer. APA testing will be carried out by a reputable Quality Assurance laboratory acceptable to the City.The APA device must meet the requirements of AASHTO TP63-03 and must be equipped with an automatic rut measurement system. The APA device must be calibrated at least once per year according to the procedures in the test method. In addition, the load cell used for checking wheel loads shall be calibrated at least once per year. Each test shall have 6 cylindrical samples fabricated and tested with the interior temperature of the APA set at 52o C. The downward force shall be set at 45 Kg and the hoses shall be pressurized to 689 kPa. Each specimen shall be compacted so that 7+/- 0.5 percent air voids are achieved. The APA rut test results shall be provided to the nearest 0.1 mm. The average rut depth for the specimens tested shall not exceed 5.0mm.

iii) Modifications to the Stone Mastic mix design procedure or criteria are as follows:

1. Metric sieves in accordance with CGSB Specification 8-GP-2M shall be used in place of the sieves specified in the Asphalt Institute Manual.
2. PG Asphalt Cement content shall be reported based on the total mass of the mix
3. Fine aggregate angularity criteria shall be as defined in Clause 6.2.2.1 – Table 6.2.3.

4. The Alberta Transportation and Utilities ATT and TLT test procedures shall be used to determine fine aggregate angularity.

c) Job-Mix Formula

i) Do not make changes to the approved job-mix formula without written approval from the Engineer. Display the currently approved job-mix formula in clear sight of the plant operator.

4.3.2.1.10 SGC Hot-Mix Asphalt Paving

.1 Content

a) This section includes the supply and placement of SGC hot-mix asphalt concrete for roadway paving.

.2 Definitions

a) **QA**: A Certified Quality Assurance Laboratory

b) **Overlay**: paving over an existing pavement for rehabilitation purposes and not as part of staged paving.

c) **Staged Paving**: paving where a lift or lifts that form part of the total pavement structure are deferred to a future date.

d) **SGC Density**: the Superpave Gyratory Compactor (SGC) shall be used to prepare laboratory formed specimens at Ndesign of either 75 or 100 gyrations. The SGC formed specimens shall be used for the determination of volumetric properties on a field produced SGC hot-mix as outlined in the Asphalt Institute SP-2 Manual.

.3 Quality Assurance

a) Thickness Cores

b) QA will:

i) Take a minimum of one core per 1,000 m2 of SGC hot-mix asphalt pavement and determine the thickness of the mat, for each stage of paving.

ii) For a staged paving project, a thickness deficiency at the completion of the first stage of paving may be accepted by the City provided the deficiency is less than 12mm and the deficient thickness can be included in the subsequent stage of paving.

iii) For non-staged paving projects the thickness tolerances as per Table 4.3.52 shall apply.

iv) If the initial core thickness is deficient at the completion of the final lift of paving, that initial thickness is discarded, and 3 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5 m between cores. The average thickness of the 3 new cores represents that area.

v) Asphalt Cement Content and Density Specimen Sampling and Testing

c) QA will:

i) Determine the Maximum Theoretical Density (MTD) and asphalt cement content of the SGC hot-mix at a minimum frequency of one test for every 250 tonnes of SGC hot-mix produced, or a day's production, whichever is less.

ii) Obtain one core from compacted mat placed from same load of SGC hot-mix from which SGC specimens were obtained, or from suspect compacted mat, and test for density. Where specified in the special provisions of the contract obtain a second core from the compacted mat for rut testing in the Asphalt Pavement Analyzer (APA).

iii) Obtain one core from compacted mat representing 1,000 m2 and test for density.

iv) Basis of Acceptance: SGC hot-mix pavement compaction will be accepted based on the ratio (in percent) of the core density to the MTD. If cores were taken from a mat where no MTD are available, acceptance will be based on the ratio of core density to the average MTD for that day’s production.

v) Representative Cores: A single core is initially taken representing the quantity of SGC hot-mix in not more than 1,000 m2 of mat, with a minimum of one core taken from a day's production. If the initial core density is below specified, that initial density is discarded, and 3 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5 m between cores. The average density of the 3 new cores represents that area.

d) Rutting Susceptibility Specimen Sampling and Testing (Where Specified)

e) QA will:

i) Where specified determine the rutting susceptibility of laboratory SGC hot-mix specimens at a minimum frequency of one test for every 5,000 tonnes of SGC hotmix produced, for an individual project by subjecting the SGC hot-mix specimens to the APA procedure. The APA device will meet the requirements of AASHTO TP63- 03 and is equipped with an automatic rut measurement system. The APA device will be calibrated at least once per year according to the procedures in the test method. In addition, the load cell used for checking wheel loads will be calibrated at least once per year. Each test shall have 6 cylindrical samples fabricated and tested with the interior temperature of the APA set at 52oC. The downward force shall be set at 45 Kg and the hoses shall be pressurized to 689 kPa. Each specimen shall be compacted so that 7.0+/- 0.5 percent air voids are achieved. The APA rut test results shall be provided to the nearest 0.1 mm

ii) Where specified, determine the rutting susceptibility of SGC hot-mix field core specimens taken at the location of the SGC hot-mix samples by subjecting the field core specimens to the APA procedure as described in the above section. The average rut depth for the specimens tested shall not exceed the specified APA requirements for the mix type. If the initial APA rutting is above specified, that initial APA result is discarded, and 6 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5 m between cores. The average APA result of the 6 new cores will be taken as to represent that area.

f) Tensile Strength Ratio (TSR) Specimen Sampling and Testing (Capital Program)

g) QA will:

i) Determine the TSR of SGC hot-mix field samples at a minimum frequency of one test for every 5,000 tonnes of SGC hot-mix produced, for an individual project, in accordance with AASHTO T283, including the optional freeze-thaw cycle.

.4 Materials

a) SGC Hot-Mix Asphalt Concrete

i) To Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete.

b) Tack Coat

i) To Section 4.3.2.1.14 - Liquid Asphalt Coats

.5 Equipment

a) Trucks for Transporting Mix:

i) Trucks shall be compatible with size and capacity of the paver; with clean, tight, smoothsided boxes equipped with waterproof tarpaulins of sufficient size to securely cover all material when boxes are fully loaded. The side of the truck box shall have a 12-mm diameter hole 300 mm from bottom for checking mix temperature. Use only approved release agents, such as water based liquid soap, dry soap powder or approved material and drain all excess release agents from truck beds prior to loading SGC hot-mix. Petroleum derivatives are not permitted as release agents.

b) Paver:

i) Pavers shall be self-propelled; with automatic screed controls to maintain grade from a reference string line or ski and to control crossfall, smoothness and joint matching; with vibratory screed equipped with vibratory extensions and augers capable of uniformly spreading the mixture to specified widths and depths without segregation or tearing. Follow the manufacturer's recommended operating procedures.

c) Rollers:

i) Shall be self-propelled, reversible; static, oscillating or vibratory steel-drum or pneumatic-tired rollers; with wetting and scraping devices to prevent adhesion of mix to drums or tires (petroleum derivatives are not permitted for cleaning); capable of attaining required density and smoothness; and pneumatic-tired rollers to be equipped with wind skirts. Follow the manufacturer's recommended operating procedures.

d) Hand Tools:

i) Rakes, lutes, tampers, straightedges, levels, and other hand tools as necessary to complete the work shall be available.

4.3.2.1.11 Stone Mastic Asphalt Paving

.1 Content

a) This section includes the supply and placement of Stone Mastic Asphalt (SMA) concrete for roadway paving.

.2 Definitions

a) **Overlay:** paving over an existing pavement for rehabilitation purposes and not as part of staged paving.

b) **Staged Paving:** paving where a lift or lifts that form part of the total pavement structure are deferred to a future date.

c) **SGC Density:** The SHRP Gyratory Compactor (SGC) shall be used to prepare formed specimens at N_{Design} gyrations of 100. The SGC formed specimens shall be used for the determination of volumetric properties on a field produced mix as outlined in the Asphalt Institute SP-2 Manual.

.3 Quality Assurance

a) Thickness Cores

i) At the Engineer's request, the quality assurance laboratory will take one or more sets of cores from SMA pavement suspected to be deficient in total thickness, each set comprising 3 cores whose average thickness represents an area of not more than 1 000 m^2 of SMA pavement.

b) Asphalt Cement Content and Density Specimen Sampling and Testing

c) The Quality Assurance Laboratory will:

i) Determine the Maximum Theoretical Density (MTD) and asphalt cement content of SMA Field Specimens at a minimum frequency of one test for every 250 tonnes of SMA produced, or a day's production, whichever is less.

ii) Obtain two sets of cores from compacted mat placed from same load of SMA from which MTD specimens were obtained, and representing 1,000 m^2 or from suspect compacted mat, and test one set for density and the second set for rut testing (APA).

iii) **Basis of Acceptance:** Pavement compaction will be accepted on the basis of the ratio (in percent) of the core density to the Maximum Theoretical Density (MTD). If cores were taken from a mat where no MTD are available, acceptance will be based on the ratio of core density to the average MTD for that day's production.

iv) **Representative Cores:** A single core is initially taken representing the quantity of SMA in not more than 1 000 m^2 of mat, with a minimum of one core taken from a day's production. If the initial core density is below specified, that initial density is discarded, and 3 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5 m between cores. The average density of the 3 new cores represents that area.

d) Rutting Susceptibility Specimen Sampling and Testing

e) The quality assurance laboratory will:

i) Determine the rutting susceptibility of SMA Field Specimens at a minimum frequency of one test for every 500 t of SMA produced, or a day's production, whichever is less by subjecting the SMA specimens to the Asphalt Pavement Analyzer (APA) procedure. APA testing will be carried out by a reputable Quality Assurance laboratory acceptable to The City. The APA device must meet the requirements of AASHTO TP63-03 and must be equipped with an automatic rut measurement system. The APA device must be calibrated at least once per year according to the procedures in the test method. In addition, the load cell used for checking wheel loads shall be calibrated at least once per year. Each test shall have 6 cylindrical samples fabricated and tested with the interior temperature of the APA set at 52$_{o}$ C. The downward force shall be set at 45 Kg and the hoses shall be pressurized to 689 kPa. Each specimen shall be compacted so that 7+/-0.5 percent air voids are achieved. The APA rut test results shall be provided to the nearest 0.1 mm. The average rut depth for the specimens tested shall not exceed 5.0mm

ii) Determine the rutting susceptibility of SMA Field core Specimens taken at the location of the MTD samples by subjecting the SMA Field core specimens to the Asphalt Pavement Analyzer (APA) procedure as described in the above section. The average rut depth for the specimens tested shall not exceed 5.0mm. If the initial APA rutting is above specified, that initial APA result is discarded, and 3 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5m between cores. The average APA result of the 3 new cores will be taken as to represent that area.

f) Tensile Strength Ratio (TSR) Specimen Sampling and Testing

g) The quality assurance laboratory will:

i) Determine the TSR of SMA Field Specimens at a minimum frequency of one test for every 500 t of SMA produced, or a day's production, whichever is less in accordance with AASHTO T283. The TSR must Exceed 75%

.4 Materials

a) Stone Mastic Asphalt Concrete To Section 4.3.2.1.9 – Stone Mastic Asphalt Concrete.

b) Tack Coat To Section 4.3.2.1.14 - Liquid Asphalt Coats

.5 Equipment

a) Trucks for Transporting Mix:

i) Trucks shall be compatible with size and capacity of the paver; with clean, tight, smoothsided boxes equipped with waterproof tarpaulins of sufficient size to securely cover all material when boxes are fully loaded. The side of the truck box shall have a 12-mm diameter hole 300 mm from bottom for checking mix temperature. Use only approved release agents, such as water based liquid soap or dry soap powder and drain all excess release agents from truck beds.

b) Paver:

i) Pavers shall be self-propelled; with automatic screed controls to maintain grade from a reference stringline or ski and to control crossfall, smoothness and joint matching; with vibratory screed equipped with vibratory extensions and augers capable of uniformly spreading the mixture to specified widths and depths without segregation or tearing. Follow the manufacturer's recommended operating procedures.

c) Rollers:

i) Shall be self-propelled, reversible; static, oscillating or vibratory steel-drum rollers; with wetting and scraping devices to prevent adhesion of mix to drums or tires (petroleum derivatives are not permitted for cleaning); capable of attaining required density and smoothness. Follow the manufacturer's recommended operating procedures. Pneumatictired rollers are not to be used on SMA.

d) Hand Tools:

i) Rakes, lutes, tampers, straightedges, levels, and other hand tools as necessary to complete the work shall be available.

4.3.2.1.12 Paving Brick on Sand Bed

.1 Content

a) This section includes to supply and placement of clay paving brick with sand bedding on soil cement base, for pedestrian and light vehicle traffic.

.2 Submittals

a) Submit the manufacturer's product data together with 2 samples representative of style, size, colour range and surface texture to the City at least 14 days prior to delivery of brick pavers on site. Submit further samples as requested by the City.

b) Submit source and gradation of bedding and joint sand to St. Albert Development Engineering at least 7 days prior to use.

.3 Quality Assurance

a) The quality assurance laboratory will test paving brick for compressive strength and absorption to ASTM C902.

b) Brick not meeting specifications shall be replaced.

.4 Materials

a) **Paving Brick:** to ASTM C902, class SX, type 1, solid fired clay units, conforming to the following:

i) Compressive strength at time of delivery: minimum 55 MPa average of 5 test samples with no unit less than 50 MPa.

ii) Moisture absorption at time of delivery: maximum 8% average of 5 test samples with no unit more than 11%.

iii) Size: 200 mm x 100 mm x 60 mm ±2 mm in any dimension.

iv) Shape and Colour: as indicated on drawings or as ordered.

b) **Bedding Sand:** to Section 4.3.2.1.7 - Aggregate, Designation 4, class 10.

c) **Joint Sand:** to Section 4.3.2.1.7 - Aggregate, Designation 4, class 2.5, with 6% bentonite.

d) **Edge Restraint:** pressure treated wood, concrete or other material or structure as indicated on drawings.

e) **Weed Barrier:** as indicated on drawings.

f) **Insulation:** as indicated on drawings.

4.3.2.1.13 Pavement Cold Milling

.1 Content

a) This section includes cold milling or grinding of existing asphalt or concrete pavement surfaces.

.2 Materials

a) **Millings:** Unless stated otherwise in the Special Provisions, millings shall become the property of the Contractor, who shall remove and transport the millings to the location of the Contractor's choice at the Contractor's expense.

.3 Equipment

a) Cold Planer: Self-propelled; capable of milling 4,000 m^2 of pavement surface in an 8 hr shift; capable of loading millings into haul vehicles; with a mandrel cutting a minimum width of 1.52 m; with sufficient power to cut a minimum 50 mm depth in one pass; with slope and grade adjustment controls.

b) All equipment shall be suitably muffled to conform to current City of St. Albert bylaws.

4.3.2.1.14 Liquid Asphalt Coats

.1 Content

a) This section includes:

i) **Asphalt prime coat:** the supply and application of liquid asphalt to seal the surface of granular base courses or soil cement and to provide a bond with subsequent paving courses.

ii) **Asphalt tack coat:** the supply and application of liquid asphalt to provide a bond between existing asphalt or concrete surface and the overlying asphalt course.

iii) Specifications for liquid and emulsified asphalts.

.2 Submittals

a) Submit refinery data to Development Engineering prior to first use and as requested by the Engineer

.3 Quality Assurance

a) The quality assurance laboratory may take and test samples of liquid asphalt used weekly from each source. Material not meeting specifications shall be replaced.

.4 Materials

a) Liquid or Emulsified Asphalt: types and grades as indicated below and conforming to related properties in Tables 4.3.64 and 4.3.65.

Table 4.3.39: Liquid or Emulsified Asphalt Types and Grades

	Liquid Asphalt Type & Grade	Application Rate litres/m^2	Concentration
Prime Coat	MS-1	1.5 ±0.5	100%
Tack Coat	SS-1	0.5 ±0.2	50%
	MS-1	0.5±0.2	100%
	MC-30*	0.3 ±0.1	100%

**Note: only to be used for paving on Bridge Decks*

Dilute SS-1 emulsified asphalt with an equal amount of water.

.5 Equipment

a) Pressure Distributor: shall be self-powered, equipped with a tachometer, a pressure gauge, an adjustable length spray bar, a positive displacement asphalt pump with a separate power unit, heating coils and a burner for even heating of asphalt and a thermometer. The pressure distributor shall be capable of maintaining a uniform speed and provide uniform application of liquid asphalt at the designated rate to areas up to 4 m wide.

b) Hand Spray Wand: shall have a nozzle connected by a hose to a pressure distributor and shall be capable of the uniform application of liquid asphalt.

4.3.2.1.15 Full Depth Reclamation Using Foamed Asphalt

.1 Content

a) This section includes the pulverization of existing asphalt, soil cement and/or aggregate roadway structures, the addition and mixing of stabilizing agents into the reclaimed base, and the grading and compaction of the reclaimed base course.

.2 Definitions

a) Full Depth Reclamation Using Foamed Asphalt:

i) Full Depth Reclamation (FDR) Using Foamed Asphalt shall consist of a full depth recycling process, where the existing bituminous cover and the top portion of the underlying base material are reclaimed and transformed into a homogenous mixture by an in-place process using foamed asphalt and if required additional course aggregate and granular material;

ii) FDR shall be performed by utilizing a recycling machine to pulverise, to the depth shown on the plans, the materials in the upper layers of the existing pavement structural section together with any imported aggregate base and to achieve the required grading and consistency of mix in a single pass. The recycled material shall exit from the mixing chamber in a manner that prevents particle segregation. Spreading and placing to form the new structural section shall be by motor grader or screed mounted on the rear of the recycling machine. Prepulverizing may be done prior to the foamed asphalt application with no extra compensation.

iii) Pulverize and reuse materials in the upper layers of the existing roadway structural section;

iv) Adjust the gradation of the existing materials by the addition of imported aggregate base (Admixture Aggregate) if and where necessary;

v) Procure, furnish, and mix in a combination of foamed bitumen and cementitious stabilizing agents together with sufficient water to approximate the optimum moisture content; and

vi) Place and compact to achieve a new structural section, as shown on the plans, as specified in the Standard Specifications and these special provisions, unless otherwise directed by the Engineer.

.3 Quality Assurance

a) **Maximum Density:** the dry unit mass of a sample at optimum moisture content as determined in the laboratory according to ASTM D1557

b) **Required Density:** a minimum of 98% of the maximum density in accordance with ASTM D1557 for the full depth foam in-place recycled material.

c) **Testing Frequency:** the quality assurance laboratory will take a minimum of one field density test for each 1 000 m_2 of compacted full depth foam in-place recycled material according to ASTM D2167 or ASTM D2922 for comparison with a maximum density determined according to ASTM D1557.

.4 Materials

a) **Cementitious Stabilizing Agent:** Cement to, CSAA3001Type GU, General use cement shall be the only cementitious stabilizing agent employed in the full depth foam inplace Recycling process

b) **In-Situ Materials:** The existing pavement structure to be pulverized has been investigated, and the results are included in the contract Special Provisions. If additional coring or sampling is desired, the coring or sampling shall be at the expense of the Contractor.

c) **Bituminous Stabilizing Agents:** Foamed bitumen shall be the only bituminous stabilizing agent employed in the full depth foam in-place recycling process. Foamed bitumen shall be produced from Asphalt Cement: PG 58-28 to AASHTO M320, Table 2 which is included in these specifications as Table 4.3.46 and Table 4.3.47.

d) **Water:** May be obtained from City fire hydrants according to the General Requirements. Other water sources are subject to the Engineer's approval.

e) **Admixture Aggregate:** 20mm aggregate to be incorporated into the existing road structure to ensure adequate fines for stabilization shall meet the following gradation:

Table 4.3.40: Gradation Requirements for Admixture Aggregate

Sieve Size	Percent Passing
20 000	100
12 500	60-90
5 000	40-60
2 000	25-45
400	15-25
160	10-20
80	10-15

f) Foamed Bitumen Mix Design

i) Submit to the The City for approval a Foamed Bitumen Mix Design performed by a qualified laboratory at least 14 days before initial Foamed Bitumen Recycling work for each location. The mix design should be carried out in accordance with the mix design method detailed in the Wirtgen Cold Recycling Manual current edition.

ii) The design of the foamed asphalt shall be completed with a laboratory asphalt expanding plant. The half -life and expansion ratio of the expanded asphalt bitumen shall be determined at a minimum of five (5) moisture contents. A minimum of two (2) trials shall be completed for each moisture content and the average values obtained shall be used in the final analysis. The moisture content of the expanded asphalt bitumen shall be established to provide a maximum expansion ratio and maximum halflife. The moisture content of the binder shall be selected to provide a minimum halflife of eight (8) seconds.

iii) The mix design sample shall be a representative sample of the roadway being rehabilitated and shall be obtained using the anticipated recycling equipment.

g) Foamed Bitumen Mix Design Criteria

i) Aggregate Gradation: The combined/pulverized material should meet the following gradation:

Table 4.3.41: Aggregate Gradation for the Combined/Pulverized Material

Sieve Size	Percent Passing
38 000	100
20 000	70-100
12 500	60-85
5000	45-70
2 500	33-60
400	15-35
160	10-25
80	5-20

h) **Cement Content**: minimum 1.0% by mass of dry aggregate used for tendering mix design requirement governs.

i) **Bitumen:** Minimum 2.6% by mass of dry aggregate used for tendering mix design requirement governs.

   i) The mix design should be performed at various bitumen contents using Marshall criteria of 75 blows per face. The Indirect Tensile Strength (ITS) of the specimens should be determined for both the soaked and un-soaked specimens. The soaked specimens should be placed under water at 25o C ± 1o C for 24 hours. Remove the specimens from the water and surface dry the specimen prior to performing ITS testing. The ratio of un-soaked to soaked Tensile Strength (TSR) must be a minimum of 50%

j) The final design shall be based on a foamed bitumen content that provides:

   i) Optimum bulk Density

   ii) Optimum dry strength properties

   iii) Optimum wet strength properties

   iv) Optimum resistance to moisture penetration

.5 Equipment

a) Reclaimer/Stabilizer: a roadway structure pulverizing machine with the following characteristics, and subject to the Engineers approval:

   i) A minimum power capacity of 600 horsepower;

   ii) A milling drum that rotates upward into the direction of advance with a minimum cut width of 2.0 m;

   iii) The capability of pulverizing asphalt, soil cement and gravel roadway structures to depths of at least 400 mm in a single pass, and accurately maintaining a preset depth of cut;

iv) Due to the cut depths as detailed in the contract documents, there is no requirement for the effective volume of the mixing chamber to be increased in relation to the depth of cut.

v) Two microprocessor controlled systems, complete with two independent pumping systems and spraybars, one to regulate the application of foamed bitumen stabilizing agent and a separate system to regulate the water (for increasing the moisture content of the recycled material), both in relation to the forward speed and mass of the material being recycled;

vi) Two spraybars shall each be fitted with nozzles at a maximum spacing of one nozzle for each 155mm width of chamber; the contractor shall ensure that all nozzles utilized in the foamed asphalt process shall be maintained in working order for the duration of the process;

vii) The foamed bitumen shall be produced at the spraybars in individual expansion chambers, or one large expansion chamber, into which hot bitumen and water are injected under pressure through orifices that promote atomization. The rate of addition of water into hot bitumen shall be kept at a constant (percentage by mass of bitumen) by the same microprocessor;

viii) An inspection (or test) nozzle shall be fitted at one end of the spraybar that produces a representative sample of foamed bitumen;

ix) An electrical heating system capable of maintaining the temperature of all bitumen flow components above 1500C;

x) A single bitumen feed pipe installed between the modified milling or recycling machine and the supply tanker can be used. A system that incorporates a return pipe to the supply tanker may be used providing the overall temperature of the bitumen can be maintained;

b) **Compaction Equipment:** self-propelled vibratory steel drum, sheepsfoot/padfoot rollers and pneumatic-tired rollers capable of achieving the required compaction of the cold foam in-place recycled material, and providing a surface suitable for the placement of hot-mix asphalt concrete. The frequency and amplitude of vibrating rollers shall exceed a static mass of 15 tons and shall be adjustable.

c) Supply Tankers for Bituminous Stabilizing Agent: Only tankers with a capacity exceeding 10,000 L shall be used to supply the recycling machine with bitumen. Each tanker shall be fitted with two recessed pin-type two hitches, on in front and the other in the rear, thereby allowing the tanker to be pushed from behind by the recycling machine, and to push a water tanker in front. No leaking tanker will be permitted on the job site. In addition, each tanker shall be equipped with the following:

i) A thermometer to show the temperature of the bottom third of the tank;

ii) A rear feed valve, with a minimum internal diameter of 75mm, capable of draining the contents of the tank when fully opened;

iii) All-round cladding to retain heat;

iv) A calibrated dipstick marked at intervals of no more than 100 litres, for measuring the contents of the tank.

4.3.2.1.16 Pavement Crack Sealing

.1 Content

a) This section includes the routing, cleaning and sealing cracks and joints in asphalt pavement.

.2 Submittals

a) Submit crack or joint sealant manufacturer's product data to the City Engineer at least 7 days prior to use.

.3 Quality Assurance

a) The quality assurance laboratory will perform the following to determine acceptability of the work and end product:

i) Evaluate rout width, depth and centering along the crack.

ii) Check sealant temperatures at the heating kettle and at application.

iii) Test sealant penetration and flow.

b) Definitions: For purposes of evaluating rout width, depth and centering accuracy, a lot is equal to a day's production of a sealing crew, or a portion thereof as designated by the Engineer. Each lot will be represented by a series of measurements at a minimum of 40 points in the lot. The compliance percentage each for width/depth ratio and centering accuracy will be the number of points meeting the specified tolerances divided by the total number of points, expressed in percent.

c) For each day's production of a sealing crew, a sample of molten sealant will be taken and tested for penetration and flow.

.4 Materials

a) **Crack or Joint Sealant:** hot-poured rubberized asphalt sealant conforming to physical requirements in ASTM D1190.

.5 Equipment

a) **Mechanical Router:** portable and capable of cutting the pavement surface in a single pass to a width of 40 mm and to a depth of 8 mm. The Contractor shall demonstrate that the router is capable of following meandering cracks and keeping the crack centred within ±8 mm of the centre of rout.

b) **Compressed Air Lance:** capable of blowing dry, oil-free compressed air at a minimum line pressure of 690 kPa.

c) **Melting Kettle:** mobile, rubber tired, double jacketed oil bath kettle, using high flash point oil heat transfer medium; with an automatic agitator to continuously stir the sealant during heating; with 2 thermocouple devices to monitor the temperatures of the heating oil and the sealant with temperature indicators which can be read by the Engineer at road level. The temperature readings shall be in Celsius degrees with an accuracy of ±2%. The use of a direct fired kettle is not permitted.

d) **Sealant Dispenser:** wand fitted with the proper size tip and connected to a low pressure pump from the melting kettle.

4.3.2.1.17 Bridge Deck Asphalt Surfacing

.1 Content

a) Provide all labour, materials, products arid equipment required to remove existing asphalt from bridge deck and supply and place a polymer modified asphalt membrane/mastic surface wearing course to the bridge deck and approaches.

.2 Quality Assurance

a) Inspection and testing

i) All products and workmanship will be inspected by the Engineer. The City of St. Albert will conduct plant inspection and materials sampling and testing described in the following paragraphs.

ii) The Contractor shall notify the Engineer in ample time to permit inspection and testing.

iii) The Contractor shall co-operate with the Engineer on the inspection of materials and sampling.

iv) The Contractor shall not cover any work before inspection and testing unless authorized by the Engineer, in writing.

v) The Contractor shall remove and replace or repair defective products or work that fails to meet the specified requirements as directed by the Engineer, at no cost to the City.

b) Asphalt Plant

i) Inspections will be conducted at least once during production to check plant calibrations, plant operation, production settings, temperatures, and materials handling. Samples of materials and mixture may be taken and tested.

c) Asphalt Cement

i) Quality assurance sampling and testing of the asphalt cement shall be performed by the St. Albert, to verify compliance to the specification. A sample shall be taken at random during paving operations on City projects from a load(s) delivered to the Contractor's asphalt plant at least twice a month or as otherwise determined by the Engineer. It is the contractor's responsibility to inform the Engineer of the delivery of asphalt Cement to their facility for sampling.

ii) If non-complying material is identified, the paving program may be suspended for 24 hours, as directed by the Engineer, during which time the Contractor, and the Engineer, will meet to determine the impact of the non-compliance, and specify the necessary remedial action to be taken by the Contractor. Remedial action shall be either acceptance, acceptance at a pay adjustment, or removal and replacement at no cost to the City. If suspended, the paving program shall only continue upon written authorization by St. Albert.

iii) Asphalt cement identified to be in non-compliance shall not be shipped to a project. SGC hot-mix mixed and placed with identified non-complying asphalt cement shall be removed and replaced, as directed by the

d) Production Mix Analysis

i) Full mix sample testing will be conducted at a minimum frequency of one test, for each day's production. Three briquettes will be made and tested for Marshall Properties and Maximum Theoretical Density, and three briquettes will be made and tested for permeability.

ii) The determination of the asphalt cement content will utilize the asphalt ignition oven correction factor, as determined by the Engineer.

iii) QA will conduct nuclear density testing on the compacted mat at locations which represent 1,000 m_2

iv) Basis of Acceptance: Bridge deck hot-mix pavement compaction will be accepted based on the ratio (in percent) of the results obtained from the calibrated nuclear densometer density to the MTD. If results are obtained from a mat where no MTD are available, acceptance will be based on the ratio of nuclear densometer density to the average MTD for that day's production.

e) Job Mix Formula

i) The QA will test a trial batch of the Bridge Deck hot-mix job mix formula to verify the mix design. The mix design and job mix formula will not be approved by the Engineer until successful results are obtained.

ii) The QA will use the mix provided in the Trail Batch to produce specimens with which to calibrate the nuclear densometer for performing field density determinations.

.3 Quality Control

a) General

b) The Contractor is responsible for quality control throughout all stages of the SGC hotmix production and placement including the aggregates, asphalt cement, and any other materials used in the mix. The Contractor shall utilize a qualified testing laboratory to undertake the quality control sampling and testing to determine and monitor the properties of the materials being produced and used on the project.

c) Sampling and Testing

i) The Contractor shall follow the sampling and testing methods and frequencies indicated in their quality control plan and/or as accepted or modified by the Engineer.

d) Curing Requirement

i) No traffic shall be allowed on newly placed asphalt until densities have been reached and surface has cooled down to 32_{o} C.

e) Existing Asphalt Depth

i) Asphalt depth data is described in the Special Provisions. No additional payments will be made for removal of asphalt below indicated depths.

f) Haul Routes

i) Haul routes shall be approved by the Engineer and in accordance with the General Conditions.

ii) Ensure that all vehicles used are equipped to prevent spilling or leaking of any part of the load.

g) Equipment

i) Pavers: mechanical automatic grade controlled self-powered pavers capable of spreading mix within specified tolerance, true to line, grade and crown indicated.

h) Rollers: sufficient number of rollers of type and weight to obtain specified density of compacted mix. Vibrators on vibratory rollers shall NOT be activated. The Engineer, at his sole discretion, may allow the Contractor to activate vibrators on vibratory rollers not exceeding 5 tonnes in weight.

i) Haul Trucks

i) Haul trucks: of adequate size, speed and condition to ensure orderly and continuous operation and as follows:

ii) Clean, tight, smooth sided boxes.

iii) Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.

iv) In cool weather or for long hauls, insulate entire contact area of each truck box.

j) Hand Tools

i) Lutes or rakes with covered teeth shall be used during spreading and finishing operations.

ii) Tamping irons having mass not less than 13 kg and a bearing area not exceeding 310 cm^2 for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by the Engineer, may be used instead of tamping irons.

iii) Straight edges, 4.5 m in length, to test finished surface.

k) Longitudinal Joints

i) If application of the wearing course is to be stopped and delayed for 6 hours or more, the temperature of the joint material cannot be maintained at a minimum of 115 ^{o}C and/or the edge of the longitudinal joint has been deformed due to vehicles driven over, carefully roll the edge of the mat. Prior to placement of the adjoining mat, trim off the rolled material from the first mat to a width of 150mm resulting in a clean vertical face to the full depth of the mat and paint with a tack coat sealer before placing the adjacent mat.

.4 Materials for Polymer Modified Asphalt

a) Asphalt Cement: Polymer Modified Bridge Mastic, supplied by Husky Oil Ltd., meeting the requirements given in Table A. No alternatives will be allowed.

i) Aggregates shall be approved by the Engineer and shall meet the gradation requirements given in Table B.

b) Fine aggregate: That fraction of the total aggregate passing the 5 000 µm sieve. Fine aggregate shall contain a minimum 75 percent manufactured or crushed fines. The total percent of manufactured fines in a mix is taken as the percentage of manufactured fines in the minus 5 000 µm sieve fraction of the total combined aggregate.

c) Coarse aggregate: That fraction of the total aggregate retained on the 5 000 µm sieve. A minimum of 75% of the coarse aggregate particles shall have at least two crushed faces.

d) Tack coat: Cutback Asphalt, grade MC-30 or approved alternate, subject to approval by the Engineer. Tack coat utilizing water as a carrier will not be allowed.

.5 Mix Properties for Polymer Modified Asphalt

a) Submit a mix design carried out by a qualified laboratory, to the Engineer for review a minimum of 4 weeks prior to commencement of the work.

b) The mix design shall include:

i) Legal description of all aggregate sources;

ii) Individual aggregate gradations;

iii) Water absorption of the individual aggregates and the combined aggregates;

iv) Aggregate blend;

v) Combined aggregate gradation;

vi) Bulk specific gravity of individual aggregates and mineral filler;

vii) Based on the individual aggregate results, the calculated bulk specific gravity of the combined aggregates;

viii) A minimum of five individual and separate asphalt cement contents must be used in the mix design and each individual asphalt cement content must be separated by a minimum of 0.40 to a maximum of 0.60 percent (by dry weight of aggregate);

ix) Graph of mix's Theoretical Maximum Density (MTD) versus asphalt cement content (by total mix) reported to two significant digits;

x) All other graphs used in the mix design (by total mix);

xi) Individual mix property results are to be plotted and a second order polynomial graph drawn through the individual data points.

xii) Recommended initial asphalt cement content and associated mix parameters;

xiii) Asphalt cement absorption of the combined aggregates;

xiv) Ignition oven asphalt cement content correction factor:

xv) The results of permeability testing carried out on briquettes at the design binder content.

c) Mix design for single lifts shall meet the requirements given in Table C for a laboratory compacted mix mixed at 180□C and compacted at 168□C with 50 blows from a mechanical compactor. Mix temperature at the plant shall NOT exceed 185 oC.

d) Mix design for membrane in multiple lifts shall meet the requirements given in Table D for a laboratory compacted mix mixed at 180□C and compacted at 168□C with 50 blows from a mechanical compactor. Mix temperature at the plant shall NOT exceed 185 oC.

e) Mix design for overlays in multiple lifts shall meet the requirements given in Table E for a laboratory compacted mix mixed at 180□C and compacted at 168□C with 50 blows from a mechanical compactor. Mix temperature at the plant shall NOT exceed 185 oC.

f) Allowable variations in aggregate gradation between the job mix and the approved mixdesign: 3% on material retained on the 160 □m and coarser sieve. 1% on material retained on the 80 □m sieve.

.6 Tolerances

a) Marshall Tolerances

i) The tolerances for the required Marshall properties for quality assurance testing are detailed in Tables C, D, or E depending on the mix designation.

b) Permeability Tolerance

i) Permeability testing shall be carried out in accordance with ASTM D 5084-90 on three briquettes molded at the time of Marshall Field sample preparation.

ii) If the average permeability of the tests of the three samples does not meet the permeability specified, the Contractor shall remove and replace the deficient areas at no cost to the Owner. The replacement of the materials shall be performed in accordance with these specifications.

c) Density Tolerance

i) Required Density: Each mat of hot-mix placed shall be compacted to a minimum of 94 Percent of Maximum Theoretical Density (MTD), or as otherwise indicated in the contract Special Provisions.

ii) Deficient Density: If the average density as determined through use of the nuclear densometer is below specified, the represented area of mat may be accepted subject to a pay factor according to Table 4.3.52 to be applied to the price of the quantity of hot-mix in that mat area

d) Thickness Tolerance

i) As detailed in Section 4.3.2.1.8 SGC Hot-Mix Asphalt Paving

.7 Field Quality Control

a) Smoothness Tolerances

i) Maximum variation under 4.5 m straight edge as follows:

1. Longitudinal in direction of travel: 6 mm.
2. Transverse to direction of travel: 6 mm. (Straight crossfall)
3. Grade: +/- 6 mm maximum variation from designated grade elevations.
4. Texture: The finished surface shall have a tightly knit texture free of visible signs of poor workmanship including but not limited to:
5. Segregation, waves, hairline cracks, roller marks or other unevenness.
6. If the finished surface of the mat does not comply with the above requirements, the Contractor shall remove and replace the deficient areas at no cost to the Owner. The replacement of the mat shall be performed in accordance with these specifications.

.8 Plant and Mixing Requirements

a) Refer to City of St. Albert Specification Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete.

4.3.2.1.18 Recycled Asphalt Paving

.1 Content

a) This section includes the reclaiming existing asphalt pavement, the design and production of recycled asphalt hot-mix and the placing recycled asphalt hot-mix.

.2 Quality Assurance

a) To Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete.

.3 Materials

a) **Reclaimed Asphalt Pavement (RAP):** Rap is salvaged, milled, pulverized, broken, or crushed asphalt pavement removed from an existing pavement.

b) **Recycled Asphalt Shingles (RAS):** Pre-consumer or post-consumer shingles that have been processed, sized, and are ready for incorporation into a hot mix Asphalt mixture.

c) **Virgin Aggregate:** New aggregate to Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete.

d) **Aggregate in Recycled Asphalt Mix:** to Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete modified as follows:

e) **Asphalt Cement:** The extracted blended asphalt cement shall meet the PG requirements as detailed in Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete.

Mix Type:	20mm - B	10mm - HT	10mm - LT
Designation 1 class:	20	10.0	10.0
Sieve Size (µm)	**Total % Passing by Mass**		
160	9-131	7 – 16	8 – 16
80	4-9	4 - 9	4 - 9

.4 Mix Design and Proportioning

a) Submit a recycled asphalt mix design to Section 6.1 – SGC Hot-Mix Asphalt Concrete for the specified mix type based on the following maximum RAP, RAS, or combination of RAP and RAS content:

Table 4.3.42: Maximum RAP and RAS Content per Recycled Asphalt Mix Design

Mix type:	20mm - B	10mm - HT	10mm - LT
Maximum RAP content if only using RAP in the mix (% by mass of total mix)	25	10	20
Maximum RAS content if only using RAS in the mix (% by mass of total mix)	3	3	3
Maximum RAP and RAS content if using both RAP and RAS in the mix, subject to the above noted individual maximums (% by mass of total mix)	25	10	20

b) Determine asphalt content and gradation of the RAS material for mixture design purposes in accordance with AASHTO T-164, Method A or B and AASHTO T-30. Calculate and ensure the ratio of the virgin binder to total binder is greater than 80% in surface mixtures and 75% in non-surface mixtures. “Surface” mixtures are defined as mixtures that will be final lifts or riding surfaces of a pavement structure. “Non-Surface” mixtures are defined as mixtures that will be intermediate or base layers in a pavement structure.

c) RAS shall contain no more that 0.5% by total cumulative weight of extraneous waste materials including but not limited to, metals, glass, paper, rubber, wood nails, plastics, soil, brick tars, and other contaminating substances. This percentage shall be determined on material retained on the 5.000mm sieve

d) RAS shall be free from asbestos fibers.

e) The Contractor shall, with the mix design, furnish PG test results from the virgin binder, the binder extracted from the individual RAP or RAS materials and PG test results indicating that the binder in the mix resulting from the blending of the RAP, RAS, or RAP and RAS materials meets the grade specified in the contract.

.5 Asphalt Plant

a) In addition to the requirements of Section 4.3.2.1.8 – SGC Hot-Mix Asphalt Concrete, the mixing plant shall be capable of receiving and mixing the proportions of RAP, RAS, virgin aggregate and asphalt cement as designed.

b) The mixing plant shall be capable of thorough degradation and heating of RAP and RAS particles and blending with virgin aggregate and asphalt cement to produce a homogeneous mix at the point of discharge.

.6 Equipment

a) **Cold Planer:** to Section 4.3.2.1.13 - Pavement Cold Milling.

b) **Haul Vehicle:** capable of receiving milled material directly from the cold planer and hauling directly to a stockpile.

c) **Weigh Scale:** shall meet the following requirements:

i) Inspected and certified by Weights and Measures Inspection Services of Canada Consumer and Corporate Affairs as often as directed by the Engineer, with the inspection certificate exhibited as required.

ii) Of sufficient size and capacity for weighing any haul vehicle in one operation with all wheels on the platform.

iii) Scale house to be provided complete with furnishings, subject to the approval of the Engineer.

d) **Mechanical Sweeper:** capable of removing loose material and debris from the milled surface

e) **Asphalt Shingle Grinder:** capable of receiving and processing asphalt shingles meeting the end product size requirements listed.

4.3.2.1.19 Roadway Signage (10 14 53)

.1 Signage materials shall conform to TAC's *Manual of Uniform Traffic Control Devices for Canada*.

a) All roadway signage shall consist of diamond-grade reflective material for the lettering and background, except for black-coloured portions.

b) Street name signage shall be placed at each intersection and shall consist of white lettering on a green metal plate. Lettering sizes shall conform to the following requirements:

.2 For local roadways, lettering shall be 100 mm (4") high, compliment shall be 75 mm (3") high upon a 150 mm (6") tall plate; and

.3 For collector and arterial roadways, lettering shall be 150 mm (6") high upon a 225 mm (9") tall plate.

a) For cul-de-sacs with the same name as the adjoining roadway, include address numbering (100 mm (4") high) on the street signage for the cul-de-sac at the adjoining intersection.

4.3.2.1.20 Pavement Marking (32 17 23)

.1 Equipment

a) Where the work is to be carried out on the City's walking pathway system, equipment must be of an appropriate size to protect the pathway structure, surrounding surfaces, and adjacent appurtenances. Only equipment mounted on a half-ton truck-type chassis, or smaller unit, will be permitted. The equipment must be self-propelled and be equipped to apply the marking material according to the manufacturer's recommendations.

b) Where the work is to be carried out on the City's road network, equipment proposed by the Contractor for use in carrying out the Work shall be subject to the review and acceptance of the City.

.2 Marking Materials

a) Marking materials shall be suitable for asphalt concrete surfaces and shall be available in both white and yellow colours. The material, while on the roadway surface and at any natural ambient temperature shall exist as a solid line with cold ductility that permits normal movement with the road surface without chipping or spalling. Propagation of a pavement crack through the lane marking material shall be excluded from this requirement.

b) Paint

i) White Paint – CGSB 1-GP-12.1C, White 513-301.

ii) Yellow Paint – To match CGSB 505-308 color chip.

iii) Reflectance: White – Min. 80%; Yellow – Min. 50% (ASTM- E1347).

c) Cold and Hot Plastic Markings

i) Colour:

1. YELLOW: CONFORMING TO CGSB COLOUR #505-308
2. WHITE: BRILLIANT WHITE OR CGSB 1-GP-12.1 C, WHITE 513-301.

ii) Water Absorption: Max. 0.5% (ASTM-D570).

iii) Impact Resistance: Min. 1.13 J at 25°C (ASTM-D256).

iv) Abrasion Resistance: Max. weight loss of 0.60 g (ASTM-D4060).

v) Chemical Resistance: No deterioration when in direct contact with asphalt cement in asphaltic materials or with sodium chloride or calcium chloride or other de-icing materials, and shall be resistant to the effect of ultraviolet light.

vi) Reflectance: White – Min. 70%; Yellow – Min. 45% (ASTM- E1347).

vii) Retroreflectivity: The initial reflectance for the in-place marking, measured 7 to 10 days after application, shall have the minimum reflectance values as follows:

1. DRY/NIGHT: WHITE – 200 MCD/LUX/M^2, YELLOW – 175 MCD/LUX/M^2

viii) Retained Retroreflectivity: The reflectance for longitudinal lines, for at least 36 months after placement, shall have the minimum reflectance values as follows:

1. DRY/NIGHT: WHITE – 75 MCD/LUX/M^2, YELLOW – 60 MCD/LUX/M^2

ix) Skid Resistance: Minimum vehicle skid resistance of the in place markings shall not be less than 45 based on Portable Skid Resistance Tester, Road Research Laboratory Road Note Number 27, British Standards Institution.

x) Curing Time: 10 to 35 min (controllable by installer).

xi) Cold Plastic Markings

1. Two component (cold-extruded and cold-curing) markings shall have a minimum specific gravity of 1.9 at 25°C (ASTM-D792).

2. The material shall be suitable for application on concrete and on new and old asphalt. Bond strength shall be sufficient for the material to remain in place for a minimum of 2 years when surface applied, and 3 years when “scratched” inlaid.
3. System 400 or accepted alternate.

xii) Hot Thermoplastic Markings

1. Hot-extruded markings shall have a minimum specific gravity of 2.0 at 25°c (ASTM-D792).
2. Glass sphere content: min. 20%; max. 30%, by mass of thermoplastic material.
3. The material shall be suitable for application on new asphalt and old asphalt. Bond strength shall be sufficient for the material to remain in place for a minimum of 2 years when surface applied, and 5 years when inlaid.
4. System 300 or accepted alternate.

d) MMA Spray Material

i) MMA Spray Material shall be manufactured for application by spraying onto pavement in liquid form with glass spheres dropped onto the material immediately after application, and shall have a minimum specific gravity of 1.6 at 25°C (ASTM-D792).

ii) Water Absorption: Max. 0.5% (ASTM-D570).

iii) Abrasion Resistance: Max. weight loss of 0.45 g (ASTM-D4060).

iv) Chemical Resistance: The compound shall not deteriorate by contact with sodium chloride, calcium chloride, or other chemicals used against formation of ice on roadways or streets, or because of oil content of pavement materials or from oil dropping from traffic. It shall be resistant to the effect of ultraviolet light.

v) Reflectance: White – Min. 75%; Yellow – Min. 50% (ASTM- E1347).

vi) Retroreflectivity: The initial reflectance for the in-place marking, measured 7 to 10 days after application, shall have the minimum reflectance values as follows:

1. DRY/NIGHT: WHITE – 200 MCD/LUX/M^2, YELLOW – 175 MCD/LUX/M^2.

vii) Skid Resistance: Minimum vehicle skid resistance of the in place markings shall not be less than 45 based on Portable Skid Resistance Tester, Road Research Laboratory Road Note Number 27, British Standards Institution.

viii) Curing Time: 5 to 20 min (controllable by installer).

ix) Dura-Spray 600 or accepted alternate.

e) Fill Material

i) To be used for any removal and fill applications, or repair of line markings.

ii) LRS 424 or accepted alternate.

f) Glass Beads

i) Glass beads shall be a minimum 80% true spherical shape, clear of cloudiness, dark inclusions, trapped air, or other defects.

ii) Index of Refraction: Minimum of 1.5 in accordance with CGSB 1-GP-71.

iii) Gradation (ASTM-D1214):

Sieve Size	Percent Passing
850 µm	95-100
300 µm	15-50
180 µm	0-10

g) Pre-Marking Paint:

i) Water based paint.

4.3.2.2 Construction

4.3.2.2.1 General

.1 The following articles represent the minimum requirements for some typical, key construction procedures for roadway construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

.2 Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Article 2.3.1.

4.3.2.2.2 Quality Assurance

.1 The Developer must maintain detailed records of all inspections and testing as evidence of compliance of the work with these Standards. These records shall be provided to the City.

.2 The Developer shall provide a written endorsement of the Contractor’s compliance with these Standards with the application for the Construction Completion Certificate.

4.3.2.2.3 Quality Control Testing (32 12 16)

.1 The Contractor shall retain the services of independent testing laboratories or agencies to conduct all quality control testing. The proposed testing laboratory or agency shall be subject to the acceptance of the City.

.2 The City may at any time require the Developer to provide evidence of certification by the testing agency the materials and performance of the work meet these Standards.

.3 Minimum quality control test frequencies, specified as follows, are the minimum number required. The Contractor shall ensure that as many tests as necessary are performed to ensure that the work conforms to the requirements of these Standards, regardless of the minimum number specified.

.4 Moisture Density Curves (ASTM-D698):

a) One for each type of material from each source to be compacted to a specified density. The maximum density shall be the dry unit mass of a soil sample at optimum moisture content as determined in accordance with ASTM-D698 Method A.

.5 Sieve Analyses (ASTM-C136):

a) Aggregate – one for each 1,000 tonnes of aggregate.

.6 Field Densities (ASTM-D2169 or ASTM-D2922):

a) Fill – one for each 1,000 m^2 of compacted lift.

b) Sub-grade – one for each 1,000 m^2 of compacted lift.

c) Base Course – one for each 1,000 m^2 of compacted lift.

.7 Hot-Mix Asphalt Concrete Testing:

Note: The contractor must be prepared to provide the following test results if requested by the City of St. Albert.

a) A minimum of one for each 1,000 tonnes or one per production day, each with a minimum of three (3) Marshall specimens taken per test, and including the following minimum requirements for testing of each mix type:

i) Asphalt content;

ii) Air voids;

iii) Stability;

iv) Flow;

v) Film thickness;

vi) Moisture content in mix;

vii) Gradation in mix;

viii) Plant discharge temperature; and

ix) Asphalt storage temperature.

b) Abrasion test, soundness test, sieve analysis, and crushed face count for each aggregate source.

c) Plant inspections, materials sampling, and testing as follows:

i) Weekly asphalt plant inspections during production will be conducted to verify plant calibrations, operation, production settings, temperatures, and handling procedures. Samples of materials and mixtures will be taken and tested.

ii) Samples of asphalt cement will be taken weekly for each source and tested for penetration and kinematic viscosity.

iii) A minimum of one (1) compacted Marshall specimen shall be tested for density for each 1,000 tonnes of hot-mix asphalt concrete, or for each production day, whichever is less.

iv) A minimum of one (1) sieve analysis, to ASTM-C136, and crushed face count for every 1,000 tonnes of aggregate used in asphalt concrete production.

v) The testing agency shall test a trial batch of the job-mix formula to verify the mix design.

.8 Asphalt Pavement

a) Density

i) A minimum of one compacted Marshall specimen shall be tested for density for each 1,000 tonnes of hot-mix asphalt concrete, or for each production day, whichever is less.

ii) Cores will be drilled from a compacted mat placed from the same load of hot-mix asphalt concrete from which the specimen was taken, and tested for density.

iii) Pavement compaction will be accepted or rejected based on the ratio, in percent, of the core density to the density of the compacted Marshall specimen.

iv) If the initial core density is below that specified, that initial core density will be discarded and three new cores will be taken within 10 m of the original core location, all within 2.5 m of each other, or penalty factors will be applied as per Article 4.3.1.2.11. The average density of the three cores will represent the mat density in that area.

b) Thickness

i) A minimum of one core shall be tested for thickness for each 1,000 m^2 of asphalt pavement, for each stage of paving. Staged paving being the process whereby a lift or lifts, forming part of the total pavement structure, are deferred to a future date.

ii) A thickness deficiency at the completion of the first stage of paving may be accepted by the City provided the deficiency is less than 12 mm and the deficient thickness can be included in the subsequent stage of paving.

iii) If the initial core thickness remains deficient at the completion of the final lift of paving, that initial core thickness will be discarded and three new cores will be taken within 10 m of the original core location, all within 2.5 m of each other. The average thickness of the three cores will represent the mat thickness in that area.

4.3.2.2.4 Shallow-Buried Utility Trenches

.1 Shallow-buried utility trenches below roadways and sidewalks must be adequately backfilled and compacted to a minimum 98% Standard Proctor Density (SPD).

.2 The Developer shall coordinate the location of all shallow-buried utility crossings with the respective utility companies. Such utilities that cross beneath roadways must be contained within suitable conduit with their locations suitably marked on the surface at each side of the roadway crossing.

.3 Each lift shall not exceed 150 mm in compacted thickness

4.3.2.2.5 Sub-grade Preparation (32 22 16)

.1 Loosen soil to required depth. Work soil with cultivating and mixing equipment until soil is pulverized into pieces no larger than 25 mm maximum dimension, exclusive of stones

a) The required compaction can generally best be achieved if the soil is dried or moistened to within ±3% of the optimum moisture content before compacting.

b) If the Engineer determines that it is not practical to dry an otherwise suitable soil, the Engineer may order soil stabilization to Section 4.3.2.1.2 - Cement Stabilized Subgrade. Spread soil in lifts not exceeding 150 mm when compacted.

c) Leave the surface of the compacted subgrade slightly higher than required elevation; then trim to design crown and grade. Leave finished surface even and free of depressions, humps and loose material.

.2 Field Quality Control

a) Check finished surface of subgrade to ensure it meets the following tolerances:

i) Grade: 6 mm maximum variation above designated elevation. 25 mm maximum variation below designated elevation.

b) When Tolerance Exceeded:

i) Trim high spots and refinish surface to within tolerance.

ii) Add approved material to low areas, scarify and blend to full subgrade depth, recompact to required density and refinish surface at the contractor's expense. Alternatively, fill low areas with extra thickness of subsequent granular sub-base or base course at the contractor's expense.

c) If a density test result is less than the required density, that test result is discarded and 3 retests shall be performed on the area represented by the failed test. The average of the 3 retests shall represent the density of that area. If this average is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and re-compacted to the required density. If the area is not retested but is reworked and re-compacted the area shall be tested at normal testing frequencies.

i) The Contractor shall assume the risk of uncovering and reworking the subgrade if it is covered before the City has accepted test results thereof.

.3 Protection of Finished Work

a) Do not permit vehicular traffic over the prepared subgrade.

b) If folding of the subgrade occurs, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches. This shall be done at the expense of the Contractor.

c) Maintain protection of prepared subgrade until subsequent granular sub-base or base course is placed. Repair and retest as required by the engineer if damaged.

4.3.2.2.6 Cement Stabilized Subgrade

.1 Preparation

a) Subgrade areas to be stabilized will be indicated on plans or designated by the Engineer.

b) Pre-grade and shape soil to designated grade and cross section.

.2 Stabilization

a) Loosen soil to required depth. Work soil with cultivating and mixing equipment until soil is pulverized into pieces no larger than 25 mm maximum dimension, exclusive of stones.

b) Dust Control: Contain cement dust within site area. Do not spread cement during or when there is imminent danger of high winds or rain.

c) Spread and blend cement into soil at a rate of 10 kg/m2 of 150 mm compacted depth, or as directed by the Engineer, but in no case should the cement exceed 20 kg/m2. In the event that it is determined, in the field that more than 20 kg /m2 is required it is recommended that the situation be examined by a qualified geotechnical engineer and approved by the City to determine the requirements moving forward. In any case no more than 30kg/m2 will be allowed.

d) Add sufficient water to the blended soil and cement to best achieve the required compaction. Mix until homogeneous.

e) Spread the mixture uniformly in lifts of 150 mm compacted thickness. Compact each lift to the required density.

f) Complete mixing, compaction and finishing on the same day.

g) Water may be lightly sprayed with a pressurized distributor for surface finishing.

h) Leave the surface of the compacted subgrade slightly higher than required elevation; then trim to design crown and grade. Leave finished surface even and free of depressions, humps or loose material.

i) Material should not be frozen at the time of stabilization.

.3 Field Quality Control

a) Check finished surface of stabilized subgrade to ensure it meets the following tolerances:

b) Grade:

i) 6 mm maximum variation above design elevation.

ii) 25 mm maximum variation below design elevation.

c) When Tolerance Exceeded

i) Trim high spots and re-work entire structure to within tolerance.

ii) Add approved mixed material to low areas, scarify and blend to full subgrade depth, re-compact to required density and refinish surface. Alternatively, fill low areas with extra thickness of subsequent sub-base or base course.

iii) If a density test result is less than the required density, that test result is discarded and 3 retests shall be performed on the area represented by the failed test. The average of the 3 retests shall represent the density of that area. If this average is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and re-compacted to the required density. If the area is not retested but is reworked and re-compacted the area shall be tested at normal testing frequencies.

iv) The Contractor shall assume the risk of uncovering and reworking the subgrade if it is covered before the City has accepted test results thereof.

.4 Protection of Finished Work

a) Do not permit vehicular traffic over the stabilized subgrade.

b) If subgrade floods, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches. This shall be done at the expense of the Contractor.

c) Maintain protection of stabilized subgrade until subsequent sub-base or base course is placed. Repair and retest as required by the engineer if damaged.

.5 Reconstruction

a) Break up and pulverize rejected stabilized subgrade into no larger than 25 mm pieces. Spread the pulverized material for addition of cement.

b) Add cement as follows:

i) For a section reprocessed within 24 hours and 48 hours of the original construction, add 50% of the original cement content.

ii) For a section reprocessed more than 48 hours following the original construction, add 100% of the original cement content.

iii) Process the new mixture using pulverization equipment.

4.3.2.2.7 Proof Rolling

.1 Content

a) This section includes the verification of the stability and uniformity of the subgrade compaction. This procedure shall be performed in the presence of the Engineer or it’s designate. Actual requirements for representation on the project site for the proof rolling operation will be site dependent.

.2 Equipment

a) The vehicle used to perform the Proof rolling shall conform to the following:

b) Tandem axle, dual wheel dump truck.

c) Tire pressure shall be no less than 90 percent of the manufacturer’s recommended maximum inflation.

d) The minimum gross weight of the loaded truck shall be 24,800 kg. A weigh scale slip shall be available upon request to confirm the truck weight.

.3 Procedure

a) The proof rolling vehicle shall be operated at a rate not to exceed 3.0 to 6.0 km/hr. or a comfortable walking pace. Adjust the speed to allow the Inspector/Engineer to measure any deflections and/or areas of rutting.

b) Operate the proof roll in a pattern so that all areas are loaded with at least one pass of the Proof rolling vehicle.

c) After proof rolling, check the subgrade for conformance to the plans, and correct all surface irregularities. Re-shape the subgrade to specified tolerances.

.4 Evaluation

a) There shall not be any discernable rutting during the proof roll. Rutting exceeding 100 mm shall be considered a failure and will require the subgrade to be reworked and compacted.

b) There shall not be any discernable deflection (pumping) of the subgrade during the proof roll. Deflections exceeding 100 mm shall be considered a failure, and will require the subgrade be reworked and compacted.

c) Rutting and/or deflections in excess of 100 mm must be reviewed by a Geotechnical Engineer who is to provide recommendations as to how to meet density and performance requirements.

d) When remedial work is performed, a final proof roll must be performed upon completion of the work. If remedial work is performed, a second proof roll may be required at the discretion of the Engineer or his designate.

4.3.2.2.8 Plant Mix Soil Cement

.1 Preparation

a) Have the prepared or stabilized subgrade, or the prepared subbase, inspected by the City before placing soil cement.

b) Repair imperfections to the prepared subgrade or subbase and clean the surface f debris and loose material.

c) Moisten the subgrade or the subbase surface without creating mud or ponding water, to minimize absorption of water from deposited soil cement mix.

.2 Placing Mixture

a) Transport the soil cement mixture to the site in trucks with protective covers in place until discharge, to minimize evaporation.

b) Do not place the soil cement mixture when the subgrade or subbase is frozen, or when the ambient air temperature is likely to drop below 2^{o}C within 24 hours. Protect the soil cement from freezing for at least 7 days after placement.

c) Deposit the mixture within one hour after plant mixing and immediately spread the mixture in sufficient depth to achieve the designated cross-section and thickness when compacted. Do not dump the mixture into piles or windrows.

d) Limit the time interval between adjacent spreads to not more than 30 minutes. If the time interval is exceeded, form a construction joint.

.3 Compaction and Finishing

a) Begin compaction within one hour of plant mixing and complete finishing within 2 hours of plant mixing.

b) Keep the surface moist at not less than optimum moisture content during compaction, finishing and until the surface seal is applied.

c) Compact mixture in one lift to the required density. Spread and compact the mixture in two lifts if the designated thickness is greater than 200 mm.

d) Finish the compacted surface to be smooth and dense, free of compaction planes, cracks, ridges, equipment imprints, segregation or loose material and to the correct grade and cross-section.

e) Smoothness and Grade: Check the finished surface with a 3 m straightedge and against survey stakes to ensure that surface and grade tolerances are met. Rework deficient areas. Filling low spots with a thin application of the soil cement mixture is not permitted.

f) Apply curing seal to the surface after finishing.

g) Construction Joint: Place a construction joint between adjacent spreads more than 30 minutes apart and at the end of a day's work. Trim the compacted mixture to a clean vertical edge along a straight line perpendicular to the centerline of the road or along a straight line between parallel spreads.

.4 Field Quality Control

a) Surface Tolerance: 12 mm maximum variation under 3 m straightedge.

b) Grade Tolerance: 6 mm maximum variation above designated elevation and 15 mm maximum variation below designated elevation.

c) Where surface and grade tolerances are exceeded:

d) Grind down excessively high areas without destroying the surface, provided specified thickness is met.

e) Compensate low areas with extra thickness of subsequent paving course. This will be done at the expense of the Contractor.

f) Deficient Thickness: If the average core thickness is deficient, that area of soil cement will be assessed a pay factor according to Table 4.3.43.

Table 4.3.43: Soil Cement Thickness Pay Factors

THICKNESS DEFICIENCY (mm)	PAY FACTOR (% of Contract Price)
15	100.0
16	97.8
17	95.3
18	92.3
19	88.8
20	84.8
21	80.0
22	74.5
23	68.0
24	60.0
25	50.0
>25	Remove and replace or reconstruct

g) Excess Thickness: Soil cement with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

.5 Soil Cement Density

a) Deficient Density: If the average density is less than the required density, that area of soil cement will be assessed a pay factor according to Table 4.3.44.

Table 4.3.44: Soil Cement Density Pay Factors (100% Compaction Requirement)

AVERAGE PERCENT (Of Maximum Density)	PAY FACTOR (% of Contract Price)
99.0	100.0
98.8	99.8
98.6	99.4
98.4	98.8
98.2	97.9
98.0	96.8
97.8	95.5
97.6	94.0
97.4	92.2
97.2	90.1
97.0	87.8
96.8	95.3
96.6	82.5
96.4	79.5
96.2	76.2
96.0	72.7
95.8	68.9
95.6	64.7
95.4	60.2
95.2	55.3
95.0	50.0
<95.0	Remove and replace or reconstruct

Table 4.3.45: Soil Cement Density Pay Factors (95% Compaction Requirement

AVERAGE PERCENT (Of Maximum Density)	PAY FACTOR (% of Contract Price)
95.0	100.0
94.8	95.5
94.6	90.0
94.4	85.5
94.2	80.0
93.0	75.5
93.8	70.0
93.6	65.5
93.4	60.0
93.2	55.5
93.0	50.0
<92.0	40.0

b) The Contractor shall assume the risk of uncovering and replacing the soil cement if it is covered before the City has accepted the test results.

c) Deficient Strength: If strength test results are less than 3.0 MPa, the Contractor will be required to perform immediate corrective measures. In addition, if the average strength of any 3 consecutive cylinders is below 2.0 MPa, payment for soil cement in place represented by the 3 cylinders will be reduced to 50%.

.6 Reconstruction

a) Break up and pulverize rejected soil cement into no larger than 25 mm pieces. Spread the pulverized material for addition of cement.

b) Add cement as follows:

i) For a section reprocessed within 24 hours of the original construction, add 50% of the original cement content.

ii) For a section reprocessed between 24 and 48 hours following the original construction, add 75% of the original cement content.

iii) For a section reprocessed more than 48 hours following the original construction, add 100% of the original cement content.

c) Process the new mixture using pulverization

.7 Subsequent Paving

a) If paving of the finished soil cement does not begin within 24 hours after placement then paving must not begin until the soil cement has cured for a minimum of 7 days.

b) If the road is required for traffic before paving, cover the surface with sand and open the road to traffic not earlier than 72 hours after soil cement placement. When ready to pave, remove the sand, repair any damage, clean the soil cement surface and apply prime coat.

4.3.2.2.9 Geotextile

.1 **Placement**

a) Unless otherwise directed in the applicable specification, the placement of geotextile shall be in accordance with the following:

b) The surface to receive the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, debris, and soft or low density pockets of material. The geotextile fabric shall be installed free from tensile stresses, folds, wrinkles, or creases.

c) If more than one width of geotextile fabric is used, the Contractor shall either overlap the joints by a minimum of 400 mm with no stitching, or overlap the joint by 200 mm and provide two rows of stitching at each joint.

d) The geotextile fabric shall be protected all times during construction. Wheeled or tracked vehicles shall not be allowed to travel directly on the geotextile fabric. Any geotextile fabric damaged during installation or during placement of granular material shall be replaced by the Contractor at his own expense.

4.3.2.2.10 Granular Base Course and Granular Sub-Base (32 11 00)

.1 Preparation

a) The prepared subgrade shall be inspected by the City before placing the granular course.

b) On existing gravel roads or lanes, clean the surface of clay lumps, vegetation and other deleterious material. To assess the condition of subgrade and depth of gravel, make exploratory cuts along the third points of the road width, or along the centreline of the alley. After assessment, regrade and compact the gravel to prevent ponding water.

.2 New Granular Base or Sub-Base Course

a) Deposit aggregate and spread uniformly in lifts not exceeding 150 mm thickness when compacted.

b) Segregation: If segregation occurs:

i) In Class 20 aggregate: blade the lift and mix thoroughly before final spreading and shaping to crown and grade.

ii) In Class 63 or Class 80 aggregate: remove and replace the segregated material.

.3 Existing Gravel on Suitable Subgrade

a) If subgrade is found to be acceptable by the City and is on designated grade and if there is sufficient depth of gravel, scarify the existing gravel to 75 mm depth and pulverize material to no larger than 50 mm pieces. Remove rocks larger than 75 mm.

b) If there is insufficient depth of gravel and subgrade is on grade, scarify to 50 mm depth, remove rocks larger than 75 mm, pulverize to no larger than 50 mm pieces, add the designated class of imported aggregate and mix thoroughly with existing gravel.

c) Spread and shape to crown and grade in lifts not exceeding 150 mm when compacted.

.4 Existing Gravel on Subgrade to be Reworked

a) If subgrade is found to be unsuitable or not on designated grade, windrow existing gravel to one half of the road or lane and rework the exposed subgrade as required.

b) When directed by the Engineer, excavate and remove unsuitable subgrade soil and backfill with approved material to Section 4.3.2.1.7 - Aggregate.

c) Prepare 150 mm subgrade to Section 4.3.2.2.5 - Subgrade Preparation or Section 4.3.2.2.6 - Cement Stabilized Subgrade.

d) If subgrade is found to be too low, scarify and blend with approved imported fill and compact in 150 mm lifts to Section 4.3.2.2.5 - Subgrade Preparation or Section 4.3.2.2.6 - Cement Stabilized Subgrade.

e) If subgrade is found to be too high, remove excess soil, scarify to 150 mm depth and compact to Section 4.3.2.2.5 - Subgrade Preparation or Section 4.3.2.2.6 - Cement Stabilized Subgrade.

f) Repeat i-iv on the other half of the road or alley.

g) After reworking the subgrade, prepare gravel for compaction.

.5 Compaction

a) Bring the moisture content of the aggregate to near optimum and have the compaction tested within 24 hour of concrete or asphalt placement.

b) **Non-compliance**: If a density test result is less than the required density, that test result is discarded and 3 retests shall be performed on the area represented by the failed test. The average of the 3 retests shall represent the density of that area. If this average is less than the required density, the area shall be reworked to the full depth of the lift; the aggregate moisture content altered as necessary and re-compacted to the required density. If the area is not retested but is reworked and re-compacted the area shall be tested as per normal testing frequencies.

c) The Contractor shall assume the risk of uncovering and reworking the granular base if it is covered before the City has accepted test results thereof.

.6 Field Quality Control

a) Check finished surface of granular base to ensure that it meets the following tolerances:

i) Surface Tolerance: 15 mm maximum variation under 3 m straightedge.

ii) Grade Tolerance: 6 mm maximum variation above designated elevation and 15 mm maximum variation below designated elevation.

iii) When Tolerance Exceeded

1. Trim high spots and refinish surface to within tolerance.
2. Add approved aggregate to low areas, scarify, blend, re-spread and re-compact to required density and refinish surface. Alternatively, compensate low areas with extra thickness of subsequent granular base course.

.7 Subsequent Paving Course

a) Do not permit vehicular traffic on the compacted granular base before paving.

b) If the granular base floods, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches.

c) Repair any damage, including freezing, to the granular base course and retest for density before paving or concrete pour.

4.3.2.2.11 Full Depth Reclaimed Base Course

.1 Preparation

a) Roadway areas to be reclaimed will be indicated on plans or designated by the Engineer.

b) Ensure that any conflicts with underground utilities in the zone of reclamation are resolved prior to pulverization.

.2 Pulverization

a) Pulverize the existing roadway structure into fragments no larger than 25 mm maximum dimension, exclusive of existing aggregate.

b) Ensure that the reclaimed base course mixture is homogeneous and well graded using additional passes of the reclaimer/stabilizer if required.

.3 Addition of Stabilizing Admixtures

a) Add stabilizing admixtures to the reclaimed base course as shown on the Drawings or as directed by the Engineer.

i) Cement: to Section 4.3.2.2.6 – Cement Stabilized Subgrade

ii) Liquid chemical or bituminous stabilizers: as defined in the contract Special Provisions.

b) Ensure that the stabilizing admixtures are uniformly distributed and mixed with the pulverized material.

.4 Grading and Compaction

a) To Section 4.2 – Grading and Section 4.3.2.2.10 – Granular Base Courses.

b) Leave the surface of the compacted reclaimed base course slightly higher than the required elevation; then trim to the design crown and grade. Leave the finished surface even and free of depressions, humps or loose material.

.5 Field Quality Control

a) Check the finished surface of the reclaimed base course to ensure it meets the following tolerances:

i) Grade: 6 mm maximum variation above design elevation.

ii) 25 mm maximum variation below design elevation.

b) When Tolerance Exceeded

i) Trim high areas and refinish surface to within tolerance.

ii) Add reclaimed base material or approved granular material to low areas, scarify and blend to full reclamation depth, re-compact to required density, and refinish surface.

c) Density Tests: If a density test result is less than the required density, that test result is discarded and 3 retests shall be performed on the area represented by the failed test. The average of the 3 retests shall represent the density of that area. If this average is less than the required density, the area shall be reworked to the full depth of the lift; the aggregate moisture content altered as necessary and recompacted to the required density. If the area is not retested but is reworked and re-compacted the area shall be tested at normal testing frequencies.

.6 Protection of Finished Work

a) Do not permit vehicular traffic over the reclaimed base course until permitted by the Engineer.

b) If the reclaimed base course floods, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches.

c) Maintain protection of the reclaimed base course until paved with hot-mix asphalt concrete. Repair base course if damaged.

4.3.2.2.12 SGC Hot-Mix Asphalt Concrete

.1 Production of Mix

a) Good Practice Guide

i) Refer to the publication TB-1 “Hot Mix Asphalt Materials, Mixture Design and Construction” as prepared by the National Center for Asphalt Technology (NCAT) and published by the National Asphalt Pavement Association (NAPA), for guidance in good practices of handling materials and SGC hot-mix production insofar as consistent with this Section.

b) Production Rate

i) Produce SGC hot-mix at a rate compatible with the rate of placement and compaction on the project.

c) Aggregate in Stockpile

i) Stockpile aggregate in horizontal lifts. Stacking conveyors are not allowed for stockpiling. Draw aggregate from stockpile in a manner that mixes the full depth of stockpile face.

ii) When it is necessary to blend aggregates from one or more sources to produce the combined gradation, stockpile each source or size of aggregate individually. Do not blend aggregates in a stockpile.

iii) If one or more of the SGC hot-mix properties are not met, the City will order suspension of mix production until the Contractor has demonstrated to the City’s satisfaction that corrective measures have been taken to produce a mix that meets the requirements of this Section.

Table 4.3.46: Specifications for Premium Grade Asphalt Cements

TEST CHARACTERISTICS	A.S.T.M. TEST METHOD	Premium Grades of Asphalt Cements					
		150-200 (A)			200-300 (A))		
Absolute Viscosity, 60°C, Pa - s	D2171	The viscosity and penetration values must fall within the area bounded by A-B-C-D-A plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:			The viscosity and penetration values must fall within the area bounded by C-D-E-F-C plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:		
Penetration, 25°C, 100g, 5s, dmm	D5	Pt.	Abs. Visc.	Pen.	Pt.	Abs. Visc.	Pen.
		A	155	150	C	50	200
		B	70	150	D	92	200
		C	50	200	E	45	300
		D	92	200	F	26.5	300
Kinematic Viscosity, 135°C, sq. mm/s	D2170	The viscosity and penetration values must fall within the area bounded by A-B-C-D-A plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:			The viscosity and penetration values must fall within the area bounded by C-D-E-F-C plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:		
Penetration, 25°C, 100g, 5s, dmm	D5	Pt.	Kin. Visc.	Pen.	Pt.	Kin. Visc.	Pen.
		A	360	150	C	205	200
		B	225	150	D	285	200
		C	205	200	E	205	300
		D	285	200	F	150	300
Flash Point, Cleveland Open Cup, °C minimum	D92	205			175		
Solubility in Trichlorethelene, % minimum	D2042	99.5			99.5		
Tests on Residue from Thin Film Oven Test: **Ratio of Absolute Viscosity of Residue from Thin-Film Oven Test to Original Absolute Viscosity, maximum:**	D1754 D2171	4.0			4.0		
Ductility, 25°C, cm, maximum	D113	100			-		
Ductility, 15.6°C, cm, minimum		-			100		

Table 4.3.46: AASHTO M320 Table 2

Performance	PG 46			PG 52							PG 58					PG 64					
	34	40	46	10	16	22	28	34	40	46	16	22	28	34	40	10	16	22	28	34	40
Average 7-day max pavement design temperature, °C[a]	<46			<52							< 58					<64					
Min pavement design temperature, °C[a]	>-34	>-40	>-46	>-10	>-16	>-22	>-28	>-34	>-40	>-46	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-40
Original Binder																					
Flash point temp, T48, min °C[a]	230																				
Viscosity, T 316:[b] Max 3 Pa•sm test temp, °C	135																				
Dynamic shear, T315:[c] G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	46			52							58					64					
Rolling Thin-Film Oven Residue (T 240)																					
Mass change, [e] max, percent	1.00																				
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	46			52							58					64					
Pressurized Aging Vessel Residue (R 28)																					
PAV again temperature, °C[f]	90			90							100					100					
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16
Critical low cracking temp, R49. [g] Critical cracking temp determined by R 49, test temp, °C	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30

Notes:

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R35.

b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

c. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G/sinδ at test temperatures where the asphalt is a Newtonian fluid.*

d. G/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.*

e. The mass change shall be less than 1.00 percent for either a positive (mass gain) or negative (mass loss) change.

f. The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally, the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or needed for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG70-xx, or 110°C when used in climates requiring PG 76-xx and above.

g. For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C ant T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.

Table 4.3.47: AASHTO M320 Table 2 (continued)

Performance	PG 70						PG 76					PG 82				
	10	16	22	28	34	40	10	16	22	28	34	10	16	22	28	34
Average 7-day max pavement design temperature, °C[a]	<70						<76					<82				
Min pavement design temperature, °C[a]	>-10	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-10	>-16	>-22	>-28	>-34
Original Binder																
Flash point temp, T48, min °C[a]	230															
Viscosity, T 316:[b] Max 3 Pa•sm test temp, °C	135															
Dynamic shear, T315:[c] G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	70						76					82				
Rolling Thin-Film Oven Residue (T 240)																
Mass change, [e] max, percent	1.00															
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	70						76					82				
Pressurized Aging Vessel Residue (R 28)																
PAV again temperature, °C[f]	100 (110)						100 (110)					100 (110)				
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	34	31	28	25	22	19	37	34	31	28	25	40	37	34	31	28
Critical low cracking temp, R49. [g] Critical cracking temp determined by R 49, test temp, °C	0	-6	-12	-18	-25	-30	0	-6	-12	-18	-24	0	-6	-12	-18	-24

Notes:

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R35.

b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

c. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G/sinδ at test temperatures where the asphalt is a Newtonian fluid.*

d. G/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.*

e. The mass change shall be less than 1.00 percent for either a positive (mass gain) or negative (mass loss) change.

f. The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally, the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or needed for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG70-xx, or 110°C when used in climates requiring PG 76-xx and above.

g. For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C ant T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.

.2 Method for Determining Film Thickness

B1 Surface Area Factors (Sa):

Sieve Size (μm)	Surface Area Factor (m²/kg)
5000	0.38
2500	0.78
1250	1.55
630	2.90
315	5.60
160	12.20
80	29.00

Determine total surface area as the sum of the surface areas for the seven specified sieve sizes according to the formula:

$$S_a = 0.38 + \frac{\Sigma\,(\%\ \text{Passing x Surface Area Factor})}{100}$$

B2 Corrected Sa (Sac):

Correct Sa for actual Aggregate Bulk Specific Gravity by the formula:

Sac = Sa x (2.650/Actual Bulk Specific Gravity)

B3 Film Thickness (Ft) Calculation:

Ft = 10 x (Pac - Pabs) / Sac x SGac in microns (mm)

Where Pac = Percent Asphalt Cement Content by dry mass of Aggregate

Pabs = Percent of Absorbed Asphalt Cement by dry mass of Aggregate

Sac = Corrected Sa

SGac = Specific Gravity Asphalt Cement

4.3.2.2.13 Stone Mastic Asphalt Concrete

.1 Production of Mix

a) Good Practice Guide

b) Refer to the Quality Improvement Series 122 “Designing and Constructing SMA Mixtures – State of the Art Practice” as published by The National Asphalt Pavement Association (NAPA), for guidance in good practices of handling materials and hotmix production insofar as consistent with this Section.

c) Production Rate

d) Produce hot-mix at a rate compatible with the rate of placement and compaction on the job.

.2 Aggregate in Stockpile

a) Stockpile aggregate in horizontal lifts. Stacking conveyors are not allowed for stockpiling. Draw aggregate from stockpile in a manner that mixes the full depth of stockpile face.

b) When it is necessary to blend aggregates from one or more sources to produce the combined gradation, stockpile each source or size of aggregate individually. Do not blend aggregates in a stockpile.

c) If one or more of the mix properties are not met, the Engineer will order suspension of mix production until the Contractor has demonstrated to the Engineer's satisfaction that corrective measures have been taken to produce a mix that meets the requirements of this section.

4.3.2.2.14 SGC Hot-Mix Asphalt Paving

.1 Good Paving Practice

a) Production, Placement, Compaction and Quality Assurance of the SGC hot-mix mix should be pursuant to the requirements of TB-1 “Hot Mix Asphalt Materials, Mixture

Design and Construction" as prepared by the National Centre for Asphalt Technology (NCAT) and published by the National Asphalt Pavement Association (NAPA), for guidance in good practices of handling materials and hot-mix production insofar as consistent with this Section.

b) Refer to the latest edition of the "Construction of Hot Mix Asphalt Pavements", Asphalt Institute Manual Series No. 22 (MS-22), for guidance in good paving practice insofar as consistent with this Section.

c) Provide an experienced foreman who shall be in full time attendance on the paving site to take charge of the entire paving operation from transporting of the mix to final rolling.

.2 Preparation

a) The Engineer will inspect the existing pavement, base, or subbase before SGC hotmix paving. The Contractor shall repair imperfections and clean up as directed by the Engineer. Surface shall be true to line and grade within tolerance, firm, dry, and free of loose and deleterious material.

b) For new construction or as directed by the Engineer all Catch basins, manholes, water valves, and other fixtures shall be brought to proper grade before final lift paving. Provide temporary protection where necessary until completion of paving. If catch basins, manholes, water valves, and other fixtures are not raised prior to final lift paving as required and are required to be raised subsequent to final lift paving a $2,000.00 penalty per occurrence, as documented by the Engineer, will be assessed.

c) Multiple Lift Paving

i) Apply tack coat to the previous lift before placing a lift, unless permitted otherwise by the Engineer. Clean the exposed surface before tacking.

ii) Preparation for Overlay or for Succeeding Stage Paving

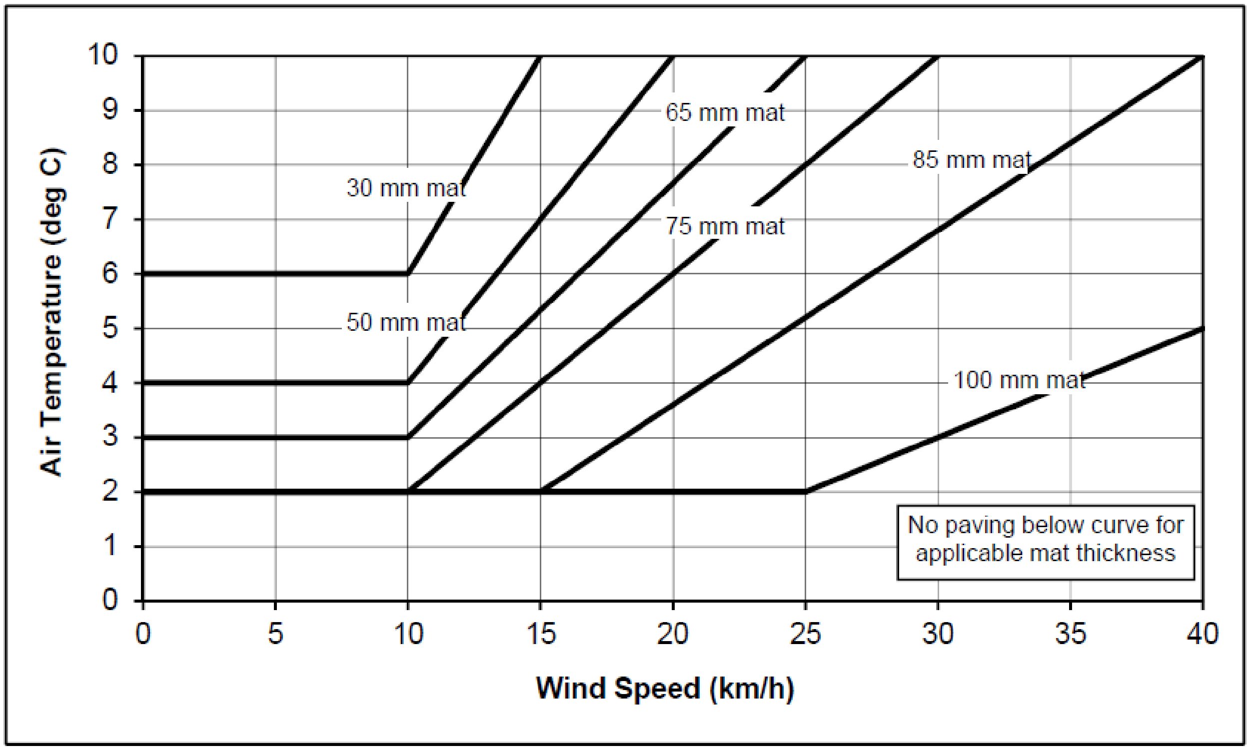
1. Sweeping and Cleaning: Sweep the existing pavement surface with an approved mechanical sweeper. Remove all residual debris and accumulations of deleterious material.
2. Surface Milling: If specified, grind the existing surface to specified depth according to Section 4.3.2.2.17 – Pavement Cold Milling
3. Tack Coat: When the existing surface has passed inspection by the Engineer, apply tack coat to Section 4.3.2.2.18 - Liquid Asphalt Coats.
4. Apply tack coat to surfaces intended to be in contact with SGC hot-mix, including the sides of gutters, catch basins, manholes, and other concrete and metal fixtures. Before placing SGC hot-mix, let tack coat completely cure and have tacked surfaces inspected by the Engineer
5. Asphalt Levelling Course: The Engineer will designate those areas having 20 mm or greater depressions for levelling course application. Spread the levelling course of SGC hot-mix with a paver one lift at a time, not exceeding 60 mm compacted thickness, and compact to required density.

.3 Weather Limitations

a) No paving is permitted when rain or snow is imminent, or when the surface or base to be paved is wet, icy, snow-covered, or frozen, unless waived by the Engineer.

b) No paving is permitted when air temperature and wind speed conditions are below the applicable mat curve in Chart 4.3.1, unless waived by the Engineer.

Chart 4.3.1: Air Temperature and Wind Limitations on Paving



.4 Transportation of SGC Hot-Mix

a) Transport the SGC hot-mix in approved trucks with protective covers properly secured to the sides and back of truck box so that no funnelling air movement develops under the cover during hauling.

b) Before loading with SGC hot-mix, thoroughly clean the box of any accumulation of asphaltic material. Lubricate inside surfaces with a light coating of soap, detergent solution or an approved release agent. Petroleum derivatives are not permitted.

c) Maintain trucks clean of mud and other material that could contaminate the paving area.

d) Discharge SGC hot-mix into the paver hopper without spilling and without the truck box bearing down on the hopper.

e) If the unit for payment is tonnes, no payment will be made for SGC hot-mix tonnage unless the Engineer is provided with a copy of the corresponding asphalt mix load ticket immediately upon arrival at the site.

.5 Spreading

a) Placing the SGC hot-mix shall be a continuous operation with the paver moving at a uniform speed compatible with the rate of compaction rolling and SGC hot-mix mix delivery.

b) Spreading of Mix

i) Ensure that mix compaction temperature meets the asphalt cement manufacturer's requirements, as measured in the mat, immediately behind the paver.

ii) Spread the SGC hot-mix uniformly in one or more lifts, or as directed by the Engineer, to depths sufficient to obtain a minimum compacted thickness of 30 mm for 10mm–LT and 10mm–HT mixes and 45 mm for 20mm-B mixes and a maximum compacted thickness of 75 mm for 10mm–LT and 10mm–HT mixes and 100 mm for 20mm-B mixes.

iii) Excess SGC hot-mix is to be wasted. Do not pick up any SGC hot-mix materials that has been placed through a paver and put back into the paver hopper. Placing of any excess paver laid SGC hot-mix back into the paver hopper will be assessed a $500.00 penalty per occurrence, as documented by the Engineer.

c) Segregation

i) If segregation of mix material occurs, the Engineer will immediately suspend spreading until the cause is determined and corrected.

ii) Prior to roller compaction, remove fat spots, sandy accumulations, high and low spots, and other irregularities and repair with SGC hot-mix. Scratch surface with rake tines to ensure bonding of added mix. Do not spread loose SGC hot-mix that has been raked off onto the mat.

.6 Hand Spreading

a) Hand spread SGC hot-mix in small areas not accessible to paver, and where permitted by the Engineer.

b) Do not broadcast SGC hot-mix. Hand place mix carefully to avoid the segregation of coarse and fine aggregate. Use lutes and rakes to thoroughly loosen and uniformly distribute the SGC hot-mix. Remove lumps that do not break down readily.

c) Heat hand tools to prevent asphalt sticking. Do not overheat tools to prevent damaging of the SGC hot-mix.

d) Before rolling, check surface with template or straightedge, and correct irregularities.

.7 Compaction

a) Compact the SGC hot-mix mat with rollers in good working order and operated by competent operators. Use the number, type, and mass of rollers required to obtain the required compaction within the available compaction time and compatible with the rate of SGC hot-mix placement.

b) Develop and follow the best pattern of rolling to obtain the uniform compaction across the mat including joints and edges without degrading the aggregate through over compaction. Indicate the rolling pattern to the Engineer when requested.

c) Perform compaction rolling with rollers following the paver as closely as possible, until required density is obtained. Perform finish rolling to eliminate equipment marks and to create a surface with a uniform tightly knit texture.

d) Complete final rolling before the mat surface temperature reaches 40°C as determined with an infrared thermometer. If a second lift of asphalt is required the surface temperature of the first lift should be no more than 30oC at the time of placement of the second lift.

e) For small areas inaccessible to rollers, use an approved vibratory plate compactor or hand tamper to thoroughly compact the SGC hot-mix.

f) If compaction or finish rolling difficulties occur, suspend paving operations, redesign the mix and obtain Engineer's approval of a trial batch before resuming paving.

.8 Joints

a) Transverse Joint

i) Plan length of spread to provide for a minimum 1 m offset of transverse joints in successive lifts and adjacent mats.

ii) Transverse joints shall be straight, have a vertical face painted with tack coat before placement of the adjacent mat, be thoroughly compacted, and meet surface tolerances.

.9 Longitudinal Joint

a) Location: Plan mat limits to ensure that surface longitudinal joints will be offset not more than 150 mm from the centre of a proposed pavement marking line between travel lanes. If permitted by the Engineer, the joint may be located at the centre of a travel lane.

b) Plan width of spread to provide for a minimum 150 mm offset (in a dovetail pattern) of longitudinal joints in successive lifts.

c) Create a longitudinal joint while the temperature at the edge of the first of two adjacent mats is above 80°C. Allow an overlap of 25 to 50 mm between mats. This may be accomplished by multiple pavers in staggered formation, or by limiting paver advance.

d) Do not roll the 150 mm wide strip along edge of first mat until the adjacent mat is placed. Roll the joined mat immediately to insure bonding while the mix at the joint is about 80°C.

e) If a hot longitudinal joint as described in above cannot be created, then carefully roll the edge of the first mat, form or cut a clean vertical face 150 mm back from the mat edge and to the full depth of the mat, and paint with tack coat before placing the adjacent mat.

f) Should the longitudinal joint treatment indicated in above not be performed where required, the area of asphalt pavement will be assessed a pay factor of 95 percent.

This pay factor will be applied to the price of the total quantity of asphalt placed in the mat area

g) The finished longitudinal joint shall be thoroughly compacted and shall meet surface tolerances.

.10 Mix Production and Paving Tolerances

a) Aggregate Gradation Tolerance

i) The variation from the approved job-mix aggregate gradation shall not exceed the following limits:

Table 4.3.48: Aggregate Gradation Tolerance

Sieve Size (µm)	% Passing by Mass	
	Individual Sample	Average of Last 3 Samples
20 000	± 2.0	± 1.0
16 000	± 3.0	± 1.0
12 500	± 4.0	± 2.0
10 000	± 5.0	± 3.0
8 000	± 4.0	± 3.0
6 300	± 4.0	± 3.0
5 000	± 3.0	± 3.0
1 250	± 3.0	± 2.5
630	± 3.0	± 2.0
315	± 3.0	± 2.0
160	-3.0 to +1.0	-2.0 to +1.0
80	-2.5 to +1.0	-1.0 to +0.5

b) **Asphalt Content Field Mix Tolerance:** Allowable variation from approved design asphalt content shall be ±0.3 percent by mass of mix.

c) Tolerance for Air Voids in Field Mix:

Table 4.3.49: Tolerance for Air Voids in Field Mix

Mix Type:	10mm - HT	10mm - LT	20mm - B
Air Voids, %:	4.0 ± 0.5	3.0 ± 0.5	3.5 ± 0.5

d) Minimum Film Thickness in Field Mix:

Table 4.3.50: Minimum Film Thickness in Field Mix

Mix Type:	10mm - HT	10mm - LT	20mm - B
Min Film Thickness, µm:	7.5 min.	7.5 min.	6.5 min.

e) Voids Filled in field Mix:

Table 4.3.51: Voids in Field Mix

Mix Type:	10mm - HT	10mm - LT	20mm - B
Voids Filled, %:	70 - 80	73 - 85	65 - 75

f) Mixing Temperature Tolerance:

i) The allowable variation from the design mixing temperature shall be ± 10°C.

g) Mixture Handling Tolerance:

i) In accordance with Section 4.3.2.2.14; $500.00 penalty per documented occurrence.

h) Smoothness Tolerances:

i) Maximum variation under 3 m straightedge as follows:

1. Longitudinal (in the direction of travel): 3 mm.
2. Transverse (across the direction of travel): 6 mm. (straight crossfall)

i) **Grade:** ±6 mm maximum variation from designated grade elevations.

j) **Texture:** Finished surface shall be free of visible signs of poor workmanship such as, but not limited to:

i) Segregation, as demonstrated through sandy spots or excessively open spots (areas of water bleeding from the mat),

ii) Areas exhibiting excess or insufficient asphalt cement, as demonstrate through fat spots or open textured spots,

iii) Improper matching of longitudinal and transverse joints,

iv) Dimpling, roller marks, cracking, or tearing.

1. If surface and grade tolerances are exceeded, or if surface texture is not met, grind down and resurface defective areas as directed by the Engineer.

k) Thickness Tolerance:

i) **Deficient Thickness**: If average core thickness is deficient that area of asphalt pavement will be assessed a pay factor according to Table 6.3.5 to be applied to the price of the quantity of SGC hot-mix in that mat area.

ii) **Excess Thickness:** Asphalt pavement with excess thickness may be accepted with no extra payment, if surface and grade tolerances and texture are met.

Table 4.3.52: Asphalt Thickness Pay Factors

THICKNESS DEFICIENCY (%)	PAY FACTOR (%)
10.0	100.0
11.0	97.0
12.0	93.7
13.0	90.0
14.0	85.5
15.0	80.5
16.0	75.0
17.0	68.0
18.0	60.0
19.0	50.0
Over 19.0 %	Grind and Resurface

l) Density Tolerance

i) **Required Density:** Each mat of hot-mix placed shall be compacted to the following minimum density (Percent of Maximum Theoretical Density (MTD)) for the type of paving, or as indicated in the contract Special Provisions.

Table 4.3.53: Density Requirements

Minimum Density	Type of Paving
94%	All stages in staged paving for freeways, arterials, industrial/commercial roadways and residential collector roadways, and residential local roadways including FAC Overlays
94%	Paving on FDR locations where 10mm-HT is utilized
93%	Alley paving.
93%	Paving on FDR locations where 10mm-LT is utilized
93%	Rehabilitation overlay(mill and overlay locations)
93%	Asphalt walk/bikeway.

m) **Deficient Density:** If the average core density is below specified, the represented area of mat may be accepted subject to a pay factor according to Table 4.3.54 to be applied to the price of the quantity of SGC hot-mix in that mat area.

Table 4.3.54: Asphalt Density Pay Factors

Percentage of MTD 94% MTD Required	Pay Factor (%)	Percentage of MTD 93% MTD Required	Pay Factor (%)
94.0	100.0	93.0	100.0
93.9	99.9	92.9	98.4
93.8	99.8	92.8	96.8
93.7	99.6	92.7	95.2
93.6	99.4	92.6	93.9
93.5	99.1	92.5	92.0
93.4	98.7	92.4	90.4
93.3	98.3	92.3	88.8
93.2	97.8	92.2	87.3
93.1	97.2	92.1	85.7
93.0	96.5	92.0	84.1
92.9	95.8	91.9	82.5
92.8	95.0	91.8	80.9
92.7	94.2	91.7	79.3
92.6	93.3	91.6	77.7
92.5	92.3	Less than 91.5	Grind and Resurface
92.4	91.1		
92.3	89.8		
92.2	88.5		
92.1	87.1		
92.0	85.5		
91.9	83.8		
91.8	82.0		
91.7	80.0		
91.6	77.7		
Less than 91.5	Grind and Resurface		

n) APA Tolerance (Where Required)

i) **Maximum APA rutting:** If average core APA rutting is above 5.0 mm for 10mm-HT and 20mm–B and 7.0 mm for 10mm-LT, that area of asphalt pavement will be assessed a pay factor according to Table 4.3.55 to be applied to the price of the quantity of SGC hotmix in that mat area.

Table 4.3.55: APA Rutting Pay Factors

10mm - HT & 20mm - B, APA RUTTING MEASUREMENT (mm)	10 mm - LT, APA RUTTING MEASUREMENT (mm)	PAY FACTOR (%)
5.0	7.0	100.0
5.2	7.2	95.0
5.4	7.4	90.0
5.6	7.6	85.0
5.8	7.8	80.0
6.0	8.0	75.0
6.2	8.2	70.0
6.4	8.4	65.0
6.6	8.6	60.0
6.8	8.8	55.0
Over 7.0 mm	Over 9.0 mm	Grind and Resurface

o) Asphalt Cement Content Tolerance

i) The allowable variation from the approved design asphalt content shall be ± 0.30 Percent by mass of mix.

ii) Deficient Asphalt Cement Content: If the asphalt cement content, as determined by the City indicates low or high asphalt cement content, the represented area of mat may be accepted subject to a pay factor according to Table 4.3.56 and is to be applied to the unit price of the 250 tonnes or equivalent area of hot-mix in the mat.

Table 4.3.56: Asphalt Cement Content Pay Factor

ESS Asphalt Cement Content (%)	PAY FACTOR (%)
± 0.00 – 0.30	100.0
± 0.31 - 0.35	94.0
± 0.36 – 0.40	90.0
± 0.41 – 0.45	86.0
± 0.46 – 0.50	78.0
± 0.51	Grind and Resurface

p) Asphalt Cement Content Appeal Mechanism (Capital Projects)

i) In the event of a Deficient Asphalt Cement Content result the following Asphalt Cement Content Appeal Mechanism will be allowed by the City of St.Albert:

1. The original core location shall be confirmed by the City;

2. The City will then re-core for determination of asphalt cement content. The recoring (which may require multiple cores to obtain the required quantity of materials for a re-test) will be taken from the mat representing the original test within 10 meters on either side of the original test location. Only a single test is required for verification process. All core holes to be filled with hot-mix asphalt, by the Contractor, to the satisfaction of the Engineer.
3. The asphalt cement content test result from the re-core will supersede the original QA result.
4. If the asphalt cement content of the re-core is within the penalty range the penalty will be calculated in accordance with Table 4.3.56 Asphalt Cement Pay Factors for the quantity of asphalt represented by the test. No further re-coring is allowed.
5. If the asphalt cement content of the re-core is in the “remove and replace” range, additional cores will be taken at equal distances on either side of the original core and tested for asphalt cement content. This process is to be repeated until locations on either side of the re-core identify asphalt within specification. The spacing is at the discretion of the contractor.
6. Once the area of asphalt to be removed and replaced” is identified, the area inclusive of the last core used to delineate the deficient area shall be removed and replaced to the satisfaction of the Engineer.

q) Asphalt Cement Content Appeal Mechanism (Development):

i) In the event of a Deficient Asphalt Cement Content result the following Asphalt Cement Content Appeal Mechanism will be allowed by the City of St. Albert and shall be paid for by the Contractor:

1. The original core location shall be confirmed by Engineer, the Quality Assurance agency and the City Inspector;
2. The Contractor will then be allowed to re-core for determination of asphalt cement content. The re-coring (which may require multiple cores to obtain the required quantity of materials for a re-test) will be taken from the mat representing the original test within 10 meters on either side of the original test location. Only a single test is required for verification process. All core holes to be filled with hot-mix asphalt, by the contractor, to the satisfaction of the Engineer.
3. The asphalt cement content test result from the re-core, along with the original test result, shall be submitted to the City of St. Albert for review. The result from the asphalt cement content test from the re-core will supersede the original QA result.
4. If the asphalt cement content of the re-core is within the penalty range the penalty will be calculated in accordance with Table 4.3.56 Asphalt Cement Pay Factors for the quantity of asphalt represented by the test. No further re-coring is allowed.

5. If the asphalt cement content of the re-core is in the “remove and replace” range, additional cores will be taken at equal distances on either side of the original core and tested for asphalt cement content. This process is to be repeated until locations on either side of the re-core identify asphalt within specification. The spacing is at the discretion of the contractor.
6. Once the area of asphalt to be removed and replaced” is identified, the area inclusive of the last core used to delineate the deficient area shall be removed and replaced to the satisfaction of the Engineer.

r) TSR Tolerance

i) Deficient TSR (Capitol Program): If the TSR result, as determined by the City, of field samples is below 80.0 percent (for laboratory prepared samples of field mix), the following actions will be taken by the City:

1. First occurrence; the contractor will receive a warning letter from the the City indicating the deficient TSR value.
2. Second consecutive occurrence; In the event of a second consecutive low TSR value below 80.0 percent the contractor will have their production suspended until it can provide acceptable TSR test results to the City. During this period of time the Contractor and the City Engineer will meet to determine the impact of the noncompliance, and specify the necessary remedial action to be taken by the Contractor. Remedial action shall be either acceptance, acceptance at a pay adjustment as detailed in the following Table 5.3.57, or removal and replacement at no cost to the City. If suspended, the paving program shall only continue upon approval by the City.

Table 5.3.57: TSR Pay Factors

Percentage of TSR	Pay Factor (%)
80.0 or higher	100.0
78.0 to 79.9	99.0
76.0 to 77.9	97.0
74.0 to 75.9	95.0
72.0 to 73.9	92.0
70.0 to 71.9	89.0
68.0 to 69.9	85.0
66.0 to 67.9	81.0
64.0 to 65.9	76.0
62.0 to 63.9	71.0
60.0 to 61.9	65.0
Less than 59.9	Grind and resurface

s) Cleanup

i) Leave site clean and free of debris and surplus materials.

ii) Opening to Traffic: Open new SGC hot-mix pavement to traffic when the surface has cooled to ambient temperature or when authorized by the Engineer. Remove barricades and signs when no longer needed.

4.3.2.2.15 Stone Mastic Asphalt Paving

.1 Good Paving Practice

a) Production, Placement, Compaction and Quality Assurance of the SMA mix should be pursuant to the requirements of Chapter Three “Construction Procedures” as outlined in National Asphalt Paving Association’s QIP-122 booklet entitled “Designing and Constructing SMA Mixtures, State-of the Practice”.

b) Refer to the latest edition of the “*Construction of Hot Mix Asphalt Pavements”*, Asphalt Institute Manual Series No. 22 (MS-22), for guidance in good paving practice insofar as consistent with this Section.

c) Provide an experienced foreman who shall be in full time attendance on the paving site to take charge of the entire paving operation from transporting of the mix to final rolling.

d) **Test Strips and JMF Adjustment.** Do not begin full production of the SMA until receiving authorization from the Engineer. This authorization will be based on the successful construction of one or more test strips. Test strips will consist of 100 - 150 tons of SMA produced and placed in accordance with these specifications. No further SMA production will occur that day unless another test strip is needed. A test strip will consist of a full roadway width and be consistent with the contractor’s proposed laydown procedure. Test strips are incidental to the pay item. During the construction of a test strip, perform 1 set of quality control tests as described above and obtain and test 3 random cores of the compacted pavement. Within 1 working day after a test strip is completed, the Engineer, the Quality Control Laboratory and the Contractor will determine if any changes in the SMA JMF, production, or placement procedures are needed. If there is a redesign of the JMF another test strip may be required. The Quality Control Laboratory will notify the Engineer of any JMF adjustments. Do not start production until notified by the Engineer.

.2 Preparation

a) The Engineer will inspect the existing pavement, base or subbase before SMA paving. The Contractor shall repair imperfections and clean up as directed by the Engineer. Surface shall be true to line and grade within tolerance, firm, dry and free of loose and deleterious material.

b) Catch basins, manholes, water valves, and other fixtures shall be brought to proper grade before the final lift. Provide temporary protection where necessary until completion of paving.

c) Multiple Lift Paving

d) Apply tack coat to the previous lift before placing a lift, unless permitted otherwise by the Engineer. Clean surface before tacking.

e) Preparation for Overlay or for Succeeding Stage Paving

i) **Sweeping and Cleaning:** Sweep the existing pavement surface with an approved mechanical sweeper. Remove all residual debris and accumulations of deleterious material.

ii) **Surface Milling:** If specified, grind the existing surface to specified depth according to Section 4.3.2.2.17 - Pavement Cold Milling

iii) **Tack Coat:** When the existing surface has passed inspection by the Engineer, apply tack coat to Section 4.3.2.2.18 - Liquid Asphalt Coats.

iv) Apply tack coat to surfaces intended to be in contact with SMA, including the sides of gutters, catch basins, manholes, and other concrete and metal fixtures. Before placing SMA, let tack coat completely cure and have tacked surfaces inspected by the Engineer

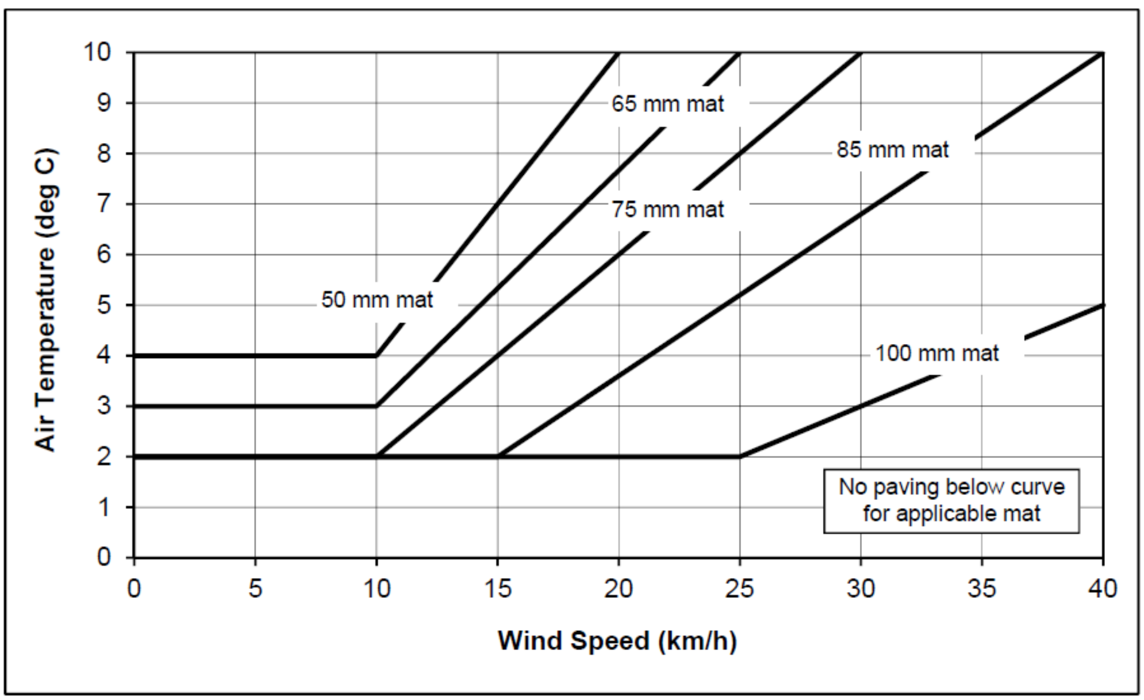
v) Asphalt Levelling Course: The Engineer will designate those areas having 25 mm or greater depressions for levelling course application. Spread the levelling course of SMA with a paver one lift at a time, not exceeding 75 mm compacted thickness, and compact to required density.

.3 Weather Limitations

a) No paving is permitted when rain or snow is imminent, or when the surface or base to be paved is wet, icy, snow-covered or frozen, unless waived by the Engineer.

b) No paving is permitted when air temperature and wind speed conditions are below the applicable mat curve in Chart 4.3.2, unless waived by the Engineer.

Chart 4.3.2: Air Temperature and Wind Limitations on Paving



.4 Transportation of SMA

a) Transport the SMA in approved trucks with protective covers properly secured to the sides and back of truck box so that no funneling air movement develops under the cover during hauling.

b) Before loading with SMA, thoroughly clean the box of any accumulation of asphaltic material. Lubricate inside surfaces with a light coating of soap or detergent solution. Petroleum derivatives are not permitted.

c) Maintain trucks clean of mud and other material that could contaminate the paving area.

d) Discharge SMA into the paver hopper without spilling and without the truck box bearing down on the hopper.

e) If the unit for payment is tonnes, no payment will be made for SMA tonnage unless the Engineer is provided with a copy of the corresponding asphalt mix load ticket immediately upon arrival at the site.

.5 Spreading

a) Placing the SMA shall be a continuous operation with the paver moving at a uniform speed compatible with the rate of compaction rolling and SMA mix delivery.

b) Spreading Temperature of Mix

i) Ensure that mix temperature meets the PMA binder manufacturer’s requirements.

c) Segregation

i) If segregation of mix material occurs, the Engineer will immediately suspend spreading until the cause is determined and corrected.

ii) Prior to roller compaction, remove fat spots, sandy accumulations, high and low spots, and other irregularities and repair with SMA. Scratch surface with rake tynes to ensure bonding of added mix. Do not spread loose SMA that has been raked off onto the mat.

.6 Hand Spreading

a) Hand spread SMA in small areas not accessible to paver, and where permitted by the Engineer.

b) Do not broadcast SMA. Hand place carefully to avoid segregation of coarse and fine aggregate. Use lutes and rakes to thoroughly loosen and uniformly distribute the SMA. Remove lumps that do not break down readily.

c) Heat hand tools to prevent asphalt sticking. Do not overheat tools to prevent damaging of the SMA.

d) Before rolling, check surface with template or straightedge, and correct irregularities.

.7 Compaction

a) Compact the asphalt mat with rollers in good working order and operated by competent operators. Use the number, type and mass of rollers required to obtain the required compaction within the available compaction time and compatible with the rate of hotmix placement.

b) Develop and follow the best pattern of rolling to obtain the most uniform compaction across the mat including joints and edges without degrading the aggregate through over compaction. Indicate the rolling pattern to the Engineer when requested.

c) Perform compaction rolling with rollers following the paver as closely as possible, until required density is obtained. Perform finish rolling to eliminate equipment marks and to create a surface with a uniform tightly knit texture.

d) Complete final rolling before the mat temperature reaches 90°C.

e) For small areas inaccessible to rollers, use an approved vibratory plate compactor or hand tamper to thoroughly compact the SMA.

f) If compaction or finish rolling difficulties occur, suspend paving operations, redesign the mix and obtain Engineer's approval of a trial batch before resuming paving.

.8 Joints

a) Transverse Joint

i) Plan length of spread to provide for a minimum 1 m offset of transverse joints in successive lifts and adjacent mats.

ii) Transverse joints shall be straight, have a vertical face painted with tack coat before placement of the adjacent mat, be thoroughly compacted, and meet surface tolerances.

b) Longitudinal Joint

i) Location: Plan mat limits to ensure that surface longitudinal joints will be offset not more than 150 mm from the centre of a proposed pavement marking line between travel lanes. If permitted by the Engineer, the joint may be located at the centre of a travel lane.

ii) Plan width of spread to provide for a minimum 150 mm offset (in a dovetail pattern) of longitudinal joints in successive lifts.

iii) Create a longitudinal joint while the temperature at the edge of the first of two adjacent mats is above 100 C. Allow an overlap of 25 to 50 mm between mats. This may be accomplished by multiple pavers in staggered formation, or by limiting paver advance. Allow an overlap of 25 to 50 mm between mats

iv) Do not roll the narrow strip along edge of first mat until the adjacent mat is placed. Roll the joined mat immediately to insure bonding while the mix is still hot.

v) If a hot longitudinal joint as described cannot be created, then carefully roll the edge of the first mat, form or cut a clean vertical face to full depth of the mat, and paint with tack coat before placing the adjacent mat.

vi) The finished longitudinal joint shall be thoroughly compacted and shall meet surface tolerances.

.9 Field Quality Control

a) Smoothness Tolerances

b) Maximum variation under 3 m straightedge as follows:

i) Longitudinal (in the direction of travel): 3 mm.

ii) Transverse (across the direction of travel): 6 mm

iii) (straight crossfall)

c) Grade: ±6 mm maximum variation from designated grade elevations.

d) **Texture:** Finished surface shall be free of visible signs of poor workmanship such as, but not limited to:

i) Segregation, as demonstrated through sandy spots or excessively open spots (areas of water bleeding from the mat),

ii) Areas exhibiting excess or insufficient PMA Binder, as demonstrate through Fat spots.

iii) Improper matching of longitudinal and transverse joints,

iv) Dimpling, roller marks, cracking, or tearing.

v) If surface and grade tolerances are exceeded, or if surface texture is not met, grind down and resurface defective areas as directed by the Engineer.

e) Thickness Tolerance:

i) Deficient Thickness: If average core thickness is deficient that area of asphalt pavement will be assessed a pay factor according to Table 4.3.58 to be applied to the price of the quantity of SMA in that mat area.

ii) Excess Thickness: Asphalt pavement with excess thickness may be accepted with no extra payment, if surface and grade tolerances and texture are met.

Table 4.3.58: Asphalt Thickness Pay Factors

THICKNESS DEFICIENCY (%)	PAY FACTOR (%)
10.0	100.0
11.0	97.0
12.0	93.7
13.0	90.0
14.0	85.5
15.0	80.5
16.0	75.0
17.0	68.0
18.0	60.0
19.0	50.0
Over 19.0 %	Grind and resurface

f) Density Tolerance

i) Required Density: Each mat of SMA placed shall be compacted to 94% of MTD.

ii) Deficient Density: If the average core density is below specified, the represented area of mat may be accepted subject to a pay factor according to Table 4.3.59 to be applied to the price of the quantity of SMA in that mat area.

Table 4.3.59: Asphalt Density Pay Factors

Percentage of MTD	Pay Factor (%)
94.0	100.0
93.9	99.9
93.8	99.8
93.7	99.6
93.6	99.4
93.5	99.1
93.4	98.7
93.3	98.3
93.2	97.8
93.1	97.2
93.0	96.5
92.9	95.8
92.8	95.0
92.7	94.2
92.6	93.3
92.5	92.3
92.4	91.1
92.3	89.8
92.2	88.5
92.1	87.1
92.0	85.5
91.9	83.8
91.8	82.0
91.7	80.0
91.6	77.7
Less than 91.5	REJECT

g) APA Tolerance

i) Maximum APA rutting: If average core APA rutting is above 5.0mm that area of asphalt pavement will be assessed a pay factor according to Table 4.3.60 to be applied to the price of the quantity of SMA in that mat area.

Table 4.3.60: Asphalt APA Rutting Pay Factors

APA RUTTING MEASUREMENT (mm)	PAY FACTOR (%)
5.0	100.0
5.2	95.0
5.4	90.0
5.6	85.0
5.8	80.0
6.0	75.0
6.2	70.0
6.4	65.0
6.6	60.0
6.8	55.0
Over 7.0 mm	Grind and resurface

h) Asphalt Cement Content Tolerance

i) Deficient Asphalt Cement Content: If the asphalt cement content as determined by the Quality Assurance agency indicates low or high asphalt cement content, the represented area of mat may be accepted subject to a pay factor according to Table 4.3.61 to be applied to the unit price of the 250 tonnes or equivalent area of hot-mix in the mat.

Table 4.3.61: Asphalt Cement Pay Factors

Quality Assurance Asphalt Cement Content (%)	PAY FACTOR (%)
± 0.0 – 0.20	100.0
± 0.21 - 0.25	98.0
± 0.26 – 0.30	94.0
± 0.31 - 0.35	90.0
± 0.36 – 0.40	86.0
± 0.41 – 0.45	82.0
± 0.46 – 0.50	78.0
± 0.51	Reject

.10 Cleanup

a) Leave site clean and free of debris and surplus materials.

b) Opening to Traffic: Open new pavement to traffic when the surface has cooled to ambient temperature and when authorized by the Engineer. Remove barricades and signs when no longer needed.

4.3.2.2.16 Paving Brick on Sand Bed

.1 Preparation

a) Construct concrete base to Section 4.3.3.1.1 – Cement Concrete and 4.3.3.1.3 – Concrete for Roadways with the following modified tolerances:

i) Smoothness: 8 mm maximum variation under 3 m straightedge.

ii) Grade: 0 mm maximum variation above designated elevation.

iii) 8 mm maximum variation below designated elevation.

b) The concrete base shall be inspected by the City before placing bedding sand. Repair imperfections and clean surface of debris and loose material. Do not use bedding sand for corrective levelling.

c) Edge Restraint: Install as detailed on drawings.

d) Weed Barrier: Install as detailed on drawings.

e) Insulation: Install as detailed on drawings.

.2 Sand Bedding

a) Bedding sand shall have a uniform moisture content of 6% to 8% by mass when spread.

b) Spread sand uniformly and screed lightly to achieve a uniform thickness of 30 ±8 mm after placement and tamping of paving brick.

c) Alternatively, spread sand in a loose lift of sufficient thickness to achieve 2/3 of the required thickness and lightly tamp with one pass of a plate vibrator. Then spread and screed the remaining lift of loose sand onto which the paving brick can be laid.

d) Once screeded, the sand shall not be disturbed. If screeded sand is disturbed or exposed to rain or dew, it shall be removed or loosened, re-spread and re-screed.

e) Place no more sand than will be covered with paving brick on the same day.

.3 Laying Paving Brick

a) Lay paving brick on sand bed in the specified pattern, leaving joint spaces no wider than 3 mm.

b) Arrange brick to maximize the use of full bricks and to minimize the use of slivers. Fill edge gaps with units cut with a masonry saw.

c) Use planks for foot and wheelbarrow traffic to prevent disturbance of units prior to tamping.

d) Tamp brick with a flat plate vibrator shortly after laying to bring surface to correct grade, eliminate lipping between adjacent units and consolidate sand bedding. Remove and replace damaged brick.

e) Tamp all brick laid in a day's work except brick within 1 m of laying edge.

f) Brush and vibrate joint sand to completely fill joints between units. Sweep and remove excess sand and leave finished surface clean.

g) Check finished surface to ensure surface and grade tolerances are met.

.4 Field Quality Control

a) Surface Tolerance:

i) 6 mm maximum variation under 3 m straightedge.

ii) 2 mm maximum differential level between adjacent units and between units and edge restraint.

b) Grade Tolerance:

i) 6 mm maximum variation above designated elevation.

ii) 0 mm maximum variation below designated elevation.

.5 Protection and Cleanup

a) Do not open newly installed paving brick to pedestrian or vehicle traffic until directed by the Engineer.

b) Before opening to traffic, ensure that surface is clean and free of surplus material or debris.

4.3.2.2.17 Pavement Cold Milling

.1 Traffic Safety

a) Provide signed advance warning of cold milled areas opened to traffic before paving, as follows:

i) **'Bump'** - all transverse milled edges and edges at exposed utility structures.

ii) **'Uneven Pavement'** - all longitudinal milled edges, and edges within pedestrian crosswalk areas.

b) Ramp vertical edges created by milling operations according to the following tables.

c) Material used in ramping must be approved by the Engineer and must be maintained until removal prior to paving.

Table 4.3.61: Transverse Edges

Depth of Milling (mm)	Speed Limit (km/h)	Length of Ramp (mm)	Location of Ramp
0 - 50	< 60	600	At end of milled area (up ramp)
0 - 50	≥ 60	1200	At end of milled area (up ramp)
> 50	< 60	600 600	At start of milled area (down ramp) At end of milled area (up ramp)
> 50	≥ 60	600 1200	At start of milled area (down ramp) At end of milled area (up ramp)

Table 4.3.62: Localized Edges - Manholes, Vault Covers, Valves, Etc

Depth of Milling (mm)	Speed Limit (km/h)	Length of Ramp (mm)	Location of ramp
< 25	all speeds	N/A	Paint all edges in fluorescent colour
25 or greater	all speeds	600	At all edges of milled area

Table 4.3.63: Patch Milled Edges

Length of Milled Area (m)	Speed Limit (km/h)	Length of Ramp (mm)	Location of Ramp
0 - 15	< 60	600 600	At start of milled area (down ramp) At end of milled area (up ramp)
0 - 15	≥ 60	600 1200	At start of milled area (down ramp) At end of milled area (up ramp)

.2 Preparation

a) Sweep the pavement surface with a mechanical sweeper to remove debris and dirt

b) accumulations.

c) Remove any standing water from the pavement surface.

.3 Milling

a) Mill to depth and/or gradeline as determined by the Engineer.

b) Mill pavement to expose vertical surface of gutter face, manhole frames, water valves, survey monuments, power, telephone, or water vaults, or any other structures within milling area for the full required depth of milling.

c) Load millings into haul vehicles and transport to the Contractor's chosen location.

d) Minimize use of water during milling.

.4 Cleanup

a) Leave milled areas clean to the satisfaction of the City upon the completion of milling.

b) Immediately remove and dispose of any spilled millings on milled areas and on haul routes.

4.3.2.2.18 Liquid Asphalt Coats

.1 Common Requirements

a) Prepare surface to be coated to the applicable Section. Have the surface inspected by the City before coating.

b) Protect adjoining curb, gutter, walk, slabs, barrier, poles and other surfaces not intended for coating, from splattering or overspray. Remove any splattering stains.

c) Do not apply liquid asphalt when the weather is foggy, rainy, windy, or when the air temperature is below 2□C, unless otherwise permitted by the Engineer.

d) Spray liquid asphalt to a uniform coat. Do not spray excessively to create ponding.Hand spray areas missed by or inaccessible to the distributor.

.2 Prime Coat

a) Apply prime coat while the soil cement surface is still moist.

b) Do not allow traffic on prime coat within 6 hours of application or until the prime coat has cured.

.3 Tack Coat

a) Do not apply tack coat unless the surface is dry and free of dust and other material that could reduce the bond.

b) Apply tack coat only to an area that can be paved in the next 24 hours.

c) Minimize construction traffic on the cured tack coat. Reapply the tack coat if damaged by traffic.

Table 4.3.64: Specifications for Medium Curing Asphalt

ASPHALT GRADE REQUIREMENTS	ASTM TEST	MC-30	
		Min	Max
Flash Point, Open Tag, °C	D-1310	38	-
Kinematic Viscosity at 60°C, mm^2/s	D-2170	30	60
Distillation Test:	D-402		
% by volume of total distillate to 360°C			
- 190°C		-	-
- 225°C		-	25
- 260°C		40	70
- 315°C		75	93
Residue from distillation to 360°C			
Volume % by difference		50	-
Tests on Residue from Distillation:			
Penetration at 25°C, 100 g, 5 s, dmm	D-5	120	250
Ductility at 25°C, cm	D-113	100	-
Solubility in Trichloroethylene, % by mass	D-2042	99.5	-
Water, % by mass or volume	D-95	-	0.2
Delivery Temperature, °C		35	55

Note: If the ductility at 25□C is <100 cm, the material will be acceptable if the ductility at 15□C is >100 cm

General Requirements: The asphalt shall not foam when heated to the application temperature range. The asphalt shall be produced by the refining of petroleum and shall be uniform in character

Table 4.3.65: Specifications for Anionic Emulsified Asphalt

ASPHALT GRADE REQUIREMENTS	ASTM TEST	SS-1		SS-1H		MS-1	
		Min	Max	Min	Max	Min	Max
Viscosity at 25°C, SF s	D-88	20	60	20	60	20	100
Residue by Distillation, % by mass	D-244	55	-	55	-	55	-
Settlement in 5 days, % difference by mass	D-244	-	5	-	5	-	5
Storage Stability Test, 24 hour, % by mass	D-244	-	1	-	1	-	1.5
Retained on No. 1000 sieve, % by mass	D-244	-	0.10	-	0.10	-	0.10
Cement Mixing Test, % by mass	D-244	-	2.0	-	2.0	-	2.0
Tests on Residue from Distillation:							
Penetration at 25°C, 100 g, 5 s, dmm	D-5	100	200	40	100	100	200
Ductility at 25°C and 5 cm/minute, cm	D-113	60	-	60	-	40	-
Solubility in Trichloroethylene, % by mass	D-2042	97.5	-	97.5	-	97.5	-
Delivery Temperature, °C		40	70	40	70	40	70

Notes: *The upper limit on % residue is governed by the consistency limits.*
The test for settlement may be waived when the emulsified asphalt is used in less than 5 days.
The 24 hour storage test may be used in place of the 5 day settlement test. However, in case of dispute the 5 daystorage settlement test shall govern.
CAN/CGSB-8.2-M Sieves, woven wire, metric shall be used for the sieve test.
General Requirements: *All tests shall be performed within 15 days of the date of delivery.*
The asphalt shall be uniform in character and shall have a refined petroleum base.

4.3.2.2.19 Full Depth Reclamation Using Foamed Asphalt

.1 Preparation

a) Roadway areas to be reclaimed will be indicated on plans or designated by the Engineer.

b) Ensure that any conflicts with underground utilities in the zone of reclamation are resolved prior to pulverization.

c) The Contractor is responsible for clearing all foreign matter from the entire roadway width, including any adjacent lanes or shoulders that are not to be recycled.

d) The contractor is responsible for the removal of all standing water.

.2 Unsuitable Weather Conditions

a) **Wet Weather:** No full depth foam reclamation work shall be performed during wet conditions, nor started without completing before wet conditions set in.

b) **Cold Weather:** No full depth foam reclamation work shall be performed if the ambient pulverized roadway material temperature is below 0_0C other than finishing and compaction operations.

c) **Windy Weather:** Spreading of cementitious stabilizing agents on the roadway ahead of the recycling machine will not be allowed when windy conditions adversely affect the operations.

d) Time Limitations:

i) The maximum time period between mixing the recycled material with a stabilizing agent and compacting the placed material shall be determined by the type of stabilizing agent applied. Where combinations of two or more different stabilizing agents are used, the stabilizing agent that predominates shall dictate the time limitation. Where Cement is added in conjunction with a bituminous stabilizing agent at an application rate of less than 2 percent, the time limit of the bituminous stabilizing agent shall apply. The maximum time periods shall be as follows:

Table 4.3.66: Time Limitations

Stabilizing Agent	Time Limit
GU Cement	3 Hours
Bitumen Emulsion	Before the emulsion breaks
Foamed Bitumen	24 Hours if kept moist

.3 Production Plan

a) Prior to beginning with the recycling work each day, the Contractor shall prepare a production plan detailing proposals for the forthcoming day's work. The production plan shall contain the following information:

b) A sketch showing the overall layout of the length and width of roadway intended for recycling during the day, broken into the number of parallel cuts required to achieve the stated width, and the overlap dimensions at each joint between cuts;

c) The sequence and length of each cut to be recycled before starting on the adjacent or following cut;

d) An estimate of the time required for pulverizing, mixing and compacting the cut. The sketch shall also show the time when completion of each is expected;

e) The proposed water addition for each cut;

f) The quantity and location where aggregate base is to be imported;

g) The amount and type of stabilizing agent, or agents, to be applied to each cut;

h) The proposed quality control testing program; and

i) Any other information that is relevant for the intended work.

.4 Pulverization

a) Pulverize the existing roadway structure into fragments no larger than 25mm maximum dimension, exclusive of existing aggregate. The forward speed of the recycling machine, rotation rate of the recycling drum, and the positioning of the gradation control beam shall be set to break down the in-situ material to an acceptable grading.

b) The Contractor shall take all necessary steps to ensure that the grading of the recycled material conforms to the requirements specified in "Test Sections" of these specifications.

c) In the event that the roadway is pre-pulverized, shaped and recompacted prior to the addition of stabilizing admixtures. The pre-pulverized material shall be compacted to the satisfaction of the Engineer to allow use of the roadway prior to further processing.

.5 Addition of Water and Stabilizing Admixtures

a) Add stabilizing admixtures to the reclaimed base course as specified or as directed by the Engineer.

b) **Cement:** as detailed in Section 4.3.2.2.19 Cementitious Stabilizing Asphalt of these Specifications.

c) **Bituminous stabilizers:** as detailed in Section 4.3.2.2.19 – Bituminous Stabilizing Agent of these Specifications.

d) Ensure that the stabilizing admixtures are uniformly distributed and mixed with the pulverized material. The microprocessor control system for the addition of water and foamed bitumen shall be set and carefully monitored to meet the required compaction moisture and stabilizer content. Bulk bitumen tankers shall be dipped at the end of each cut in order to determine actual usage against the calculated theoretical demand.

.6 Overlap of Longitudinal Joints

a) Premark cut lines on the road surface designating the width of each cut in a section of the roadway.

b) To ensure complete recycling across the full width of the roadway, longitudinal joints between successive cuts shall overlap a minimum of 150mm.

c) Pre-marked cut lines on the road surface shall be checked to ensure that the width of the first cut is equal to that of the milling drum and that the width of all successive cuts shall be narrower than the drum width by at least 150mm. The milling/Recycling machine shall be steered so as to accurately follow the pre-marked lines. Any deviation in excess of 50mm shall be rectified immediately by reversing to where the deviation commenced and reprocessing along the correct line, without the addition of any further water or stabilizing agent.

d) The overlap width shall be confirmed before starting each new cut sequence and any adjustments made to ensure that the amount of water and fluid stabilizing agents to be added is reduced proportionately by the width of the overlap.

.7 Continuity of Stabilized Layer

a) The Contractor shall ensure that there is no gap of unrecycled material created between successive cuts (along the same longitudinal cut line), nor any untreated wedges created by the entry of the milling drum into existing material by:

b) Carefully marking the exact location at which each cut terminates, this mark shall coincide with the position of the center of the pulverizing drum at the point at which the supply of stabilizing agent ceased.

c) Start the next successive cut at least 0.5m behind this mark to ensure continuity.

.8 Subgrade Instability

a) Where subgrade instability is encountered during the recycling process, the subgrade shall be:

b) Excavated and removed to a depth of 600mm; and

c) Replaced and backfilled with 3-20A granular base placed in lifts not exceeding 150mm when compacted and followed by successive layers until the level of the existing roadway is reached.

.9 Grading and Compaction

a) To Section 4.2 – Grading and Section 4.3.2.1.5 – Granular Base Courses.

b) Leave the surface of the compacted recycled material slightly higher than the required elevation; then trim to the design crown and grade. Leave the finished surface even and free of depressions, humps or loose material.

c) Rolling shall commence as soon as it is practical, and follow the predetermined sequence specified in “Test Sections” of these specifications.

.10 Watering, Finishing, and Curing

a) After compaction the roadway surface shall be treated with a light application of water, and rolled with pneumatic-tired rollers to create a close-knit texture. The finished layer shall be free from:

b) Surface Laminations;

c) Segregation of fine and course aggregate;

d) Corrugations or any other defects that may adversely affect the performance of the layer.

e) Tack coat shall not be applied until the moisture content of the recycled layer is at least 2 percent below the as placed moisture content.

.11 Test Sections

a) At the start of the project the contractor shall assemble all items of plant and equipment for the recycling operations and process a section of the roadway to:

b) Demonstrate that the equipment and processes and produce recycled layers to meet the requirements specified in these provisions;

c) Determine the effect on the grading of the recycled material by varying the forward speed of the recycling machine and the rotation of the pulverizing drum;

d) Determine the sequence and manner of rolling necessary to obtain the minimum compaction requirements.

e) The test section shall be at least 100m in length of a full lane-width.

f) If the test section fails or if modifications are made to the methods, processes, equipment, and materials, additional test sections shall be performed in accordance with the requirements listed above before further work can be performed.

.12 Field Quality Control

a) Check the finished surface of the reclaimed base course to ensure it meets the following tolerances:

i) Grade: 6 mm maximum variation above design elevation.

ii) 6 mm maximum variation below design elevation.

b) When Tolerance Exceeded:

i) Trim high areas and refinish surface to within tolerance.

ii) Add recycled material to low areas, scarify and blend to full reclamation depth, recompact to required density, and refinish surface.

iii) **Density Tests:** If a density test result is less than the required density, the initial test result is discarded and three retests shall be performed on the area represented by the failed test. The average of the three retests shall represent the density of that area. If this average is less than the required density, the area shall be reworked to the full depth of the lift; the moisture content altered as necessary and recompacted to the required density. If the area is not retested but is reworked and re-compacted the area shall be tested at normal testing frequencies.

.13 Protection of Finished Work

a) Do not permit vehicular traffic over the recycled material until permitted by the Engineer.

b) If the recycled material floods, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches.

c) Maintain protection of the recycled material until paved with hot-mix asphalt concrete. Repair recycled material if damaged.

Table 4.3.67: Specifications for Premium Grade Asphalt Cements

TEST CHARACTERISTICS	A.S.T.M. TEST METHOD	Premium Grades of Asphalt Cements					
		150-200 (A)			200-300 (A))		
Absolute Viscosity, 60°C, Pa - s	D2171	The viscosity and penetration values must fall within the area bounded by A-B-C-D-A plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:			The viscosity and penetration values must fall within the area bounded by C-D-E-F-C plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:		
Penetration, 25°C, 100g, 5s, dmm	D5	Pt.	Abs. Visc.	Pen.	Pt.	Abs. Visc.	Pen.
		A	155	150	C	50	200
		B	70	150	D	92	200
		C	50	200	E	45	300
		D	92	200	F	26.5	300
Kinematic Viscosity, 135°C, sq. mm/s	D2170	The viscosity and penetration values must fall within the area bounded by A-B-C-D-A plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:			The viscosity and penetration values must fall within the area bounded by C-D-E-F-C plotted as straight lines on a full logarithmic plot (log-log), with the co-ordinates of the points as follows:		
Penetration, 25°C, 100g, 5s, dmm	D5	Pt.	Kin. Visc.	Pen.	Pt.	Kin. Visc.	Pen.
		A	360	150	C	205	200
		B	225	150	D	285	200
		C	205	200	E	205	300
		D	285	200	F	150	300
Flash Point, Cleveland Open Cup, °C minimum	D92	205			175		
Solubility in Trichlorethelene, % minimum	D2042	99.5			99.5		
Tests on Residue from Thin Film Oven Test: Ratio of Absolute Viscosity of Residue from Thin-Film Oven Test to Original Absolute Viscosity, maximum:	D1754 D2171	4.0			4.0		
Ductility, 25°C, cm, maximum	D113	100			-		
Ductility, 15.6°C, cm, minimum		-			100		

General Requirement:
The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 175C.
The temperature at delivery to the site shall be between 170C and 190C.

Chart 4.3.3: Specifications for Asphalt Cement Absolute Viscosity

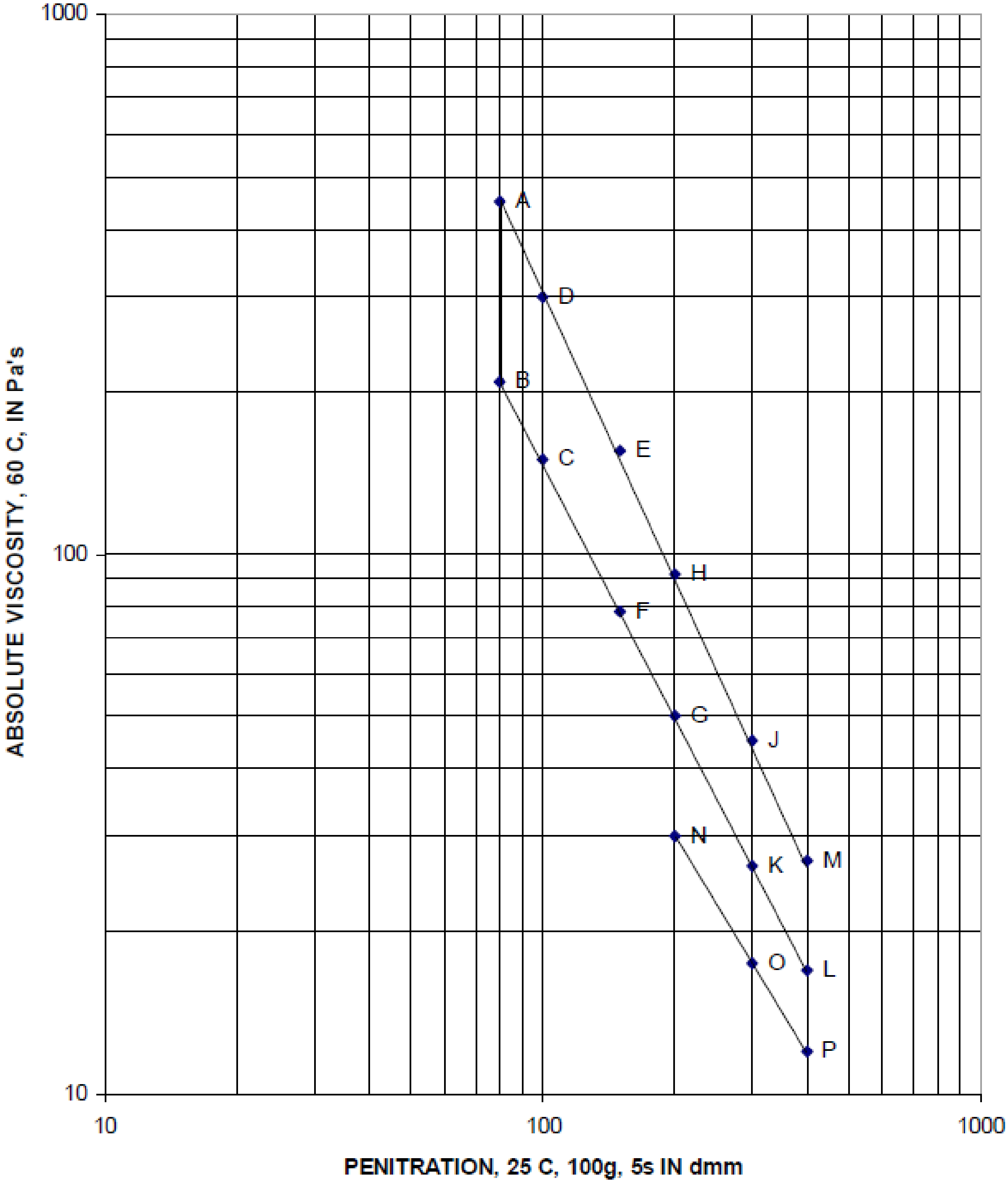


Chart 4.3.4: Specifications for Asphalt Cement Absolute Viscosity

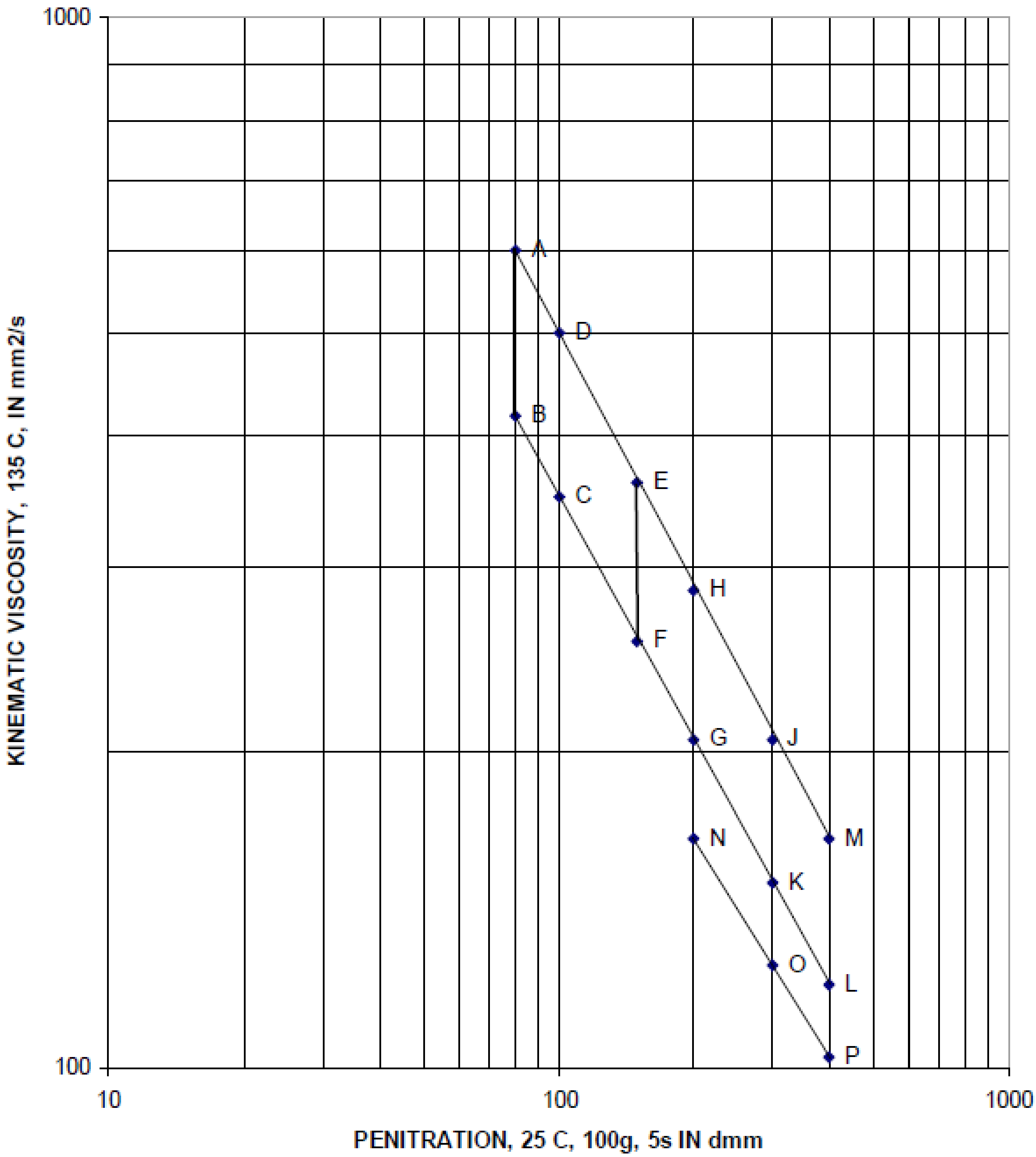


Table 4.3.68: AASHTO M320 Table 2

Performance	PG 46			PG 52							PG 58					PG 64					
	34	40	46	10	16	22	28	34	40	46	16	22	28	34	40	10	16	22	28	34	40
Average 7-day max pavement design temperature, °C[a]	<46			<52							< 58					<64					
Min pavement design temperature, °C[a]	>-34	>-40	>-46	>-10	>-16	>-22	>-28	>-34	>-40	>-46	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-40
Original Binder																					
Flash point temp, T48, min °C[a]	230																				
Viscosity, T 316:[b] Max 3 Pa•sm test temp, °C	135																				
Dynamic shear, T315:[c] G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	46			52							58					64					
Rolling Thin-Film Oven Residue (T 240)																					
Mass change, [e] max, percent	1.00																				
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	46			52							58					64					
Pressurized Aging Vessel Residue (R 28)																					
PAV again temperature, °C[f]	90			90							100					100					
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16
Critical low cracking temp, R49, [g] Critical cracking temp determined by R 49, test temp, °C	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30

Notes:

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R35.

b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

c. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G/sinδ at test temperatures where the asphalt is a Newtonian fluid.*

d. G/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.*

e. The mass change shall be less than 1.00 percent for either a positive (mass gain) or negative (mass loss) change.

f. The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally, the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or needed for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG70-xx, or 110°C when used in climates requiring PG 76-xx and above.

g. For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C ant T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.

Table 4.3.69: AASHTO M320 Table 2 (continued)

Performance	PG 70						PG 76					PG 82				
	10	16	22	28	34	40	10	16	22	28	34	10	16	22	28	34
Average 7-day max pavement design temperature, °C[a]	<70						<76					<82				
Min pavement design temperature, °C[a]	>-10	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-10	>-16	>-22	>-28	>-34
Original Binder																
Flash point temp, T48, min °C[a]	230															
Viscosity, T 316:[b] Max 3 Pa•sm test temp, °C	135															
Dynamic shear, T315:[c] G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	70						76					82				
Rolling Thin-Film Oven Residue (T 240)																
Mass change, [e] max, percent	1.00															
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	70						76					82				
Pressurized Aging Vessel Residue (R 28)																
PAV again temperature, °C[f]	100 (110)						100 (110)					100 (110)				
Dynamic shear, T 315: G*/sinδ[d], min 1.00 kPa Test temp @ 10 rad/s, °C	34	31	28	25	22	19	37	34	31	28	25	40	37	34	31	28
Critical low cracking temp, R49. [g] Critical cracking temp determined by R 49, test temp, °C	0	-6	-12	-18	-25	-30	0	-6	-12	-18	-24	0	-6	-12	-18	-24

Notes:

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R35.
b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.
c. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G/sinδ at test temperatures where the asphalt is a Newtonian fluid.*
d. G/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.*
e. The mass change shall be less than 1.00 percent for either a positive (mass gain) or negative (mass loss) change.
f. The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally, the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or needed for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG70-xx, or 110°C when used in climates requiring PG 76-xx and above.
g. For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C ant T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.

4.3.2.2.20 Pavement Crack Sealing

.1 Routing and Sealant Preparation

a) Before routing, sweep designated pavement area clean of dirt accumulations to expose cracks and joints.

b) Rout cracks and joints that are 2 mm to 25 mm wide, unless directed otherwise by the Engineer. Do not rout cracks in areas with severe block cracking.

c) Rout crack or joint to a width of 40 mm and a depth of 8 mm.

d) Sealant Preparation: Slowly melt the sealant in the heating kettle with continuous agitation. Do not add any other material to the sealing compound. The preferred temperature range for sealant heating is 190□C to 200□C and sealant shall not be heated to temperatures greater than 205□C at any time. Discard overheated or burnt sealant.

.2 Sealant Application

a) After routing, air-blow loose debris to the edge of the road away from the area to be sealed to ensure that fresh sealant is not contaminated. Sealed cracks that are contaminated with routing debris will be rejected.

b) Immediately before pouring the sealant, use the compressed air lance to blow any remaining dust and loose debris from the routed groove.

c) Carefully apply the sealant with the tip of wand placed close to the bottom of the routed groove to ensure uniform application. Fill the groove only to the extent that when cooled the sealant is flush with the adjacent pavement surface within ±2 mm.

d) Use traffic barriers to prevent tracking of uncured sealant. Newly sealed cracks may be dusted with an approved material only when permitted by the Engineer. Do not open the road to traffic until the sealant has properly set up and no danger of damage to the sealant exists, a minimum of 20 minutes after sealant placement.

e) Allow the sealant to set and cure for 48 hours after application prior to cleanup sweeping, unless permitted otherwise by the Engineer.

.3 Field Quality Control

a) Rout Cross-Section Dimensions:

i) Width: 40 mm

ii) Depth: 8 mm

iii) Width/Depth Ratio: 3.5 to 6.0

b) **Non-compliance:** A lot with a compliance percentage of less than 90% for width/depth ratio shall be subject to a pay factor equal to the compliance percentage.

c) Rout Centering along Crack

i) Centre of crack shall not be more than 8 mm from the centre of rout. Non-compliance: A lot with a compliance percentage of less than 80% shall be subject to a pay factor equal to 1.25 multiplied by the compliance percentage for centering.

d) Heating Temperature

i) At no point in the heating process shall the sealant temperature exceed 205□C. Discard all overheated or burnt sealant.

e) Application Temperature

i) The sealant temperature at the time of application shall not be less than 185□C. If the application temperature is less than 185□C, suspend application until sealant temperatures are corrected in the kettle without overheating.

f) Sealant Quality

i) When tested according to ASTM D5329, the sealant shall have the following properties:

ii) Penetration at 25□C: 90 maximum

iii) Flow at 60□C: 5 mm maximum

iv) Non-compliance: If the maximum penetration is exceeded, the day's production represented by the failed test shall be subject to the following pay factors:

Table 4.3.70: Excess Penetration Pay Factor

Penetration at 25°C	Pay Factor
91-92	100.0%
93-94	99.4%
95-96	98.6%
97-98	97.2%
99-100	95.6%
101-102	93.5%
103-104	91.1%
105-106	88.4%
107-108	85.3%
109-110	80.0%
>110	Reject

The pay factors shall be individually applied, where applicable, to the contract price.

.4 Rejected Work

a) Sealed cracks shall be rejected if there is evidence of poor workmanship or obvious defects, including:

i) Routed crack not filled completely

ii) Lack of bond to sides of rout

iii) Excessive debris or moisture in the rout

iv) Contamination of the sealant

v) Routed crack not filled flush within ±2 mm

vi) Tracking of uncured sealant

vii) Excessive rounding or spalling of the routed edges

b) Repair of Rejected Work

i) Repair rejected sealed cracks by removing the sealant and resealing the cracks, to the Engineer's satisfaction and at no further cost to the City.

.5 Warranty

a) Completed and accepted pavement crack sealing shall be guaranteed for a one year period following the date of the Construction Completion Certificate.

b) If, during the warranty period, there is evidence of bond failure or of water or material ingress through the crack, remove the sealant, clean the crack and reseal, to the Engineer's satisfaction.

.6 Cleanup and Opening to Traffic

a) Remove excess material and clean up soiled pavement and concrete surfaces within 48 hours after the sealant has properly cured.

b) Keep traffic off the newly sealed pavement until the sealant has properly set up and is in no danger of being damaged or pulled out by traffic.

c) Repair damage to the sealant caused by traffic and by the Contractor's operations.

4.3.2.2.21 Bridge Deck Asphalt Surfacing

.1 Removal of Existing Deck Materials

a) The existing deck materials shall be removed through use of milling equipment. A minimum of 90% of the area of the concrete bridge deck must be visible after the removal operation. Any materials left in place shall not exceed 10 mm in height. Remove all unbounded, loose materials by scraping and sandblasting.

b) Place protection in all expansion joints prior to the removal operation. Protection to be left in place until after paving is completed.

c) Clean bridge surface after removal operation is complete and blow dry entire concrete deck.

d) Temporary ramping is to be placed at all manholes and expansion joint and left in place until just prior to paving.

.2 Site Preparation

a) The Contractor must provide, at his expense, a satisfactory working area at both ends of the bridge to maneuver trucks and clean truck tires, paving equipment, including the spreader, steel rollers and pneumatic rollers, etc., using concrete, asphaltic concrete or other material acceptable to the Engineer.

b) Blow dry the deck using min. of 125 CFM compressed air to ensure that no mud, dirt, standing water, or surface moisture is left in place.

c) Depressions greater than 10 mm in depth shall be brought level with surrounding areas by manual application and tamping of the mastic pavement mixture.

d) Apply a tack coat of MC-30 or approved alternate at a rate of 0.3 liters per square meter. Complete drying of the tack coat is required before paving can commence.

e) Adjacent structures and appurtenances shall not be spattered by the tack coat. The Contractor shall remove any spattering and make good the affected surface to the satisfaction of the Engineer at no cost to the Owner.

f) Apply a uniform coating of MC-30 or approved alternate along gutter lines, adjacent to expansion joints and around drainpipes using a brush or squeegee. Vertical faces of curbs and other appurtenances shall be brush coated with a rubberized asphaltic compound such as Bakor 570-05 (CR-10) rubber asphalt edge sealer or approved equal.

g) The tack coat shall be applied only when the surface to be treated is dry, when the weather is not foggy or rainy, and when the surface temperature is above 15°C.

h) The tack coat shall be applied by means of a self-propelled pressure bituminous material distributor subject to the approval of the Engineer.

i) The tack coat shall be applied in a single application.

j) The Contractor must be responsible for accidents or damage resulting from the use of excessive temperatures and shall replace, at no expense to the Owner, any material destroyed.

k) Areas missed by the distributor or inaccessible to the distributor, shall be treated using hand spray prior to tacking section adjacent.

l) No traffic shall be allowed on the tack coat until the material is fully cured and approved by Engineer.

.3 Mix Delivery

a) Transport mix to the job site in vehicles cleaned of foreign material.

b) Paint or spray truck beds with light oil, limewater, soap or detergent solution at least once a day or as required. Elevate truck bed and thoroughly drain. No excess solution will be permitted.

c) Schedule delivery of material for placing in daylight, unless the Engineer approves artificial light.

d) Deliver material to paver at a uniform rate in an amount within capacity of paving and compacting equipment.

e) Deliver loads continuously in covered vehicles and immediately spread and compact.

f) Loaded or empty trucks shall not be turned around on the bridge deck.

g) Ensure vehicle tires are clean of deleterious material prior to driving onto the bridge deck.

h) Maintain asphalt within truck at a temperature greater than 160□C. The load will be rejected by the Engineer or his representative if the asphalt temperature of the truckload falls below 160□C.

.4 Placing

a) Placing - Single Lift

i) Standard paving machines shall be adjusted to place a continuous mat of asphalt to match existing thickness.

ii) Place asphalt mixtures only when air temperature is above 12□C and deck temperature is above 10□C. Secondary rolling will be completed before the temperature of the mat falls below 90□C.

iii) Coverage of the single lift membrane/wearing course pavement shall be a minimum of no less than 45 mm pavement thickness in any area, and no more than 80 mm. Some adjustment of mat thickness may be required to match the elevations of existing features.

iv) The Engineer may suspend spreading if segregation of mix material occurs until such time as the cause can be determined and corrected.

b) Placing - Multiple Lifts

i) Membrane Placement

1. Standard paving machines shall be adjusted to place a continuous mat of 25 mm nominal thickness.
2. The thickness of the mastic membrane shall at no time be less than 20 mm. Place asphalt mixtures only when air temperature is above 12°C and deck temperature is above I0°C. Secondary rolling will be completed before the temperature of the mat falls below 90°C.

c) Overlay Placement

i) Surface course asphalt shall be applied at a minimum thickness of 75 mm or as indicated on the drawings. Some adjustment of mat thickness may be required to match elevations of existing features.

ii) If application of the wearing course is delayed for more than 48 hours, or if construction traffic creates a visible coating of dust or dirt, a tack coat of emulsion, approved for standard pavement construction, shall be applied. Use of tack coat on top of the membrane pavement shall be subject to the approval of the Engineer.

iii) Longitudinal joints in the surface course shall be offset 300 mm lateral distance, or greater, from the longitudinal joint in the underlying membrane mix.

iv) The Engineer may suspend spreading if segregation of mix material occurs until such time as the cause can be determined and corrected.

.5 Compacting

a) Asphaltic concrete shall be compacted to not less than 94 percent of Maximum Theoretical Density (MTD).

b) Steel and pneumatic-tired rollers shall be kept slightly moistened by water. Steel rollers shall be equipped with scrapers. Pneumatic tire rollers shall be equipped skirting. Excessive use of water will not be permitted.

c) The roller shall not be driven onto or off the mat over the longitudinal edge of mat.

d) Do not turn rollers around on the deck. The roller must run off the deck to stop and turn.

e) The line of rolling shall not suddenly be changed or the direction of rolling suddenly reversed. Any pronounced change or direction shall be made on stable material.

f) Rollers shall not be permitted to stand on the mat.

Table 4.3.71

Property	Units	ASTM No.	Minimum	Maximum
LOW SERVICE TEMPERATURE CHARACTERISTICS				
Stiffness Modulus @ -20°C (Loading Time 500sec) (Recommended Method)	Pa			5×10^7
Pen @ 0°C, 200g 60sec. (Alternate Method Only)	Dmm	D5	30	
HIGH SERVICE TEMPERATURE CHARACTERISTICS				
Viscosity @ 60°C (Shear Rate $5 \times 10^{-2} s^{-1}$)	Pa·s		600	
Elastic Behavior (@ Room Temperature)				
Toughness	J	Benson Test (or Equivalent)	10	
Tenacity	J	Benson Test (or Equivalent)	8	
TECHNOLOGICAL CHARACTERISTICS				
Kinematic Viscosity @ 135°C	mm²/s	D2170		3000
Flashpoint	°C	D92	230	
AGING CHARACTERISTICS (Test After Thin Film Oven Test)				
Weight Loss Aging Index	%	D1754		1.0 4.0

$$\text{Aging Index} = \frac{\text{Viscosity @ 60 °C (Shear rate } 5 \times 10^{-2} s^{-1}\text{) after TFOT}}{\text{Viscosity @ 60 °C (Shear rate } 5 \times 10^{-2} s^{-1}\text{) before aging}}$$

Table 4.3.72

Sieve Size (µm)	% Passing
10 000	100
5 000	90 – 95
2 500	70 – 76
160	8 – 16
80	6 – 10

Table 4.3.73

Property	Limit	ASTM Designation
Binder Content (%)	8.5 min.	D2172/ATT-12 Part II
Marshall Stability (N)	6000 min.	D1559
Flow (250 µm)	20 max.	D1559
VMA (%)	14 min.	
Air Voids (%)	3 – 5	
Permeability @ 70 kPa (cm/s)	10^{-7} max.	D5084-90
Film Thickness (microns)	8.0 min.	

Table 4.3.74

Property	Limit	ASTM Designation
Binder Content (%)	9.5 min.	D2172/ATT-12 Part II
Marshall Stability (N)	5200 min.	D1559
Flow (250 µm)	20 max.	D1559
VMA (%)	18 min.	
Air Voids (%)	3 - 5	
Permeability @ 70 kPa (cm/s)	10^{-7} max.	D5084-90
Film Thickness (microns)	8.0 min.	

Table 4.3.75

Property	Limit	ASTM Designation
Binder Content (%)	6.5 ± 0.3%	D2172/ATT-12 Part II
Marshall Stability (N)	7000 min.	D1559
Flow (250 µm)	20 max.	D1559
VMA (%)	14 min.	
Air Voids (%)	3 – 5	
Permeability @ 70 kPa (cm/s)	10^{-7} max.	D5084-90
Film Thickness (microns)	7.0 min.	

4.3.2.2.22 Recycled Asphalt Paving

.1 Reclaiming Asphalt Pavement

a) **Cold Milling:** Mill the designated pavement with a cold planer to Section 4.3.2.2.17-Pavement Cold Milling, supplemented as follows:

i) **Sweeping before Milling:** Before milling, sweep the pavement surface with a mechanical sweeper to remove debris and dirt accumulations that may contaminate the millings.

ii) Operate the planer in a manner that will minimize tearing and breaking of the underlying and adjacent pavement.

iii) **Water Use:** Carefully control the amount of water used in milling. Moisture in the RAP is of critical importance during hot-mix production.

iv) Load milled material directly from the planer into the haul vehicle.

v) **Sweeping after Milling:** Immediately sweep the milled surface clean with a mechanical sweeper following the planer by not more than 100 m.

vi) **Milling Stop Line:** Terminate milling at a uniform line across the roadway at the end of a working day. Provide a transition in the road surface profile at a slope of not more than 25 mm/m.

vii) **Rain:** Suspend the milling operation in the event of rain or other inclement weather. Fill the milled area with a paving mix if the potential to pond water exists. Remove the temporary cover before resuming milling operations.

viii) **Traffic Hazard:** Promptly repair, to the Engineer's satisfaction, any distress in the newly milled surface which could become a hazard to vehicular traffic.

ix) Minimize contamination of the RAP with granular, clay and other deleterious materials at all times.

.2 **Stockpiling RAP**

a) The RAP becomes the Contractor's property after removal from the jobsite, unless otherwise stated in the Special Provisions of the contract. The Contractor is responsible for stockpiling RAP in accordance with the following guidelines.

b) **Drainage:** Choose a site that has positive surface drainage away from the base of the stockpile.

c) **Stockpile Base:** Must have adequate strength to support the anticipated volume of RAP in the stockpile.

d) **Particle Sizes:** RAP being stockpiled shall meet the following gradation, or must be crushed to obtain the required gradation.

Table 4.3.76: Stockpiles RAP Gradation

Sieve Size (mm)	Total % Passing by Mass
125	100
80	99 - 100
40	95 - 100

e) Ensure that the RAP is not disturbed after stockpiling. The RAP shall remain loose and un-compacted. No equipment shall be permitted to operate on the stockpile.

.3 Recycled Asphalt Shingles (RAS)

a) RAS Production

i) Process the RAS by ambient grinding or granulating to meet the requirements in the following table when tested in accordance with AASHTO T27 (prior to extraction process)

Table 4.3.77: RAS Gradation Requirements

Sieve Size (µm)	Total % Passing by Mass
10 000	100
5 000	70.0 - 95.0
160	15.0 Max.
80	7.0 Max.

b) Stockpiling RAS:

i) The Contractor is responsible for stockpiling RAS in accordance with the following guidelines.

ii) **Drainage:** Choose a site that has positive surface drainage away from the base of the stockpile.

iii) **Stockpile Base:** Must have adequate strength to support the anticipated volume of RAS in the stockpile

iv) Ensure that the RAS is not disturbed after stockpiling. The RAS shall remain loose and un-compacted. No equipment shall be permitted to operate on the stockpile.

1. The Contractor may uniformly blend sand or fine aggregate with RAS in stockpiles if needed to keep the processed material workable. The sand or fine aggregate added must be considered in the final gradation of the new HMA.
2. Use RAS that is sufficiently dry to be- free flowing and to prevent foaming when blended with the hot binder.

c) If the Contractor elects to use RAS, the following additional conditions shall apply: The Contractor shall have an approved Quality Control Plan (QCP) that details how the RAS will be processed and controlled. When the Contractor intends to use RAS from a RAS Supplier, that supplier's QCP shall be submitted by the Contractor. The QCP shall be submitted with the Contractor's HMA mix design and shall address the following:

i) **RAS Processing Techniques**. This requires a schematic diagram and narrative that explains the processing (grinding, screening, and rejecting) and stockpile operation for this specific project. Hand sorting of deleterious material prior to grinding is required. In addition, this plan must address the control of agglomeration and moisture.

ii) **Determination and Control of RAS Asphalt Binder Content (AASHTO T-164, Method A or B):** Frequency: 1/200 tonnes of processed RAS material (minimum five tests).

iii) **Control of RAS Gradation (CP31 or AASHTO T-30**): Frequency: 1/200 tonnes of processed RAS material (minimum three tests)

iv) **Asbestos content of RAS:** Frequency: 1/1000 tonnes of processed RAS material (minimum three tests)

v) **Moisture content of RAS:** Frequency: 1/day

vi) **Deleterious Material: Frequency:** 1/1000 tonnes of RAS material (minimum three tests)

.4 Production of Recycled Asphalt Mix

a) Production: Produce recycled asphalt mixture in accordance with the approved mix design and to Section 4.3.2.2.12 – SGC Hot-Mix Asphalt Concrete.

.5 Paving

a) Paving Operation: to Section 4.3.2.2.14 – SGC Hot-Mix Asphalt Paving.

b) Substitute Mix: Provide at least 24 hours' notice to the Engineer if recycled asphalt hotmix cannot be produced as intended.

c) Tolerances: to Section 4.3.2.2.14 – SGC Hot-Mix Asphalt Paving

4.3.2.2.23 Roadway Signage (10 14 53)

.1 Roadway signage shall be completed as soon as possible following completion of roadway and curb/gutter paving.

.2 Roadway signage shall be inspected during the City's Construction Completion Certificate inspection and Final Acceptance Certificate inspection. The Developer is responsible for correcting any noted deficiencies before the City will issue the applicable certificate.

.3 Regulatory signage is required at CCC.

.4 During the Warranty Period, the Developer shall be responsible for sign maintenance. The following table outlines the required maintenance response times, in working days, to be observed by the Developer:

Sign Description	Problem Description	Maximum Response Time for Temporary Sign Installation	Maximum Response Time for Repair Following Temporary Sign Installation
Regulatory: RA-1 RA-2 RB-1 etc.	Missing, damaged or knocked down – unreadable	24 hours	5 days
Regulatory	Damaged but clearly visible by driver	7 days	10 days
Street Name	Missing, damaged or knocked down Unreadable	5 days	5 days
Street Name	Damaged but clearly visible by driver	7 days	10 days
Information: IC-16 IC-10 ID-31 etc.	Missing	72 hours	10 days
Information	Damaged but clearly visible by driver	5 days	14 days

Warning: WA-1 WA-8 WA-5 etc.	Missing, damaged or knocked down	72 hours	10 days
Warning	Damaged but clearly visible by driver	5 days	7 days
Miscellaneous	Missing, damaged or knocked down	7 days	14 days

4.3.2.2.24 Pavement Marking (32 17 23)

.1 General

a) The Contractor shall assume all costs resulting from the use of patented materials, equipment, devices, or processes used on or incorporated in the Work, agrees to indemnify and save harmless the purchaser and his duly authorized representatives from all suits at law, or action of every nature for or on account of the use of any patented materials, equipment, devices or processes.

b) All conflicting markings shall be removed (surface only or removed and filled) prior to the roadway opening with new marking placement.

c) Do not apply markings until pre-marking has been approved by City Inspectors.

d) Prior to commencing any work on a roadway, the contractor shall obtain all required On Street Construction Permits from the City.

e) Contractor shall install temporary pavement markings prior to roadway opening with paint in accordance with section 3.22. Prior to FAC of the road, the contractor shall install permanent thermoplastic pavement markings in accordance with section 3.22.

.2 Pre-Marking

a) Pre-marking must be done on a clean, dry pavement surface with pre-marking paint.

b) Pre-marking shall be within 100mm accuracy of plan dimensions and indicate straight lines and smooth curves

.3 Traffic Control and Work Area

a) The Contractor shall, at all times, provide warning and passage for all users of the pathway within the area of the Work. The Work shall be carried out as quickly as possible to prevent excessive delay and inconvenience.

b) Vehicle movement shall not be permitted over applied markings until they have adequately hardened or dried.

.4 Workmanship

a) Install painted pavement markings on a clean, dry pavement surface.

b) Remove, or remove and fill, any and all conflicting road markings.

c) Spraying will not be permitted during high wind conditions, or other adverse weather conditions.

d) Faulty markings must be removed and replaced within 5 working days.

e) The Contractor shall minimize overspray as much as possible.

f) Contractor shall remove any spillage or overspray.

.5 Thickness Tolerances

a) Cold Plastic Markings:

i) Surface Applied: 3 mm thick.

ii) “Scratch” / Inlaid Applied = 2 mm grind / 3 mm above surface.

iii) Where deficiencies occur in the work, involving average thicknesses greater than 3.0 mm or less than 1.8 mm, the Inspector may order removal and replacement or application of additional material.

iv) If surface dishing deeper than 0.5 mm occurs, the Inspector may order removal and replacement of material. Variations in asphalt surface profile may be taken into consideration.

b) Thermoplastic Markings:

i) Surface Applied: 3 mm thick.

1. Where deficiencies occur in the work, involving average thicknesses greater than 3.0 mm or less than 1.8 mm, the City may order removal and replacement or application of additional material.
2. If surface dishing deeper than 0.5 mm occurs, the City may order removal and replacement of material. Variations in asphalt surface profile may be taken into consideration.

ii) Inlaid Applied:

1. Longitudinal Markings: 5 mm Grind (below asphalt) / 2 mm above asphalt.
2. Transverse Markings: 10 mm Grind (below asphalt) / 2 mm above asphalt.
3. Where grind depth is less than 70 % specified, the City may order removal, re-grinding of asphalt and re-fill material.
4. If surface dishing is greater than 0.5 mm, the City may order the removal and replacement of material or additional material. Variations in asphalt surface may be taken into consideration.

4.3.2.2.25 Rejected Work

.1 Completely remove and replace rejected work to the limits specified by the City.

4.3.3 Concrete

4.3.3.1 Materials

4.3.3.1.1 Cement Concrete (32 16 13)

.1 Content

a) This section includes the production of Cement Concrete and the requirements for

b) concrete mix design, quality control, quality assurance and placement.

.2 Submittals

a) Submit the cement manufacturer's mill test reports to the Engineering Services

b) Section, Transportation Department, monthly or as requested by the City.

c) Submit physical fly-ash test reports to the Engineering Services Section, Integrated

d) Infrastructure Services, monthly or as requested by the City.

.3 Quality Assurance

a) Provide, without charge, facilities for the City to inspect equipment, materials and processes used in the production and delivery of concrete and to obtain samples for testing.

b) Approval of a mix design, or inspection and testing by the City shall not relieve the Contractor of responsibility for the quality of concrete used in the Work.

c) The quality assurance laboratory will perform concrete plant checks and quality assurance sampling and testing for slump, air content, air voids and compressive strength.

d) Quality assurance testing shall be performed by a technician certified by CSA or ACI.

e) Slump Tests

i) **Methods:** to CSA-A23.2-1C and CSA-A23.2-5C.

ii) **Test Frequency:** Slump tests will be taken between the 10% and 90% points of discharge of a concrete load with every strength test and as required by the Engineer.

f) Air Content Tests

i) **Methods:** to CSA-A23.2-1C and CSA-A23.2-4C or CANCSA-A23.2-6C.

ii) **Test Frequency:** Air content tests will be taken between the 10% and 90% points of discharge of a concrete load with every strength test and as required by the Engineer.

g) Air-Void Examination

i) **Method:** to ASTM C457, modified point-count traverse method at 100X magnification.

ii) **Sample:** a 100 mm diameter core drilled from hardened concrete.

iii) **Cross-Section Preparation:** The top of the core shall be ground to 2 mm ±0.5 mm below and parallel to the finished concrete surface to produce a surface suitable for microscopic examination.

iv) **Maximum Allowable Spacing Factor:** If the spacing factor obtained by a full traverse of the cross-section of the single core is greater than 0.23 mm, the concrete represented by the core shall be removed and replaced.

h) Strength Tests

i) **Methods:** Compressive strength test specimens shall be cast and cured in accordance with CSA A23.2-3C. Initial curing Temperatures must be reported. Test specimens cast from concrete mixes with slump levels equal to or less than 40mm shall be consolidated by rodding. The testing agency shall ensure complete densification of the test cylinders and will confirm that corresponding unit weights are characteristic of the mix design unit weights. Test cylinders exhibiting a lack of consolidation will be weighed and the unit weight and accompanying remarks recorded on the concrete test report. Compressive strength determination shall be in accordance with CSA A23.2-9C.

ii) **Test Frequency:** Standard tests for strength will be conducted at a frequency of not less than one strength test for each $60m^3$ of concrete or fraction thereof, for each class of concrete produced in any one day from each individual plant/supplier.

iii) Definition of a Strength Test: to CSA A23.1.

iv) For standard strength tests, either 150mm x 300mm cylinders or 125mm x 250mm cylinders may be used.

v) Required Strength: The result of each compressive strength test shall equal or exceed the specified minimum compressive strength.

.4 Concrete Materials

a) **Cement:** to CSA-A3000, A3001-03 of the following types.

i) Type GU – General use hydraulic cement

ii) Type HE - High early-strength hydraulic cement

iii) Type HS – High sulphate-resistant hydraulic cement

b) **Aggregate:** to CSA-A23.1, testing shall include but not be limited to: unconfined Freeze-thaw in course aggregate, $MgSO_4$ soundness loss, petrographic examination, alkali-aggregate reactivity, and ironstone content.

c) **Water:** to CSA-A23.1, clear, free from injurious amounts of oil, acid, alkali, organic matter, sediment, or other substance harmful to the mixing and curing of concrete. For concrete and fillcrete, the City of St. Albert will allow a Maximum of 20% of the mix water can consist of recycled slurry water. If recycled slurry water is utilized in the production of concrete or fillcrete the supplier shall provide quality assurance reports for the slurry water to the Engineering Services Section, Transportation Department.

d) **Air-Entraining Admixture:** to ASTM C260.

e) **Chemical Admixtures**: to ASTM C494, including water-reducing agents, retarders and accelerators. Chemical admixtures shall not be used unless permitted in writing by the City.

f) **Fly Ash:** to CSA-A3000, A3001-03 pozzolan type F or CI.

.5 Forms

a) To Section 4.3.3.1.10 - Concrete Forms and Accessories.

.6 Reinforcement

a) To Section 4.3.3.1.12 - Reinforcing Steel.

.7 Production of Concrete

a) Produce concrete to clause 5.2, CSA-A23.1 and conforming to the approved mix design requirements of Section 4.3.3.1.3 - Concrete for Roadways.

4.3.3.1.2 Concrete Sidewalk, Curb and Gutter, and Slabs

.1 Content

a) This section includes the construction of Cement concrete curb, curb and gutter, gutter, walk, monolithic curb, gutter and walk, median or island slabs, curb ramp and crossings.

.2 Quality Assurance

a) Slump, Air Content, Nuclear Density Tests, Air-Void Examination, Strength Tests and Acceptance Criteria to Section 4.3.3.1.1 - Cement Concrete.

.3 Materials

a) Concrete: Class A or Class C, to Section 4.3.3.1.1 - Cement Concrete and Section 4.3.3.1.3 - Concrete for Roadways.

b) Joint Sealant, Preformed Joint Filler, Curing Compound and Probe Hole Grout To Section

c) 4.3.3.1.3 - Concrete for Roadways.

d) Reinforcement Bars, Tie Bars, Dowels, Welded Steel Wire Fabric To Section 4.3.3.12 -Reinforcing Steel

4.3.3.1.3 Concrete for Roadways

.1 Content

a) This section includes the production of Cement concrete for pavement and associated structures, and additional requirements for concrete mix design, quality control, quality assurance, and placement for pavement and associated structures.

.2 Submittals

a) Submit a mix design for each designated class of concrete to the St. Albert Transportation Department, at least 14 days prior to initial concrete work and when there is a change in materials, sources or proportions. Submit separate mix designs specifically designed for particular placement applications (i.e. pumping, hand placement, slip form placement, etc.)

b) Submit a complete petrographic analysis of the fine and coarse aggregate proposed for use with the concrete mix design. The petrographic analysis shall include the results of unconfined Freeze-thaw in course aggregate, $MgSO_4$ soundness loss and alkaliaggregate reactivity evaluation.

c) Submit the results of ironstone determination to the Engineering Services Section, Transportation Department, at least once per week.

d) Submit physical fly-ash test reports to the Engineering Services Section, Transportation Department, monthly or as requested by the City.

.3 Quality Assurance

a) To Section 4.3.3.1.1 Cement Concrete

.4 Quality Control

a) The supplier shall conduct a quality control program that will ensure their concrete product meets the specifications. The supplier shall provide test results, if requested by the Engineer. The quality control program should be conducted at the plant with corresponding spot checks at the jobsite. Construction sites are not to be used as reactionary quality control points by the supplier to deficiencies in the supplied product through excessive or continuous re-tempering of the mix.

b) Quality control testing initiated by the supplier shall be performed by a CSA or ACI certified technician.

.5 Materia**ls**

a) **Cement:** To Section 4.3.3.1.1 - Cement Concrete

b) **Aggregate:** To Section 4.3.3.1.1 Cement Concrete, and as supplemented below:

i) **Petrographic Analysis:** To be performed by a qualified laboratory to CSA-A23.2- 15A.

ii) **Ironstone Content:** To be performed by an approved facility to the Method for Ironstone Content Determination in Fine and Coarse Concrete Aggregates. Do not use aggregate until the corresponding results have been reviewed by the Engineer. Ironstone content in coarse aggregate shall not exceed 1.0% by mass of the total coarse sample (retained on the 5 mm sieve and larger), and in fine aggregate shall not exceed 1.5% by mass of the total dry, unwashed fine aggregate sample (passing the 5 mm sieve to that retained on the 2.5 mm sieve). Any concrete supplied with aggregate exceeding the specified ironstone content will be rejected, and shall be removed by the Contractor as directed by the Engineer.

c) **Water:** To Section 4.3.3.1.1 Cement Concrete

d) **Fly Ash:** For Class A, and C concrete no replacement of the specified minimum cement content with fly ash from the commencement of the construction season to May 15 and after September 30 unless permitted by the City Engineer.

e) **Sulfate Resistant Concrete:** Concrete using Type HS (High sulfate-resistant hydraulic cement) cement shall not be placed after September 30, for Class A, and C concrete.

f) **Curing compound:** to ASTM C309, Type 2, class B, white pigmented, resin based, liquid membrane-forming compound.

g) **Evaporation Retarder:** The concrete evaporation retardant must be a commercially available monomolecular film compound. Currently there is no ASTM designation for this product, however the manufacturer must certify the evaporation retardant has no adverse effect on the cement hydration process or the concrete and that it reduces surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, or low relative humidity.

h) **Preformed Joint Filler:** to ASTM D1751.

i) **Joint Sealant:** to ASTM D1190, Sika 2c or approved equivalent.

j) **Forms:** To Concrete Forms and Accessories.

k) **Reinforcement:** To Section 4.3.3.1.12 Reinforcing Steel.

.6 Mix Design

a) Application of concrete classes:

i) Class A: One course exposed pavements, commercial and residential alley crossings.

ii) Class B: Unexposed pavement base.

iii) Class C: All exposed road associated works including curb and gutter, sidewalks, walkways, private crossings, swales, medians, New Jersey barriers and parapet walls.

iv) Class D: Structural pile foundations.

v) Class E: Exposed retaining walls.

b) Mix design criteria for each class of concrete:

Table 4.3.78: Spring and Fall Mixes

Class	Minimum 28 Day Compressiv e Strength (MPa)	Slump (mm)	Entrained Air Limits (% by volume)	Maximum Aggregate Size (mm)	Maximum Water to Cementing Materials Ratio (by mass)	Minimum Portland Cement Content (kg/m^3)	Cement Type
A	30	60 ± 20	5.5 - 8.0	20	0.45	335	GU*
B	30	60 ± 20	5.5 - 8.0	20	0.45	335	GU*
C	30	60 ± 20	> 5.5	20	0.45	335	GU*
D	30	100 ± 30	5.5 - 8.0	20	0.45	335	HS*
E	30	80 ± 20	5.5 - 8.0	20	0.45	300	HS*

Table 4.3.79: Summer Mixes

Class	Minimum 28 Day Compressive Strength (MPa)	Slump (mm)	Entrained Air Limits (% by volume)	Maximum Aggregate Size (mm)	Maximum Water to Cementing Materials Ratio (by mass)	Minimum Portland Cement Content (kg/m3)	Cement Type
A	30	60 ± 20	5.5 - 8.0	20	0.45	302	GU*
B	30	60 ± 20	5.5 - 8.0	20	0.45	302	GU*
C	30	60 ± 20	> 5.5	20	0.45	302	GU*
D	30	80 ± 20	5.5 - 8.0	20	0.45	335	HS*
E	30	80 ± 20	5.5 - 8.0	20	0.45	300	HS*

Note: GUb and HSb cements can be used only upon approval of the Engineer

c) **Class C concrete:** shall attain the minimum compressive strength corresponding to the percentage of entrained air in the plastic concrete as follows.

Table 4.3.80: Class C Concrete Compressive Strength Requirement

Air Content (%)	Minimum 28 Day Compressive Strength (MPa)
5.5 to 5.9	30.0
6.0 to 8.0	42 - (2 * Air Content)
greater than 8.0	26.0

d) **High Early Strength Concrete:** For special situations or conditions the Engineer may require that the specified 28 day compressive strength be met in 7 days.

e) If any class of concrete is to be placed by pumping, the specified slump and air content shall be met at the point of pump discharge. Samples for testing will be obtained at the point of pump discharge.

f) For class C extruded parapet retaining walls and New Jersey Barriers the mix shall contain 0.6kg of synthetic micro fibres or approved equivalent per m^3 of concrete.

g) For class E concrete the following mix conditions shall apply:

i) A minimum ratio of supplementary cementitious materials to total mass of cementitious materials of 0.15, and

ii) A minimum sand content of 45% by total weight of aggregate.

iii) Slump may be increased using an approved superplasticizer to 120 mm for a mix with GU cement and 90□ 30 mm for mixes where high early strength is a requirement.

h) Application of concrete classes:

i) Class A: One course exposed pavements, commercial and residential alley crossings.

ii) Class B: Unexposed pavement base.

iii) Class C: All exposed road associated works including curb and gutter, sidewalks, walkways, private crossings, swales, medians, New Jersey barriers and parapet walls.

iv) Class D: Structural pile foundations.

v) Class E: Exposed retaining walls.

i) Seasonal concrete mix requirements:

i) Spring Mixes

1. From the commencement of the construction season to May 15, or as directed by the City: no replacement of the minimum cement content with fly ash is permitted.

ii) Summer Mixes

1. From May 16 to September 30: no more than 10% of the specified minimum cement content may be replaced with fly ash.

iii) Fall Mixes

1. From October 1 to October 15: no replacement of the minimum cement content with fly ash is permitted and type HS cement may not be used.

iv) Cold Weather Mixes

1. From October 16 to the end of the construction season, or as defined by the Engineer: meet the requirements for cold weather concrete in below.

j) **Cold weather concrete**: All classes of concrete placed after October 15 shall attain a minimum compressive strength of 27.0 MPa in 7 days and shall be provided with cold-weather protection to CSA A23.1. High early strength concrete (as defined in CSA A23.1 shall attain a minimum compressive strength of 30.0 MPa in 7 days and shall be provided with cold weather protection to CSA A23.1 (type 2 curing). This cold weather protection must be adequate to maintain concrete surface temperatures at a minimum of 10º C for a period of 7 days following placement.

k) For slipformed (machine placed) concrete, limit slump as follows:

i) 20 ± 10 mm for curb, curb and gutter and New Jersey barrier, and

ii) 30 ± 10 mm for walk, monolithic walk and pavement.

l) Type HE or Type HS cement may be substituted for Type GU cement, except as limited in Clause 4.3.3.1.3 –Class E Concrete.

m) Class A, C and E concrete may be subjected to air-void examination. Concrete mix designs shall be prepared by a CSA approved laboratory, or by a concrete supplier with the capability and a facility approved by the City.

n) If requested, the supplier shall provide evidence that proportions in the mix design will produce concrete of the quality specified. Include strength tests on trial mixes made under plant conditions.

o) Concrete production may not proceed until the City has approved the applicable mix design.

4.3.3.1.4 Concrete Base

.1 Content

a) This section includes the construction of non-reinforced Cement concrete base for streets and alleys intended for asphalt surfacing.

.2 Quality Assurance

a) Slump, air content and strength tests and acceptance criteria: to Section 4.3.3.1.3 - Concrete for Roadways.

.3 Materials

a) Concrete: class C to Section 4.3.3.1.3 - Concrete for Roadways.

b) Tie bars, reinforcement if required, preformed joint filler and curing compound: to Section 4.3.3.1.1 - Cement Concrete, Section 4.3.3.1.3 - Concrete for Roadways and Section 4.3.3.1.12 - Reinforcing Steel.

c) Granular Backfill: to Section 4.3.2.1.7 - Aggregate, Designation 3 Class 20A.

.4 Equipment

a) Slipform Paver: to Section 4.3.3.1.10 - Concrete Forms and Accessories, equipped with adequate internal vibrators to consolidate concrete to the full depth and width of the slab; adjustable to crown and crossfall; subject to approval by the City.

4.3.3.1.5 Concrete Pavement

.1 Content

a) This section includes the construction of one-course non-reinforced Cement concrete pavement for streets and alleys.

.2 Quality Assurance

a) The quality assurance laboratory will conduct slump, air content, nuclear density tests, air-void examination, strength tests and acceptance criteria to Section 4.3.2.1.7 - Aggregate and Section 4.3.3.1.1 - Cement Concrete.

.3 Thickness

a) At the City's request, the quality assurance laboratory will take one or more sets of cores from suspect concrete pavement, each set comprising 3 cores whose average thickness represents not more than 500 m^2 of concrete pavement

.4 Materials

a) Concrete Class A to Section 4.3.2.1.7 - Aggregate and Section 4.3.3.1.1 - Cement Concrete.

b) Tie bars, reinforcement if required, joint sealant, preformed joint filler, curing compound to Section 4.3.3.1.12- Reinforcing Steel.

c) Granular backfill to Section 4.3.2.1.7 - Aggregate, Designation 3 class 20A.

.5 Equipment

a) **Slipform Paver:** To Section 7.10- Concrete Forms and Accessories; equipped with adequate internal vibrators to consolidate concrete to full depth and width of slab;adjustable to crown and crossfall; subject to the approval of the Engineer

4.3.3.1.6 Concrete Paving Units

.1 Content

a) This section includes the supply and placement of interlocking concrete paving units on soil cement base for pedestrian and vehicle traffic.

.2 Submittals

a) Submit the manufacturer's product data together with 2 samples representative of style, size, colour range and surface texture to the City at least 14 days prior to delivery of concrete pavers on site. Submit further samples as requested by the City.

b) Submit source and gradation of bedding and joint sand to the St. Albert Transportation Department at least 7 days prior to use.

.3 Quality Assurance

a) The quality assurance laboratory will test paving units for compressive strength and absorption according to ASTM C936.

b) Units not meeting specifications shall be replaced.

.4 Materials

a) Concrete Paving Units: manufactured to ASTM C936 and conforming to the following:

i) **Compressive strength at delivery:** minimum 55 MPa average of test samples with no unit less than 50 MPa.

ii) **Moisture absorption at delivery:** maximum 5% average of test samples with no unit more than 7%.

iii) **Size:** to manufacturer's standard size within a tolerance of ±2 mm in length and width.

iv) **Thickness:** 60 mm or 80 mm as indicated, within a tolerance of ±3 mm.

b) **Shape and Colour:** as indicated on drawings or as ordered.

c) **Bedding Sand:** to Section 4.3.2.1.7 - Aggregate, Designation 4, class 10.

d) **Joint Sand:** to Section 4.3.2.1.7 - Aggregate, Designation 4, class 2.5, with 6% bentonite.

e) **Edge Restraint:** pressure treated wood, concrete or other material or structure as indicated on drawings.

f) **Weed Barrier:** as indicated on drawings.

g) **Insulation:** as indicated on drawings.

4.3.3.1.7 Roller Compacted Concrete

.1 Content

a) Production of roller-compacted concrete (RCC) and construction of RCC pavement for roadways, with or without asphalt surfacing.

.2 Submittals

a) Mix Design

i) Submit to the Engineer, a RCC mix design performed by a qualified laboratory at least 14 days before the initial RCC work and when there is a change in materials, sources or proportions.

ii) If requested, provide evidence that the proportions in the mix design will produce RCC of the quality specified. Include strength tests on trial mixes made under plant conditions.

b) Optional Coring Test Results

i) Optional coring test results shall be submitted to the Engineer.

c) Job-Mix Formula

i) Submit to the Engineer, at least seven days before production, the proportions of materials and plant settings, based on the approved mix design.

.3 Quality Assurance

a) The City will conduct the plant checks, sampling and testing described in the following paragraphs.

b) Plant Check

i) RCC plant inspections will be conducted at random to check the settings, operation, materials and mixtures produced. The Engineer will order the plant shut down if deficiencies are found, such as deviation from the approved job-mix formula, segregation in the mix, or inconsistent plant operation.

c) RCC Unit Area and Cores

i) RCC pavement will be accepted or rejected, based on a unit area of 1,000 sq. m. or less. The unit area is represented by three cores taken according to A23.2M-14C when the RCC is 28 days old. The cores will be measured for thickness and tested for compressive strength.

ii) Fill the core holes with Cement mortar as directed.

d) Thickness

i) **Required Thickness:** The average thickness of the three cores, taken for a unit area of RCC, shall equal the specified thickness.

ii) **Deficient Thickness:** A unit area of RCC, represented by a deficient thickness, will be assessed a pay factor according to Table 4.3.89.

iii) **Excessive Thickness:** A unit area of RCC, with excessive thickness, may be accepted if surface and grade tolerances are met, but without extra payment.

e) Compressive Strength

i) **Procedure:** The 28-day cores will be tested for compressive strength according to CSA-A23.2 -9C (current edition). Additional cores may be taken if necessary for a 7- day strength test.

ii) **Required Strength:** The average compressive strength of three, 28-day cores, taken for a unit area of RCC, shall not be less than 85% of the specified 28-day strength, with no single core strength below 75% of specified strength.

iii) **Deficient Strength**: A unit area of RCC, represented by a deficient strength, may be accepted subject to a pay factor according to Table 4.3.90. If strength deficiencies persist, the Engineer will also require changes to mix proportions for the remainder of the work. The Contractor is responsible for taking corrective actions in the mix production and placement operations.

iv) **Optional Coring by the Contractor:** The Contractor has the option, at his expense, to show evidence of strength by coring and testing according to CSA-A23.1-14C (current edition), performed by a qualified laboratory within seven days after the failed 28-day core test. Three cores shall be drilled from the RCC unit area represented by a failed core strength test. If the average strength of the three new cores is equal to 85% of the specified strength and on one core is less than 75% of the specifies strength, then the specified strength will be considered met. Otherwise, the RCC will be subject to a pay factor as stated in Table 4.3.90 on the basis of the original core strength test.

.4 Materials for RCC

a) Cement

i) To CSA-A3001, A5, Type GU General Use Cement. Submit to the Material Engineering Section, the cement manufacturer's mill test reports monthly or as requested by the Engineer.

b) Fly Ash

i) To CSA-A3001, A300 pozzolan type C. Submit to the Materials Engineering Section, physical test reports monthly or as requested by the Engineer.

c) Water

i) To Clause 4.2.2, CSA-A23.1 (current edition), clear, free from injurious amounts of oil, acid, alkali, organic matter, sediment, or other substance harmful to the mixing and curing of RCC.

d) Aggregates

i) Normal-density, coarse and fine aggregates, conforming to CSA-A23.1 (current edition), modified as follows:

ii) **Combined Grading:** Conforming to Section 4.3.2.1.7, Designation 1, Class 20.

iii) **Gradation Tolerances:** Gradation of the aggregate used in the mix shall match the gradation of samples furnished for the mix design within the following tolerances:

Table 4.3.81: Gradation Tolerance

Sieves (µm)	Tolerance (±% Points)
12,500; 10,000	5
5,000; 1,250; 630	4
315; 160	3
80	2

iv) **Crushed Faces:** Not less than 50%, by mass of the aggregate portion larger than 5,000 mm to have at least two crushed faces.

v) **Particle Shape:** Flat particles (length to thickness ratio >5) and elongated particles (length to width ratio >5) not to exceed 15% by mass, of the aggregate portion larger than 5,000 mm, as determined according to CSA A23.2 (current edition).

e) Curing Compound

i) RCC without Asphalt Surfacing: white pigmented, liquid, membrane-forming compound conforming to ASTM C309, Type 1.

ii) RCC with Asphalt Surfacing or with Deferred Asphalt Surfacing: SS-1, emulsified asphalt conforming to Section 6.7 Liquid Asphalt Coats.

.5 Equipment

a) Mixing Plant

i) A central batch concrete plant or a continuous flow mobile concrete plant with a twin shaft pugmill mixer, capable of continuous or batch mixing; equipped with synchronized metering devices and feeders to maintain the correct proportions of aggregate, cement and water; and capable of producing a uniform mixture. The pugmill shall be equipped with a discharge hopper having the capacity of at least one tonne. The discharge hopper shall be equipped with dump gates to ensure rapid and complete discharge without segregation.

b) Paver

i) An asphalt type paver modified or equipped with dual tamping bars and vibrating screed, capable of laying down the RCC mix to at least 90% of required density. The paver shall be of suitable weight and stability to spread and finish the concrete without segregation to the required thickness, smoothness, surface texture, cross-section, and grade; subject to approval by the Engineer.

c) Compaction Rollers

i) Self-propelled steel drum rollers of the 9-tonne to 18-tonne class, capable of vibratory, primary compaction; self-propelled steel drum or rubber-tired rollers of the 18-tonne class, for static finish rolling; and suitable.

.6 Mix Designs

a) Cement Content

i) A minimum of 13% by mass of dry aggregate.

b) Fly Ash

i) Not more than 25% of the cement content may be replaced with fly ash. After September 15, no fly ash shall be used in the mix.

c) Water Content

i) Within +2% of optimum moisture content to achieve the maximum density of the mix when compacted and to produce zero slump.

d) Compressive Strength

i) A minimum of 30 MPa at 28 days to CSA A23.2 (current edition), or as designated by the Engineer.

4.3.3.1.8 Patterned Concrete Slab

.1 Content

a) This section includes the supply of materials and construction

.2 Materials

a) **Concrete:** to Section 4.3.3.1.1 - Cement Concrete and Section 4.3.3.1.3 - Concrete for Roadways, modified as follows:

b) For hand-placed concrete, a slump of 80 ±20 mm is allowable for Classes A and C.

c) **Colouring Agent**: iron oxide pigments conforming to ASTM C979, colours as designated on plans and approved by the City. The pigment shall be added during concrete mixing to produce a uniform colour throughout the pavement or walk/slab.

d) **Release Agent:** generally consisting of talc, colour, binder and bentonite-like material; shall be kept absolutely dry prior to use so it can be powdered on; shall be capable of preventing adhesion of stamping tools to the concrete surface, preventing loss of entrained air from the surface and being power-washed off when the concrete has partially cured.

e) **Curing Agent:** to ASTM C309, type I, class B, clear, resin based.

f) **Concrete Sealer:** apply a proprietary slip resistant sealer to the concrete surface in accordance with the manufacturer's recommendations.

g) **Concrete Stamping Tools:** capable of stamping the specified pattern and texture.

.3 Mix Design

a) Submit a concrete mix design to Section 4.3.3.1.3 - Concrete for Roadways and including the following:

b) The brand and colour of colouring agent used.

c) The amount of colouring agent expressed as a percentage by mass of cement in the mix (10% maximum).

d) The amount of entrained air adjusted as may be required by the type of colouring agent used.

e) Confirmation that no admixtures containing calcium chloride will be used.

f) Relevant information on reinforcing fibres, if used.

.4 Quality Control

a) Prior to installing patterned colored concrete, provide a 2.5 m x 2.5 m mock-up at the job site for the City's approval of colour, pattern, texture and workmanship. The approved mock-up shall serve as a standard for judging the completed work.

4.3.3.1.9 Ultrathin Whitetopping

.1 Content

a) This section includes the requirements for the construction of Ultra-thin Whitetopping of existing asphalt pavement and additional requirements for concrete mix design, quality control, quality assurance, and placement for pavement and associated structures.

.2 Submittals

a) Submit to the Engineer a mix design for each designated class of concrete at least 14 days prior to initial concrete work and when there is a change in materials, sources or proportions.

b) Submit a complete petrographic analysis of the aggregate proposed for use with the concrete mix design.

c) Submit the results of ironstone determination to the Engineer at least once per week.

d) Submit test results on concrete with fly ash with the mix design.

e) Optional core strength test results shall be submitted to the Engineer.

.3 Quality Assurance

a) To Section 4.3.3.1.1– Cement Concrete.

.4 Quality Control

a) The supplier shall conduct a quality control program that will ensure their concrete product meets the specifications. The supplier shall provide test results, if requested by the Engineer. The quality control program should be conducted at the plant with corresponding spot checks at the jobsite. Construction sites are not to be used as reactionary quality control points by the supplier to deficiencies in the supplied product through excessive or continuous re-tempering of the mix.

b) A technician certified by CSA or ACI shall perform quality control testing initiated by the supplier.

.5 Materials

a) **Cement:** To Section 4.3.3.1.1 – Cement Concrete.

b) **Aggregates:** To Section 4.3.3.1.1 – Cement Concrete, and as supplemented below:

i) **Petrographic Analysis:** To be performed by a qualified laboratory to the “Procedures for the Petrographic Analysis of Coarse and Fine Aggregate (Ontario)”.

ii) **Ironstone Content:** To be performed by an approved facility to the Method for Ironstone Content Determination in Fine and Coarse Concrete Aggregates. Do not use aggregate until the Engineer has reviewed the corresponding results. Ironstone content in coarse aggregate shall not exceed 1.0% by mass of the total coarse sample (retained on the 5 mm sieve and up), and in fine aggregate shall not exceed 1.5% by mass of the total fine sample (passing the 5 mm sieve to that retained on the 2.5 mm sieve). Any concrete supplied with aggregates exceeding the specified ironstone content will be rejected, and shall be removed by the Contractor as directed by the Engineer.

c) **Water:** To Section 4.3.3.1.1 Cement Concrete.

d) **Fly Ash:** For Class A, and c concrete not more than 10% of the specified minimum cement content may be replaced with fly ash from May 15 until September 30 unless not permitted by the City Engineer.

e) **Sulfate Resistant Concrete:** Concrete utilizing Type HS (High sulphate-resistant hydraulic cement) cement shall not be placed after September 30, for Class A, and C concrete.

f) **Curing compound:** to ASTM C309, type 2, class B, white pigmented, resin based, liquid membrane-forming compound.

g) **Synthetic Fibers:** to ASTM C1116. Fibers must provide a residual strength of at least 0.6 Mpa as measured by ASTM C 1399.

h) **Preformed Joint Filler:** to ASTM D1751.

i) **Joint Sealant:** to ASTM D1190, hot-poured elastic type.

j) **Forms:** To Section 4.3.3.1.10 – Concrete Forms and Accessories.

k) **Reinforcement:** To Section 4.3.3.1.12 – Reinforcing Steel.

.6 Mix Design

a) For Ultra-thin Whitetopping the concrete mix shall be designed to meet the following performance criteria:

i) CSA A23.1 Table 8 Class C1 Exposure

ii) Maximum Water/cementing materials ratio: 0.40

iii) Air Content 6.0 +/- 1%

iv) Minimum Compressive Strength:

v) 20 Mpa at 2 days

vi) 35 Mpa at 28 days

vii) Slump 70 **+/-** 20mm

viii) kg/m_3 Synthetic Fiber

ix) Minimum toughness Performance Level III at 7 days to ASTM C1018.

x) If the above class of concrete is to be placed by pumping, the specified slump and air limits shall be met at pump discharge.

b) Seasonal concrete mix requirements:

i) Spring Mixes – from the commencement of the construction season to May 15 or as defined by the Engineer

ii) No replacement of the minimum cement content with fly ash is permitted.

iii) Summer Mixes – May 16 to September 30

iv) No more than 10% of the specified minimum cement content may be replaced with fly ash.

v) Fall Mixes – October 1 to October 15

vi) No replacement of the minimum cement content with fly ash is permitted and Type HS cement cannot be used.

vii) Cold Weather Mixes – October 16 to the end of the construction season, or as defined by the Engineer

c) **Cold weather concrete:** Meet the requirements for cold weather concrete in below.

i) All Concrete placed after October 15 shall attain a compressive strength of 27.0 MPa in 7 days and shall be provided with cold-weather protection in accordance with CSA-A23.1.

ii) High early strength concrete placed after October 15 shall attain a compressive strength of 30.0 Mpa in 7 days and shall be provided with cold-weather protection in accordance with CSA-A23.1.

iii) Protection as described in CSA A23.1 shall be adequate to maintain concrete surface

iv) For slipformed (machine placed) concrete, limit slump as follows:

v) 20 ± 10 mm for curb, curb and gutter and New Jersey barrier, and

vi) 30 ± 10 mm for walk, monolithic walk and pavement.

vii) HE or HS cement may be substituted for Gu 10 cement, except as defined in Clause 7.9.2.1 Materials – Sulfate Resistant Concrete.

viii) Class A, C and E concrete may be subjected to air-void examination.

ix) Concrete mix designs shall be performed by a qualified laboratory or by a concrete supplier with the capability and a facility approved by the Engineer.

x) If requested, provide evidence that proportions in the mix design will produce concrete of the quality specified. Include strength tests on trial mixes made under plant conditions.

xi) Concrete production may not proceed until the City Engineer has approved the

xii) applicable mix design.

4.3.3.1.10 Concrete Forms and Accessories (32 16 13)

.1 Content

a) This section includes the supply of all labour, materials and equipment to complete the concrete formwork and falsework, including slipforming required for the work as indicated on the drawings or specified herein.

.2 Quality Assurance

a) At least one person thoroughly familiar with the type of material being installed, the referenced standards and the requirements of this section shall direct this portion of the Work.

b) Supply, erect and dismantle concrete formwork and falsework in accordance with CSA-A23.1-04 except where specified elsewhere.

c) The design of all formwork, falsework, scaffolding, shoring, etc. shall be the responsibility of the Contractor.

d) Supply, erect and dismantle falsework in accordance with CSA-S269.1 except where specified elsewhere.

.3 Materials

a) **Formwork Materials:** comply with CSA-S269.3, plain reusable pre-coated plywood sheets or formed steel panels.

b) **Falsework Materials:** comply with CSA-S269.1.

c) **Form Ties:** use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in the concrete surface.

d) **Form Release Agent:** chemically active release agents containing compounds that react with free lime in concrete resulting in water insoluble soaps.

e) **Void Forms:** expanded polystyrene ‘Frost Cushion” by Beaver Plastics, or equal.

f) **Form Stripping Agent:** colourless mineral oil, free of kerosene, with viscosity between 15 to 24 mm^{2}/s at 40□C, flashpoint minimum 150□C, open cup.

g) All other materials, not specifically described but required for proper completion of concrete formwork, falsework, scaffolding, or shoring shall be as selected by the Contractor, subject to the advance approval of the Engineer.

h) **Slipform Equipment:** of a design suitable to the type of work being constructed, for use with vibrators, and capable of uniformly extruding, spreading, shaping, and consolidating fresh concrete to produce a dense homogeneous mass with surfaces requiring a minimum of hand finishing; self-propelled and capable of automatically controlling alignment and grade from taut wires or string lines.

4.3.3.1.11 Fillcrete

.1 Content

a) This section includes the production and supply of unshrinkable fill (fillcrete) to be used for trench backfill.

.2 Submittals

a) Submit a mix design to the Engineer at least 14 days prior to initial fillcrete production. The mix design shall be performed by a qualified laboratory, or by the supplier, if approved by the Engineer.

b) The supplier shall notify the Engineer and shall resubmit a mix design whenever there is a change in materials, sources, or proportions.

c) If requested, the supplier shall provide proof that the proportions in the mix design will produce fillcrete of the quality specified.

d) No fillcrete shall be produced until the applicable mix design has been approved.

.3 Quality Assurance

a) The supplier shall provide facilities to permit the inspection of equipment, materials and processes used in the production and delivery of fillcrete and to obtain samples for testing.

b) Quality assurance sampling and testing for slump, air content and compressive strength shall be performed as follows:

i) Slump Tests:

1. **Methods:** to CSA-A23.2-1C and CSA-A23.2-5C.

2. **Test Frequency:** Slump tests shall be taken between the 10% and 90% points of discharge of a fillcrete load with every strength test and as required by the Engineer.

ii) Air Content Tests:

1. **Methods:** to CSA-A23.2-1C and CSA-23.2-4C.

2. **Test Frequency:** Air content tests shall be taken between the 10% and 90% points of discharge of a fillcrete load with every strength test and as required by the Engineer.

iii) Strength Tests:

1. **Methods:** to CSA-A23.2-3C and CSA-A23.2-9C.

2. **Test Frequency:** Standard tests for strength shall be conducted at a frequency of not less than one strength test per day per supplier, or as required by the Engineer.

.4 Materials

a) **Cement:** to CSA-A3001 of the following types.

i) Type GU – General use hydraulic cement

ii) Type HE - High early-strength hydraulic cement

iii) Type HS – High sulphate-resistant hydraulic cement

b) **Fine Aggregate:** to CSA-A23.1

c) **Water:** to clause 4.2.2, CSA-A23.1, clear, free from injurious amounts of oil, acid, alkali, organic matter, sediment, or other substance harmful to the mixing and curing of concrete.

d) **Air-Entraining Admixture:** to ASTM C260.Chemical Admixtures: to ASTM C494, including water-reducing agents, retarders and accelerators. Chemical admixtures shall not be used unless permitted in writing by the Engineer.

e) **Fly Ash:** to CSA-A3001 pozzolan type F

.5 Mix Design

a) Supply fillcrete in accordance with the following Table 4.3.82:

Table 4.3.82: Fillcrete Requirements

Compressive Strength at 28 Days (MPa)	Slump (mm)	Entrained Air (% by volume)	Maximum Aggregate Size (mm)	Minimum Portland Cement (kg/m^3)
Minimum - 0.15 Maximum - 0.40	100 ± 25	6.0 - 8.0	5	30

4.3.3.1.12 Reinforcing Steel

.1 Content

a) This section includes the supply of all labour, materials and equipment to complete the reinforcing steel required for the work, as indicated on the drawings or specified herein.

.2 Quality Assurance

a) At least one person thoroughly familiar with the type of material being installed, the referenced standards and the requirements of this section shall direct this portion of the Work.

b) Install steel reinforcement in accordance with CSA-A23.1 and CSA-W186.

c) Upon request, provide the Engineer with a certified copy of mill test report of the proposed reinforcing steel, showing physical and chemical analysis, a minimum of 2 weeks prior to ordering of reinforcing steel, or as necessary to facilitate a review.

d) Upon request, inform the Engineer of proposed source of material to be supplied.

.3 Submittals

a) Submit shop drawings, including placing of reinforcement.

b) Indicate on shop drawings, bar bending details, lists, quantities of reinforcement, sizes, spacing, location of reinforcement and any mechanical splices (only if approved by the Engineer), with identifying code marks to permit correct placement without reference

c) to structural drawings. Indicate sizes, spacing and locations of chairs, spacers and

d) hangers.

e) Prepare reinforcement drawings in accordance with the Reinforcing Steel Manual of Standard Practice - by the Reinforcing Steel Institute of Canada, or ACI 315 and ACI 315R, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.

f) Detail lap lengths and bar development lengths to CSA-A23.3.

g) Locate laps in co-ordination with the location of construction joints.

h) If in the opinion of the Engineer, the drawings are inadequate or inaccurately prepared, revise and resubmit all shop drawings.

.4 Materials

a) **Reinforcing Steel:** billet steel, Grade 400, deformed bars to CSA-G30.18, unless indicated otherwise. Weldable low alloy steel deformed bars to CSA-G30.18.

b) **Tie Bars:** to CSA-G30.18 grade 300, billet-steel, deformed bars, uncoated; and also to ASTM D3963 for epoxy-coated.

c) **Steel Dowels:** to CSA-G30.18, clean, straight, free from flattened or burred ends, uncoated and also to ASTM D3963 for epoxy-coated.

d) **Cold-Drawn Steel Wire:** to CSA-G30.3M, uncoated; to ASTM D3963 for epoxy coated.

e) **Welded Steel Wire Fabric:** to CSA-G30.5M, uncoated; to ASTM D3963 for epoxy coated.

f) Chairs, bolsters, bar supports, spacers: adequate for strength and support of reinforcing and live loads during construction conditions.

g) **Tie Wire:** Cold-drawn annealed steel to CSA-G30.3.

h) **Epoxy Coating:** to ASTM A775/A775M.

i) **Galvanizing:** to CSA-G164.

j) **Plain Round Bars:** to CSA-G40.21.

k) All other materials not specifically described but required for a complete and proper installation of concrete reinforcement, shall be as selected by the Contractor and be subject to the approval of the Engineer.

l) Supplementary cementing materials and their use to CSA-A3000.

.5 Fabrication

a) Fabricate reinforcing steel in accordance with CSA-A23.1, ACI 315, unless otherwise stated.

b) Obtain Engineer's approval for locations of reinforcement splices other than those shown on placing drawings.

c) Upon approval of Engineer, weld reinforcement in accordance with CSA-W186.

d) Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

e) Protect epoxy and paint coated portions of bars with covering during transportation and handling.

4.3.3.1.13 Slabjacking

.1 Content

a) This section includes the raising depressed or settled concrete boulevard walk back to grade. Slabjacking cannot be used to correct deficiencies in new construction before final acceptance.

.2 Submittals

a) Submit a grout mix design to the Engineer at least 14 days prior to initial use and when there is a change in material, source, or proportion.

.3 Quality Assurance

a) The quality assurance laboratory will take random samples of the grout and test for spread, shrinkage and compressive strength.

.4 Materials

a) **Grout Cement:** Type GU – General use hydraulic cement conforming to CSA-A3001

b) **Grout Aggregate:** to Section 4.3.2.1.7 - Aggregate, Designation 5 Class 5.

c) **Pozzolanic Material:** to CSA A3001 pozzolan type F

d) **Water:** to CSA-A23.1

e) **Admixtures:** powdered bentonite or water reducer as required.

f) **Material Sources:** All material shall be obtained from the same source or manufacturer. Submit a written request for change of source to the Engineer 10 days prior to proposed change. No change shall be made until approved by the Engineer.

.5 Equipment

a) **Grout Pump:** non-pulsing, positive displacement pump, with a pressure capacity of 350 to 1750 kPa at the discharge hose outlet, with a flow capacity of 5 m^3/h minimum and equipped with a device for accurately measuring the volume of grout pumped.

b) **Drilling Rig:** capable of drilling a 75 mm maximum diameter hole through the concrete slab.

.6 Mixes

a) The grout mix design shall meet the following criteria:

b) **Cement Content:** minimum of 160 kg/m^3.

c) **Fly Ash:** minimum of 160 kg/m^3.

d) **Compressive Strength:** minimum of 0.7 MPa at 28 days.

4.3.3.2 Construction

4.3.3.2.1 General

.1 The following articles represent the minimum requirements for some typical, key construction procedures for sidewalk, curb, and gutter construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

a) Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Article 2.3.1.

b) Any replacement of concrete due to road repairs, and/or otherwise, shall be built to the current engineering standards.

4.3.3.2.2 Cement Concrete (32 16 13)

.1 Inspection of Formwork and Reinforcement

a) Carefully inspect the installed work of all other trades prior to all of the Work of this section, and verify that all such work is complete to the point where this Work may properly commence.

b) Provide 48 hours notice and obtain the City's approval before placing concrete. Ensure that reinforcement, formwork, inserts or accessories are securely fastened and will not be disturbed during concrete placement.

c) Verify that all items to be embedded in concrete are in place.

d) Verify that concrete may be placed to the lines and elevations indicated on the Drawings with all required clearance for reinforcement. In the event of any discrepancy, immediately notify the City. Do not proceed with installation until all such discrepancies have been fully resolved.

.2 Delivery of Concrete

a) Deliver concrete to the job site to CSA-A23.1, as supplemented or modified below.

b) **Rotating Drum Trucks:** Transport concrete using only equipment with mixing or agitating capability.

c) Rotate the drum on the job site at mixing speed for 3 minutes immediately before discharge.

d) The minimum load size to be delivered to site is 3 cubic meters.

e) **Re-tempering with Water:** Do not add water after the initial introduction of mixing water at the plant except as follows:

i) When the slump at the point of initial discharge is less than specified

ii) Introduce additional water into the drum mixer in an amount not exceeding 12 litres/m^3, to bring the slump to within specified limits.

iii) Rotate the drum a minimum of 30 revolutions at mixing speed until the required uniformity of concrete is attained.

iv) Do not subsequently add any further water to the load.

v) If a load of concrete is re-tempered with water and the resulting slump exceeds the specified maximum slump, that load of concrete will be rejected.

vi) If the need for re-tempering with water becomes persistent or continuous, the Engineer or his representative may refuse to accept concrete loads that have been re-tempered with water.

f) Slow rotation of the drum for extended periods of time for the purpose of slump reduction in loads of concrete delivered with a slump exceeding the specified maximum slump will only be permitted for concrete placed by extrusion.

g) Re-tempering with Air-Entraining Admixtures is only permitted under the following conditions:

i) Re-tempering on site with an approved air-entraining admixture shall only be performed by a quality control technician working for the concrete supplier or the Contractor. Dry, powdered, bagged or pre-measured liquid air-entraining admixtures may be added by the concrete truck operator under the direction of the supplier's quality control technician. For re-tempering purposes the concrete supplier shall use a comparable air-entraining admixture to what was originally approved for use in the mix design. Rotate the drum for 3 to 5 minutes or until the mix is uniform, after the addition of the air entraining admixture.

ii) The quality assurance technician shall perform an air content test on each load of concrete re-tempered with air-entraining admixtures and shall immediately provide the test results to the Engineer.

iii) Guidelines for re-tempering with air-entraining admixtures

Table 4.3.83: Re-Tempering Guidelines with Air-Entraining Admixtures

Measured Air Content (%)	Action
5.0 – 5.4	Addition of water or air-entraining admixtures as deemed necessary by the supplier to meet specifications
4.0 – 4.9	Air-entraining admixtures or air-entraining admixtures and water must be added as deemed necessary by the supplier to meet specifications
< 3.9	No re-tempering with air-entraining admixtures or water is permitted; load will be rejected

iv) When re-tempering with air-entraining admixtures, the supplier will be given one opportunity to meet the specified air content.

v) When initial load requires re-tempering, the quality assurance technician shall perform an air content test to verify air content on subsequent loads until such timeair content is acceptable.

vi) If the need for re-tempering with air-entraining admixtures becomes persistent or continuous, the Engineer or his representative may refuse to accept concrete loads that have been re-tempered with air-entraining admixtures.

vii) The use of de-airentraining admixtures is not permitted.

viii) A load of concrete will be rejected if it is re-tempered with air-entraining admixtures and the resulting air content exceeds the specified maximum air content.

ix) A load of concrete that is rejected at the jobsite may not be re-tempered at the concrete plant with cement, aggregate, sand or admixtures and subsequently returned to the jobsite.

x) On site mix adjustments with cementitious materials, sand aggregate or any chemical admixtures other than air-entraining admixtures and superplasticizers will not be permitted.

h) When the ambient air temperature in the shade is 23º C or higher, concrete at time of placement shall not have a temperature exceeding 30º C.

i) When the ambient air temperature is lower than 5º C, the concrete delivered to the site shall have a temperature between 15º C and 30º C.

j) **Discharge Time:** Complete the discharge of concrete within 90 minutes of the initial introduction of mixing water to the cement and aggregate at the plant. The discharge time may be extended to 120 minutes by incorporating hydration control admixtures. The supplier must submit mix designs for approval and provide evidence that the plastic concrete properties (slump, air content and temperature) can be maintained through the extended discharge time period.

k) **Delivery Record:** Provide the Engineer with a delivery ticket showing the batch plant location, the supplier's name, ticket and truck numbers, mechanically punched date and time of initial plant mixing, class and mix design designation, cement type and aggregate sizes, type and amount of admixtures, water added, volume of concrete, site arrival time, start and end of discharge time and other information requested by the Engineer.

.3 Placing Concrete

a) Handle, deposit and consolidate fresh concrete to CSA-A23.1 and as supplemented below.

b) Moisten the surface of the subgrade or subbase before placing concrete to minimize absorption of water from the deposited concrete. Do not create mud, nor let water pond.

c) Ensure that reinforcement and formwork are thoroughly clean and wetted before placing concrete.

d) Do not place concrete during rain or when there is imminent danger of rain or if the weather, in the opinion of the Engineer, is not suitable.

e) Place hot and cold weather concrete to CSA-A23.1. Ensure that the procedures used are approved by the Engineer.

f) Pour concrete continuously and as rapidly as possible between predetermined construction joints to the approval of the Engineer.

g) Locate construction joints to Section 03100 - Concrete Forms and Accessories.

h) Consolidate concrete in accordance with CSA-A23.1.

i) Concrete cover over reinforcing steel shall be to CSA-A23.1.

.4 Finishing

a) Perform the initial and final finishing of the plastic concrete surfaces to CSA-A23.1 and as supplemented below.

b) Do not apply water to concrete the surface to facilitate finishing under any circumstances. To retain surface moisture and facilitate concrete finishing, the contractor may elect to fog the surface with Master Builders Confilm or an approved equivalent.

c) Protect the Work from rain to avoid excessive moisture on the unfinished surface and to prevent pitting to the finished surface if still plastic.

d) Concrete finishing shall be performed by or under the direction of certified Journeyman

e) concrete finishers.

.5 Curing

a) Curing exposed concrete surfaces using a specified curing compound applied with a pressurized spray nozzle. Curing compound shall be applied within 5 to 15 minutes after completion of the finishing process and cover the entire exposed surface with an unbroken and uniform film.

4.3.3.2.3 Concrete Sidewalk, Curb and Gutter, and Slabs

.1 Types of Construction

a) The Contractor has the option of constructing the following types of work by hand forming or by slipforming methods, or by a combination of both. Construct as detailed on plans and drawings, or in the contract Special Provisions, or as directed by the Engineer.

i) Curb, Curb and Gutter, Gutter

1. Construct curb, curb and gutter and gutter on prepared subgrade, cement stabilized subgrade, granular base course, soil cement, or asphalt concrete, as indicated on the drawings.

ii) Walk

1. Construct walk on a granular base course.

iii) Monolithic Walk Curb and Gutter

1. Construct the walk portion of monolithic walk, curb and gutter on a granular base course. If the walk portion is wider than 2 m, place longitudinal and transverse crack control joints at the proper spacing.

iv) Curb Ramps

1. Curb ramps are an incline built monolithically into curb cut and walk. Construct curb ramps on a granular base course.

v) Alley Crossings

1. The Engineer will set stakes for alley crossings. Construct alley crossings on a granular base course and monolithically with the drop curb and gutter. All alley crossings are to be Class A concrete.

vi) Commercial and Private Crossings

1. Commercial and private crossings will be staked by the property owner who has obtained the required permit. Do not construct the crossing beyond the extension of the property line across the walk or boulevard. Construct commercial or private crossings on a granular base course and monolithically with the drop curb and gutter. Commercial crossings are to be Class A concrete.

vii) Median or Island Strip

1. Construct median or island strips on a granular base course between curbs in the median or island.

viii) Slab-on Median or Island

1. Construct slab-on medians or islands on the existing pavement surface.

.2 Preparation

a) Verify that the prepared subgrade or base is ready for concrete placement and repair any deterioration or damage.

i) Cut behind Curb

1. Compact soil to Section 4.3.2.2.5 - Subgrade Preparation and trim to within 25 mm of the back of curb.

ii) Granular Base Course

1. The granular base course under concrete walk, curb ramps, lane crossings, commercial and private crossings, median or island strips and the walk portion of monolithic walk, curb and gutter shall consist of 150 mm compacted thickness of Designation 3 Class 20A aggregate. Compaction and tolerance testing shall be to Section 4.3.2.2.10 – Granular Base Courses.

.3 Hand Forming

a) Place forms to Section 4.3.3.2.11 - Concrete Forms and Accessories and as supplemented below.

b) Use flexible forms to construct curves of less than 40 m radius.

c) Place a minimum 50 m of forms before a concrete pour to allow checking for true line and grade.

d) The Engineer will not allow the use of forms that are out of shape, dented, rough, or otherwise unsuitable.

.4 Placing Reinforcement

a) Place reinforcement of the type, size and spacing as detailed on drawings or as required by Engineer, to Section 4.3.3.2.13 - Reinforcing Steel.

.5 Placing Concrete

a) Place concrete to Section 4.3.3.2.2 - Cement Concrete and Section 4.3.3.2.4- Concrete for Roadways and as supplemented below.

b) Use 50 mm pencil vibrators for curb and gutter and approved vibrating screeds for walk and slabs.

c) Place concrete continuously until the scheduled pour is complete. Arrange the rate of concrete delivery to ensure that the discharge interval between successive loads does not exceed 30 minutes. If the discharge interval is greater than 30 minutes, place a construction joint.

d) Where possible curbline walk, curb ramps and curb crossings shall be poured monolithically. Where it is possible to pour the curbline walk, curb ramps and curb crossings monolithically the use of dowels and joint sealant at the back of the curb is not permitted.

.6 Slipforming

a) Slipform concrete to Section 4.3.3.2.11 - Concrete Forms and Accessories and as supplemented below.

b) Hand form and place concrete at corners, driveways and catch basins concurrent with the slipforming operation. Where concurrent work is not practical, complete this work within 7 days of the slipforming of adjacent work.

.7 Finishing

a) Finish concrete to Section 4.3.3.2.2 - Cement Concrete and Section 4.3.3.2.4 - Concrete for Roadways and as supplemented below.

b) Tool all edges and joints to a width of 50 mm and round edges to a 6 mm radius unless indicated otherwise.

c) Apply a brush final finish longitudinally along curb and gutter and transversely on walk and slabs.

d) Name Plate

e) Stamp the Contractor's name and year of construction in the plastic concrete on:

i) The top of the curb in each block or at 200 m intervals, whichever is less and

ii) The walk at the end of each block on an extension of a property line.

.8 Crack-Control Joints

a) Formed or tooled to Section 4.3.3.2.4 - Concrete for Roadways and as supplemented below.

b) Joint Size

c) 3 mm to 5 mm wide at the following depths:

i) **For curb and gutter:** 50 mm minimum to a maximum of 25% of the gutter depth.

ii) **For walk and slabs:** 25 mm minimum to a maximum of 25% of the walk or slab thickness.

iii) **Joint Spacing:** 3 m maximum.

iv) **Surface Dummy Joints:** tooled 5 mm wide by 10 mm deep, centred between contraction joints across walk and slabs. In monolithic construction, place surface joints across the walk portion and contraction joints on the curb and gutter, both joints being on same line. Where required, place a longitudinal surface joint on walk and slabs continuing on through alley crossings and driveways.

.9 Transverse Construction Joints

a) Place to Section 4.3.3.2.4 - Concrete for Roadways and as supplemented below.

b) Use 10M deformed tie bars at 300 mm spacing and extending 300 mm minimum into both sides of the joint.

c) Vary joint spacing near the end of a concrete pour as follows:

d) If a concrete pour ends within 300 mm of a required joint location, average the spacing of last two joints.

e) If a concrete pour ends within 800 mm of a required joint location, average the spacing of last 3 joints.

.10 Longitudinal Construction Joints

a) Place according to Section 4.3.3.2.4 - Concrete for Roadways and as supplemented below.

b) Use 10M deformed tie-bars at 1 m spacing and extending 300 mm minimum into both sides of the joint.

.11 Joints Abutting Existing Curb

a) Form a 10 mm wide by 30 mm deep slot between the back of curb and the walk or slab.

b) Fill the slot with a specified joint sealant.

.12 Isolation Joints

a) Construct to Section 4.3.3.2.4 - Concrete for Roadways.

.13 Protection and Curing

a) Protect and cure concrete to Section 4.3.3.2.4 - Concrete for Roadways.

.14 Backfilling

a) Backfill Material

i) If excavation is part of the work, use approved material from site excavation. If excavation is not part of the work, supply fill material approved by the Engineer.

b) Behind Curb

i) Backfill with suitable clay within 7 days of concrete placement and before placing the initial paving course against the curb and gutter, a minimum of 300 mm width behind the curb in two 150 mm lifts. Tamp each lift with mechanical tampers to a minimum 95% of maximum density. Backfill to the top of curb elevation, unless topsoil placement or walk/slab construction immediately follows, in which case leave backfill low to accommodate subsequent work.

c) Along Slab Edges

i) Backfill along the edge of the walk or slab as soon as practical after the removal of concrete forms, allowing for topsoil depth, unless otherwise directed by the Engineer. Tamp with mechanical tampers a minimum 300 mm width along the slab edge to a minimum 92% of maximum density.

d) Maximum Density

i) As used in this Section, is the dry unit mass of sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

.15 Field Quality Control

a) Walk or Slab Surface Tolerances

i) Maximum variation under a 3 m straightedge: 6 mm.

ii) Maximum variation from walk crossfall: ±1% provided the finished crossfall is not less than 1% or more than 4%.

b) Gutter Surface and Curb Top Tolerances

i) Maximum variation under a 3 m straightedge: 6 mm.

c) Grade of Gutter Lip and Walk/Slab Tolerances

i) Maximum variation from designated elevation at any station as established from the survey stake: ±6 mm.

ii) Maximum variation from the difference in designated elevations between 2 consecutive stations as established from survey stakes, provided there is positive drainage in the designated direction: ±12 mm.

d) Lip of Gutter Alignment Tolerances

i) Maximum deviation: ±12 mm in 30 m.

e) When Tolerances Exceeded: If any of the tolerances above are exceeded, remove or correct the concrete work in question as directed by the Engineer.

f) Walk, Median Strip, Slab-on, Ramps or Crossing Thickness:

i) At the City's request, the quality assurance laboratory will take one or more sets of cores from suspect concrete walk or crossing, each set comprising 3 cores whose average thickness represents not more than 500 m^2 of concrete walk or crossing. If the average core thickness is deficient that area will be assessed a pay factor according to Table 4.3.84

Table 4.3.84: Concrete Walk/Crossing Thickness Pay Factors

THICKNESS DEFICIENCY (mm)	PAY FACTOR (% of Contract Price)
6	100.0
7	97.0
8	93.7
9	90.0
10	85.5
11	80.5
12	75.0
13	68.0
14	60.0
15	50.0
Over 15	Remove and replace

ii) Concrete walk or crossing with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

.16 Rejected Concrete Work

a) Remove and replace rejected concrete work by full segments or slabs between crack control or construction joints.

.17 Protection of Finished Work

a) Protect finished work from damage. Repair if damaged.

b) Do not open walk or crossings to traffic until permitted by the City. When opening to traffic, leave walk or crossings clean and free of debris and remove signs and barricades no longer needed.

4.3.3.2.4 Concrete for Roadways

.1 Placing

a) Place concrete to Section 4.3.3.2.2 Cement Concrete.

.2 Finishing

a) Finish concrete to Section 4.3.3.2.2 Cement Concrete, and as supplemented below:

b) **Brush or Broom Finish**: Use a brush or a broom with nylon bristles that can form surface grooves no deeper than 3 mm. Remove excess water from the bristles before brushing. Brush in the designated direction.

.3 Joints

a) Construct joints as required in each type of construction to the following standards as applicable.

i) **Crack-Control Joints:** intended to control the location of shrinkage cracks in hardening concrete. Construct joints to the indicated dimensions, spacing, and pattern by any of the following methods:

ii) **Formed Joint:** Form the groove by inserting a metal or fibre strip, or polyethylene film into the plastic concrete. Finish the edges to a 6 mm radius. Remove the insert immediately after the initial set of the concrete. Seal the joint with a specified sealant.

iii) **Tooled Joint:** Hand form the groove using a jointing tool with a thin metal blade to impress a plane of weakness into the plastic concrete. Finish the edges to a 6 mm radius. Seal the joint with a specified sealant.

iv) **Sawed Joint:** Cut the groove with a concrete saw as soon as the concrete surface has hardened sufficiently to resist raveling as the cut is made, but before shrinkage cracks form in the concrete. The Contractor is responsible for the proper timing of the saw cut. Immediately flush the saw cut clean with water. Once the joint surfaces are dry, seal the joint with a specified sealant.

v) **Isolation Joint:** required where concrete is placed adjacent to an immovable structure or where indicated on the Drawings. Construct the joint by sawing or forming to create a clean break through the full cross-section of the concrete member. Make the joint wide enough to permit a snug fit for the pre-formed joint filler. Alternatively, place the pre-formed joint filler against the structure and pour the concrete against the preformed joint filler.

vi) **Construction Joint:** required between concrete pours or for joining new concrete to existing work. Construct the joint with a keyway, dowels or tie bars as detailed on the drawings or as directed by the Engineer. Finish edges to a 6 mm radius. Vertically trim the existing concrete by sawing at least 50 mm deep and breaking. Leave the joint form in place until the concrete has set, then remove the joint form without damaging the concrete.

.4 Protection and Curing

a) Protect freshly placed concrete from freezing, premature drying, temperature extremes, adverse weather conditions, and physical disturbance to clause 7.4, CSA-A23.1, and as supplemented below.

i) **Cold Weather Protection:** Concrete shall be protected from freezing for a minimum of 7 days after placement or for the time necessary to achieve 75% of the specified 28-day compressive strength.

ii) **Membrane Curing:** Cure exposed concrete surfaces using a specified curing compound applied with a pressurized spray nozzle. Curing compound shall be applied within 5-15 minutes after final finishing and cover the entire exposed surface with an unbroken and uniform film at a rate depending on surface roughness but not less than 1 litre per 4 m_2 of surface. Membrane curing will not be required when the maximum daily air temperature for the 72 hours following placement of the concrete is not expected to be greater than 5º C.

iii) **Moist Curing:** Use where specified or directed by the Engineer. After the concrete has set, maintain exposed surfaces continuously moist using wet burlap or polyethylene film in contact with the concrete for a minimum of 7 consecutive days after placement when Type GU or Type HS cement is used, or a minimum of 3 consecutive days when Type HE cement is used.

iv) **Surface Sealant:** An approved sealing solution shall be sprayed on all exposed concrete surfaces in accordance with the manufacturers recommendations. The concrete shall be dry and swept clean prior to the application of the sealant.

.5 Field Quality Assurance

a) The contractor and the concrete supplier shall assist the field technician in obtaining samples for quality assurance testing. The contractor shall suspend pouring operations after sampling until the results of the field quality tests are known.

b) Inadequate Protection and Curing

i) For concrete where the surface temperature is measured to be below 0ºC the concrete may be accepted subject to a pay factor according to Table 4.3.85.

Table 4.3.85: Cold Weather Protection Pay Factors

TIME AFTER PLACEMENT THAT CONCRETE TEMPERATURE DROPS BELOW 0º C	PAY FACTOR (% of Contract Price)
96 hours	100.0
72 to 96 hours	80.0
48 to 72 hours	70.0
< 48 hours	Remove and Replace

c) Deficient Slump

i) For any load of concrete, if the measured slump is outside the specified limits, a check test is taken on another portion of the load, or a retest is done if re-tempering with water is permitted by the Engineer. If the second test fails, the Engineer may reject that load of concrete including removal of the portion already poured. When the slump exceeds the maximum allowable, no retesting of the concrete will be allowed

d) Deficient Air Content

i) For any load of concrete, if the tested air content is outside the specified limits, the Engineer will require one of the following:

ii) **Air content between 5.0% and 5.5%:** Concrete poured from the load shall be removed and the rest of the load shall be discarded. However, the Contractor may elect at the Contractor's risk to pour the rest of the load provided that within 40 days of placement, the Contractor submits to the Engineer proof that the load of concrete meets the required spacing factor as determined from air void examination performed by a qualified laboratory to CSA A23.2, failing which the Contractor shall remove and replace all concrete represented by the failed test.

iii) **Air content below 5.0%:** Concrete poured from the load shall be removed and the rest of the load shall be discarded.

iv) **Air content above 8.0%:** Except for class C concrete, concrete poured from the load shall be removed and the rest of the load discarded. For class C concrete where high early strength is not specified, the concrete will be accepted if the specified 28 day strength is met.

v) If the measured air content is below the specified minimum air content, then the contractor may elect to re-temper with air entraining admixtures to Section 4.3.3.2.2 - Cement Concrete.

vi) When Air Void Examination Is Required:

vii) The quality assurance laboratory will drill cores from the hardened concrete for air void examination to Section 4.3.3.2.2 Cement Concrete, Quality Assurance – Air-Void Examination, at a frequency of at least one core for each 2,000 m of local and collector sidewalk, curb and gutter or monolithic walk, curb and gutter, or as requested by the City for arterial, industrial or commercial roadways or small residential subdivisions.

viii) Where concrete has been rejected and is to be removed for not meeting the spacing factor requirement in Section 4.3.3.2.2 Cement Concrete, Quality Assurance – Air Void Examination, the Contractor at the Contractor's expense shall prove that the concrete left in place at both ends of the removal meets the specified spacing factor by air void examination to be performed by a qualified laboratory to Section 4.3.3.2.2 Cement Concrete. The test results shall be submitted to the Engineer.

e) Deficient Strength:

i) Concrete work for roadways represented by a strength test result which is less than specified may be accepted subject to a pay factor according to Table 4.3.86. If strength deficiencies persist, the Engineer will require changes in the concrete mix design for the remainder of the work.

Table 4.3.86: Concrete Strength Pay Factors

CYLINDER STRENGTH (% of Specified Strength)	PAY FACTOR (% of Contract Price)
97.0	100.0
96.0	99.2
95.0	98.2
94.0	96.9
93.0	95.4
92.0	93.6
91.0	91.7
90.0	89.4
89.0	86.7
88.0	83.5
87.0	79.7
86.0	75.5
85.0	70.0
Under 85.0	No Payment

f) Optional core strength test:

i) The Contractor has the option at the Contractor's expense of providing evidence of strength by coring and testing to CSA-A23.2-14C moisture conditioned, by a qualified laboratory within 7 days of a failed 28-day cylinder test or within 3 days of a failed 7-day cylinder test. Three cores shall be drilled from the hardened concrete represented by the failed cylinder strength tests at locations approved by the Engineer.

ii) The average strength of the 3 cores shall equal 100% of the specified cylinder strength; if the concrete fails to meet 100% of the specified cylinder strength then the concrete represented by the testing will be subject to the pay factors of Table 4.3.86 on the basis of the cylinder strength tests.

g) Optional core strength test results shall be submitted to the City Engineer.

4.3.3.2.5 Concrete Base

.1 Preparation

a) Have prepared subgrade or sub-base inspected by the City prior to placing concrete.

b) Repair and retest disturbed subgrade or sub-base and remove debris and loose material from the surface.

.2 Hand Forming and Placing Concrete

a) Place forms, reinforcement if required and concrete to Section 4.3.3.2.2 - Cement Concrete, Section 4.3.3.2.4 - Concrete for Roadways, Section 4.3.3.2.11 - Concrete Forms and Accessories and Section 4.3.3.2.13 - Reinforcing Steel and as supplemented in this section.

b) Place concrete continuously until scheduled pour is complete. Arrange the rate of concrete delivery to ensure that the discharge interval between successive loads does not exceed 30 minutes. If this discharge interval is exceeded, place a construction joint.

.3 Slipforming

a) Place concrete by slipform paver to Section 4.3.3.2.11 - Concrete Forms and Accessories, and as supplemented below.

b) Remove excess mortar that may accumulate on slipformed vertical edges.

c) If the slab edge sags, repair immediately by hand forming; do not use concrete mortar to top off the sag. If edge sagging persists, suspend operations and perform corrective measures.

.4 Finishing

a) Finish concrete to Section 4.3.3.2.2 - Cement Concrete and Section 4.3.3.2.4 - Concrete for Roadways.

b) Continually check the concrete surface while it is still plastic to ensure that surface and grade tolerances are met. Immediately correct excessive variations.

.5 Joints

a) Crack-Control Joints: formed or tooled, to Section 4.3.3.2.4 - Concrete for Roadways; at 6 m maximum spacing.

b) Isolation and Construction Joints: to Section 4.3.3.2.4 - Concrete for Roadways.

.6 Protection and Curing

a) Protect and cure concrete to Section 4.3.3.2.4 - Concrete for Roadways

.7 Backfill Along Alley Edges

a) Backfill areas between alley pavement and parking lots or driveways with specified granular material compacted to a minimum of 97.0% of maximum density according to ASTM D698 Method A.

b) Backfill other areas along alley edges with 150 mm of lightly tamped topsoil shaped to match adjacent landscaped areas.

.8 Field Quality Control

a) **Surface:** Maximum variation under a 3 m straightedge:

i) Parallel to the direction of travel: 6 mm.

ii) Transverse to the direction of travel: 6 mm.

iii) Grade: ±6 mm maximum variation from designated elevation.

b) **Thickness:** At the City's request, the quality assurance laboratory will take one or more sets of cores from suspect concrete base, each set comprising 3 cores whose average thickness represents not more than 500 m^2 of concrete base.

i) **Deficient Thickness:** If the average core thickness is deficient, that area of concrete base will be assessed a pay factor according to Table 4.3.87.

Table 4.3.87: Concrete Base Thickness Pay Factors

THICKNESS DEFICIENCY (mm)	PAY FACTOR (% of Contract Price)
6	100.0
7	97.0
8	93.7
9	90.0
10	85.5
11	80.5
12	75.0
13	68.0
14	60.0
15	50.0
>15	Remove and replace

ii) **Excess Thickness:** Concrete base with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

.9 Rejected Concrete Base

a) Remove and replace rejected concrete base by full slabs between transverse and longitudinal joints.

.10 Asphalt Surfacing

a) Asphalt surfacing to Section 4.3.2.2.14 - Hot-Mix Asphalt Paving may proceed when the concrete has attained at least 75% of its specified strength, as confirmed by a test on a field-cured cylinder.

b) If surfacing cannot proceed on schedule, do not allow vehicular traffic on the new concrete base until cylinder testing has confirmed that the concrete has attained 75% of its specified strength.

c) The Contractor shall at the Contractor's expense remove and replace asphalt surfacing if the concrete base requires removal due to unacceptable strength test results.

.11 Opening to Traffic

a) Do not open finished pavement to traffic until directed by the City.

b) When opening to traffic, leave pavement clean and free of debris and remove signs and barricades no longer required.

4.3.3.2.6 Concrete Pavement

.1 Preparation

a) The prepared subgrade or sub-base shall be inspected by the City prior to placing concrete.

b) Repair and retest disturbed subgrade or sub-base and remove debris and loose material from the surface.

.2 Slipforming

a) Slipform concrete to Section 4.3.3.2.11 - Concrete Forms and Accessories and as supplemented below.

b) Remove excess mortar that may accumulate on a slipformed vertical edge.

c) If slab edge sags, repair immediately by hand forming; do not use concrete mortar to top off the sag. If edge sagging persists, suspend operations and perform corrective measures.

.3 Handforming and Placing Concrete

a) On areas impractical for slipforming, place forms, reinforcement if required and concrete to Section 4.3.3.2.2 - Cement Concrete, Section 4.3.3.2.4 - Concrete for Roadways, Section 4.3.3.2.11 - Concrete Forms and Accessories and Section 4.3.3.2.13 - Reinforcing Steel and as supplemented below.

b) Place concrete continuously until the scheduled pour is complete. Arrange the rate of concrete delivery to ensure that the discharge interval between successive loads does not exceed 30 minutes. If the discharge interval is exceeded, place a construction joint.

.4 Finishing

a) Finish concrete to Section 4.3.3.2.2 - Cement Concrete and Section 4.3.3.2.4 - Concrete for Roadways. Apply a burlap final finish.

b) Continually check the plastic concrete surface to ensure that surface and grade tolerances are met. Immediately correct excessive variations.

.5 Joints

a) Crack-Control Joints

i) Sawcut, to Section 4.3.3.2.4 - Concrete for Roadways, at a 6 m maximum spacing, to the width and depth detailed on the drawings.

b) Isolation and Construction Joints to Section 4.3.3.2.4 - Concrete for Roadways.

.6 Protection and Curing

i) Protect and cure concrete to Section 4.3.3.2.4 - Concrete for Roadways.

.7 Backfill Along Alley Edges

a) Backfill areas between alley pavement and parking lots or driveways with specified granular material compacted to a minimum of 97% of maximum density according to ASTM D698 Method A.

b) Backfill other areas along alley edges with 150 mm of lightly tamped topsoil shaped to match adjacent landscaped areas.

.8 Site Quality Control

a) Surface Tolerance

i) Maximum variation under a 3 m straightedge:

ii) Mainline parallel to direction of travel: 3 mm

iii) Transverse to direction of travel and at intersections and ramps: 6 mm

b) Grade Tolerance

i) Maximum variation from designated grade elevations: ±3 mm

c) Correction of Hardened Surface

i) The following techniques shall be used to correct excessive variations from flatness or grade once the concrete has set.

ii) Areas higher than the designated grade from 3 mm to 15 mm: Grind down with an approved machine to within tolerance and not to a polished surface but to a texture as close as possible to a burlap finish.

iii) Areas exceeding 3 mm below, or exceeding 15 mm above, the designated grade: Remove and replace pavement to the full width between longitudinal joints and not less than 1.5 m in length. If the area extends to within 1.5 m of a transverse joint, replace the pavement to that joint.

d) Deficient Thickness

i) If the average core thickness is deficient, that area of concrete pavement will be assessed a pay factor according to Table 4.3.88.

Table 4.3.88: Concrete Pavement Thickness Pay Factor

THICKNESS DEFICIENCY (mm)	PAY FACTOR (% of Contract Price)
3	100.0
4	99.5
5	98.6
6	97.4
7	95.6
8	93.2
9	90.0
10	85.5
11	80.5
12	75.0
13	68.0
14	60.0
15	50.0
Over 15	Remove and Replace

e) Excess Thickness

i) Concrete pavement with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

f) Rejected Concrete Pavement

i) Remove and replace rejected concrete pavement by full slabs between transverse and longitudinal joints.

g) Opening to Traffic

i) Do not open new pavement to vehicular traffic until cylinder testing has confirmed that the concrete has attained 75% of the specified strength, or until directed by the City.

ii) When opening the new pavement to traffic, leave the pavement clean and free of debris and remove signs and barricades no longer required.

4.3.3.2.7 Concrete Paving Units

.1 Preparation

a) Construct Class B concrete base to Section 4.3.3.2.4 – Concrete for Roadways with the following modified tolerances:

i) Smoothness: 8 mm maximum variation under 3 m straightedge.

ii) Grade: 0 mm maximum variation above designated elevation.

iii) 8 mm maximum variation below designated elevation.

b) The Class B concrete base shall be inspected by the City before placing bedding sand. Repair imperfections and clean surface of debris and loose material. Do not use bedding sand for corrective levelling.

c) **Edge Restraint:** Install as detailed on drawings.

d) **Weed Barrier:** Install as detailed on drawings.

e) **Insulation:** Install as detailed on drawings.

.2 Sand Bedding

a) Bedding sand shall have a uniform moisture content of 6% to 8% by mass when spread.

b) Spread sand uniformly and screed lightly to achieve a uniform thickness of 30 ±8 mm after placement and tamping of pavers.

c) Alternatively, spread sand in a loose lift of sufficient thickness to achieve 2/3 of the required thickness and lightly tamp with one pass of a plate vibrator. Then spread and screed the remaining lift of loose sand onto which the pavers can be laid.

d) Once screeded, the sand shall not be disturbed. If screeded sand is disturbed or exposed to rain or dew, it shall be removed or loosened, re-spread and re-screeded.

e) Place no more sand than will be covered with paving units on the same day.

.3 Laying Paving Units

a) Lay paving units on sand bed in the specified pattern, leaving joint spaces no wider than 3 mm.

b) Arrange units to maximize the use of full units and to minimize the use of slivers. Fill edge gaps with units cut with a masonry saw.

c) Use planks for foot and wheelbarrow traffic to prevent disturbance of units prior to tamping.

d) Tamp units with a flat plate vibrator shortly after laying to bring surface to correct grade, eliminate lipping between adjacent units and consolidate sand bedding. Remove and replace damaged units.

e) Tamp all units laid in a day's work except units within 1 m of laying edge.

f) Brush and vibrate joint sand to completely fill joints between units. Sweep and remove excess sand and leave finished surface clean.

g) Check finished surface to ensure surface and grade tolerances are met.

.4 Field Quality Control

a) Surface Tolerance:

i) 6 mm maximum variation under 3 m straightedge.

ii) 2 mm maximum differential level between adjacent units and between units and edge restraint.

b) Grade Tolerance:

i) 6 mm maximum variation above designated elevation.

ii) 0 mm maximum variation below designated elevation.

.5 Protection and Cleanup

a) Do not open newly installed paving units to pedestrian or vehicle traffic until directed by the Engineer.

b) Before opening to traffic, ensure that surface is clean and free of surplus material and debris.

4.3.3.2.8 Roller Compacted Concrete

.1 Subbase Preparation

a) Prepare the subgrade according to Section 4.3.2.2.5 – Subgrade Preparation, or alternatively stabilize the subgrade with cement according to Section 4.3.2.2.6 – Cement Stabilized Subgrade. If required, construct a granular subbase according to Section 4.3.2.2.10 – Granular Base Course.

b) Moisten the surface of the subgrade or subbase, without creating mud or the ponding of water, to minimize absorption of water from the RCC mix to be deposited.

.2 RCC Production

a) Display the approved job mix formula in sight of the plant operator. Failure to display will result in a shutdown order by the Engineer. Do not make changes to the formula without the Engineer’s concurrence.

.3 Unsuitable Weather Conditions

a) Wet Weather

i) Do not place RCC during rain or when rain is imminent. Take precautions that a light mist will not result in RCC tracking by the rollers.

b) Cold Weather

i) Do not place RCC on frozen subbase or subgrade, and when ambient air temperature is 5oC and falling, or when 0oC weather is expected within 48 hours.

ii) Do not place RCC after September 30, unless permitted by the Engineer as a result of favourable weather.

iii) Protect RCC from freezing for at least seven days.

c) Hot Weather

i) Provide protective measures from hot-weather and drying conditions, according to Clause 21.2.2, CSA-A23.1 (current edition).

ii) If the above measures are not effective in preventing plastic cracking of the RCC surface, suspend placement immediately until favourable conditions exist.

.4 Placing RCC

a) Test Strip

i) The Contractor shall construct a test strip of thickness, equal to the design thickness with a minimum of 75 tonnes of mix. The strip will be used to resolve anticipated problems with equipment, mix behaviour, compaction, or strength characteristics. The test strip shall be constructed at a location chosen by the Contractor, at least 35 days prior to the start of paving operations. The Contractor shall cooperate fully with the Engineer during the construction and testing of the test strip.

b) Transporting

i) Transport the RCC mixture to site in dump trucks with boxes cleaned out before loading, and provided with protective covers, properly secured in place until discharge. The trucks shall dump directly into the hopper of the paver unless placement is by hand as directed by the Engineer. Dumping the RCC mix directly onto the underlying course will not be permitted. Hauling over the freshly placed RCC will not be permitted.

c) Continuity

i) Coordinate RCC delivery, so that the mix can be spread and rolled within the appropriate time limit and to ensure uniform progress of the paver until the scheduled spread is complete. The time between mixing and placing the RCC shall not exceed 45 minutes. This time limit may be increased or decreased by the Engineer dependent upon ambient conditions of temperature and humidity.

d) Spreading

i) With the paver, spread the mix to a sufficient depth that will produce the specified thickness when compacted and conform to the required cross-section and grade. Operate the paver in a manner that will prevent segregation and produce a smooth, continuous surface without tearing, pulling or shoving. Placing of the RCC mix shall be done in a pattern so that the water from previously placed RCC will not pose a runoff problem on the fresh RCC surface.

e) Segregation

i) If segregation occurs, suspend the spreading operation until the cause is determined

ii) and corrected. Rake off the segregated, coarse aggregate before rolling. Broadcasting

iii) or fanning of the RCC mixture onto areas being compacted is not permitted.

f) Length of Spread

i) Limit the length of the RCC spread to that, which can be compacted and finished within the appropriate, time limit under the prevailing air temperature, wind and other climactic conditions.

g) Placing Adjacent Lanes

i) Not more than 45 minutes shall elapse between the placement of the RCC in adjacent lanes, unless a cold joint is provided. Joints shall be made to assure a continuous bond between the old and the new sections of pavement. The time limit may be increased or decreased, depending on ambient conditions of temperature and humidity.

.5 Compaction and Finishing

a) Required Density

i) The Contractor is responsible for achieving 98% of the maximum dry density, when the maximum dry density is defined as the dry unit mass of the sample at the optimum moisture content as determined in the laboratory to ASTM D1557.

b) Start of Rolling

i) Begin compaction rolling with fifteen (15) minutes after spreading the RCC mix. Any additional delay will result in the coring of the affected areas at the Contractor’s expense to ensure that it meets the requirements of this specification.

c) Rolling Pattern

i) Establish a rolling pattern that will achieve the required density with a minimum number of roller passes.

d) Vibratory Rolling

i) During vibratory compaction, never let the roller start or stop in vibratory mode. Stagger the stopping point of successive rolling passes to avoid forming a depression on the surface.

e) Surface Check

i) Continually check the RCC surface, while still plastic, to ensure surface and grade tolerances are met. Immediately correct excessive variations.

f) Finish Rolling

i) Immediately follow vibratory compaction with passes of the rubber-tired roller so that surface voids and fissures are closed to form a tight, surface texture. Remove any roller marks on the surface using a steel drum roller in static mode.

g) Lane Edge

i) Each edge of each lane shall be constructed with a vertical or 15 degree from vertical configuration.

.6 Small Areas

a) Spread the RCC mix by hand in areas not accessible by the paver, as directed by the Engineer.

b) Compact the mix to the required density using suitable, vibratory compaction equipment.

.7 RCC Joints

a) Fresh Joint

i) A fresh joint is made when an adjacent RCC lane is placed within 45 minutes after placing the previous lane. Ensure that the contact face is vertical. Before rolling, handfinish the joint as necessary to produce a tight surface. Roll extra passes, as necessary, to achieve the required density and smoothness in the joint area.

b) Cold Joint

i) A cold joint is made when an adjacent RCC lane is placed more than 45 minutes after placing the previous lane. Sawcut the edge of the previous lane back to sound RCC to form a vertical face. Trimming by grader blade may be permitted if done at the end of the workday or first thing the following morning. Dampen the vertical face just before placing the fresh RCC against it. Before rolling, hand-finish the joint, as necessary, to produce a tight surface. Roll extra passes, as necessary, to achieve the required density and smoothness in the joint area. Every effort shall be made to maintain longitudinal joints as a fresh joint as described in Clause a) above. Longitudinal, cold joints shall be avoided at all times.

c) Transverse Joint

i) May be a fresh or a cold joint.

.8 RCC Curing

a) RCC without Asphalt Surfacing

i) Keep the RCC surface continuously moist by water or fog spray, or wet burlap, for a minimum of seven days before applying the curing compound. Apply the specified membrane-forming, curing compound at a rate of not less than 0.25 litre/m_2 of surface, ensuring that a continuous, void-free membrane is formed.

b) RCC with Asphalt Surfacing (within 24 hours)

i) Immediately after final rolling, apply the SS-1 liquid asphalt coating, according to Section 4.3.2.2.18 at a rate of 0.5 +- 0.2 litre/m_2 of surface.

c) RCC with Deferred Asphalt Surfacing

i) Keep the RCC surface continuously moist by water or fog spray, or wet burlap, for a minimum of seven days before applying the SS-1 liquid asphalt coating, according to Section 4.3.2.2.18, at a rate of 0.5 □ 0.2 litre/m_2 of surface, ensuring that a continuous, voidfree membrane is formed.

.9 Backfill

a) Backfilling of the edge of the RCC pavement shall not commence prior to the approval of the Engineer. Backfill shall be done in accordance with Section 4.2 – Grading.

.10 Quality Control

a) Surface Tolerances

i) A 6 mm maximum variation, under 3 m straightedge. Surface texture shall be tight.

b) Grade Tolerances

i) A 3 mm maximum variation above designated elevation, a 9 mm variation below designated elevation.

.11 Defective RCC

a) Repairs

i) All repairs are subject to the Engineer's approval. Correct deficiencies while the RCC is still plastic; otherwise, repair after seven days. After seven days, the RCC shall be removed by sawcutting full-depth before removal. Replace the RCC utilizing Cast-in- Place concrete.The new concrete shall be doweled into the existing RCC utilizing epoxy-coated, 15M reinforcing bars.

b) Remove and replace the RCC if surface cracks, wider than 15 mm, occur after seven days.

c) Remove and replace the RCC if deficient in thickness by more than 10% of the specified total thickness.

d) Remove and replace the RCC if the compressive strength is under 80% of specified strength.

e) Grind off, high surface variations to a finish acceptable by the Engineer.

f) Filling low areas with fresh RCC is not permitted.

g) If asphalt surfacing is specified, low areas shall be made up with additional surfacing material without extra payment.

.12 Asphalt Surfacing

a) Do not allow traffic, except for the water truck, on the RCC until it has cured for at least seven days or as directed by the Engineer.

b) If specified, asphalt surfacing according to Section 4.3.1 – Utility Cut Restoration may proceed after seven days of curing of the RCC or as directed by the Engineer.

c) The Contractor shall, at his expense, remove and replace asphalt surfacing if the RCC pavement must be removed and replaced because of unacceptable thickness or strength.

Table 4.3.89: RCC Thickness Pay Factors

THICKNESS DEFICIENCY (% of Total Thickness)	PAY FACTOR (% of Contract Price)
4.8	100.0
5.2	97.0
5.8	93.7
6.4	90.0
7.0	85.5
7.6	80.5
8.2	75.0
8.8	68.0
9.4	60.0
10.0	50.0

Over 10.0	Remove and Replace

Table 4.3.90: RCC Strength Pay Factors

CORE STRENGTH (% of Specified Strength)	PAY FACTOR (% of Contract Price)
85.0	100.0
84.5	97.5
84.0	95.0
83.5	92.5
83.0	90.0
82.5	87.5
82.0	85.0
81.5	82.5
81.0	80.0
80.5	77.5
80	75.0
Under 80.0	No Payment

4.3.3.2.9 Patterned Concrete Slab

.1 Concrete Placement

a) **Concrete Pavement:** to Section 4.3.3.2.6 - Concrete Pavement.

b) **Concrete Walk:** to Section 4.3.3.2.3 – Concrete Sidewalk, Curb and Gutter, and Slabs.

c) **Curb Ramp:** to Section 4.3.3.2.3 - Concrete Sidewalk, Curb and Gutter, and Slabs; surface finish according to standard drawings. No stamped pattern is permitted.

d) **Manhole, Valve and Other Fixtures:** Concrete pavement around such fixtures shall be poured separately using isolation joints as detailed on drawings. Isolation joints are not required on concrete walk or other slabs.

.2 Installing Patterned Concrete Surface

a) **Temperature:** When colour additives are used, a minimum air temperature of 8°C in shade is required. If dark pigmentation is used, the maximum air temperature shall not exceed 27°C in shade.

b) **Surface Float:** Float the concrete surface instead of applying a burlap or broom finish.

c) **Release Agent Application:** Before using the stamping tool, apply the specified release agent according to manufacturer's specifications.

d) **Polyethylene Sheet:** If appropriate for the work, a polyethylene sheet may be used in lieu of a release agent to prevent the stamping tool from adhering to the concrete surface. Carefully cover the floated concrete surface with the sheet. After stamping and while the surface is still plastic, carefully remove the sheet and apply a brush finish if specified.

e) **Stamping:** While the concrete is still in its plastic state, impress the specified pattern on the surface using the stamping tools. Tamp the tools properly into the surface to achieve the desired texture.

f) **Pavement Joints:** Sawcut and seal pavement joints to Section 4.3.3.2.4 - Concrete for Roadways. Immediately remove excess release agent, sawcut debris and stains.

g) **Walk or Slab Joints:** These joints may be hand-tooled to Section 4.3.3.2.3 – Concrete Sidewalk, Curb and Gutter, and Slabs before applying release agent and stamping. Remove excess release agent and stains before applying the curing seal.

h) **Curing:** Apply at least one coat of the specified curing seal to the dry concrete surface according to the manufacturer's specifications.

.3 Workmanship

a) The concrete work is subject to the same tolerances and quality assurance as specified in Section 4.3.3.2.6 - Concrete Pavement, or Section 4.3.3.2.3 - Concrete Sidewalk, Curb and Gutter, and Slabs.

b) The patterned concrete surface shall be uniform in colour, pattern and texture, conforming to the approved job mock-up.

c) The patterned concrete surface shall exhibit no efflorescence, discoloration and other defects for a period of 24 months after placement. Any such defects occurring during that period shall be remedied before final acceptance of the work.

.4 Open to Traffic

a) Do not open the completed work to traffic until cylinder testing has confirmed that the concrete has attained 75% of its specified strength, or until directed by the City.

b) Before opening to vehicle traffic, clean all debris from the pavement, walk or slab and remove signs no longer required.

.5 Tools for Repair

a) Provide stamping tools of the specified patterns to the City for the sole purpose of repair work when maintenance of the work is assumed by the City, unless otherwise directed by the City.

4.3.3.2.10 Ultrathin Whitetopping

.1 Asphalt Surface Preparation

a) Mill existing asphalt surface to the depth indicated on the project drawings to Section 4.3.2.1.13 – Pavement Cold Milling.

b) Sawcut the longitudinal and transverse edges of the scarified asphalt to provide a vertical face.

c) Mechanically sweep the roadway clean of all loose or foreign material (i.e. dirt in a subsidence, grass along a gutter face, grindings, etc.). The Contractor shall dispose of all sweepings.

d) Water and air blast the surface of the roadway clean of all loose or foreign material.

.2 Formwork

a) Set, align and brace forms to Section 4.3.3.2.11 - Concrete Forms and Accessories.

b) Apply form release agent to inside face of forms prior to placement of the concrete. Do not apply form release agent to the prepared asphalt surface.

.3 Placing Fixed Formed Pavement

a) Deposit concrete directly from the transporting equipment onto the prepared dry asphalt surface.

b) Do not place concrete when the asphalt surface temperature is less than 0_{o} C.

c) Deposit the concrete between forms to a uniform height.

d) Vibrate concrete to remove voids and air pockets. Do not move the concrete horizontally with the vibrator.

e) Strike off concrete between forms using a form riding paving machine or vibrating screed. Vibrate the surface of the concrete at a frequency of no less than 3500 vibrations/minute.

.4 Placing Slipform Pavement

a) Slipform paving equipment can be used. Furnish machines capable of spreading, consolidating, screeding and finishing concrete in one pass.

b) Deposit concrete in accordance with Section 4.3.3.2.10.

c) Produce a dense and homogeneous concrete overlay requiring minimal hand finishing by vibrating the surface of the concrete with a pan vibrator operating at a frequency of no less than 3500 vibrations/minute.

.5 Finishing

a) Finish concrete to Section 7.1 – Cement Concrete, and as supplemented below:

b) **Tine Finish:** Tine the surface in the transverse direction to a depth of 3 to 6 mm and individual tine width of 2.5 to 3.5 mm. Space tines randomly at a minimum spacing of 13 mm apart, a maximum spacing of 38 mm apart, with no more than 50% of the tines apart by more than 25 mm.

.6 Joints

a) Construct joints at a minimum 1.2-meter spacing as required in each type of construction to the following standards as applicable.

i) The minimum angle between any two intersecting joints shall be 80 degrees.

ii) Joints shall intersect the pavement free edges at a 90-degree angle and shall extend straight for a minimum of 0.3 m from the pavement edge.

iii) Align joints of adjacent panels.

iv) Minimum joint depth shall be 25 mm or one-fourth of the Ultra-thin Whitetopping thickness.

b) **Crack-Control Joints**: intended to control the location of shrinkage cracks in hardening concrete. Construct joints to the indicated dimensions, spacing, and pattern by sawcutting of the fresh concrete

i) **Sawed Joint:** Cut the groove with a concrete saw as soon as the concrete surface has hardened sufficiently to resist raveling as the cut is made, but before shrinkage cracks form in the concrete. The Contractor is responsible for the proper timing of the saw cut. Immediately flush the saw cut clean with water.

c) **Isolation Joint:** required where concrete is placed adjacent to an immovable structure or where indicated on the Drawings. Construct the joint by sawing or forming to create a clean break through the full cross-section of the concrete member. Make the joint wide enough to permit a snug fit for the pre-formed joint filler. Alternatively, place the pre-formed joint filler against the structure and pour the concrete against the preformed joint filler.

d) **Construction Joint:** required between concrete pours or for joining new concrete to existing work. Construct the joint with a keyway, dowels or tie bars as detailed on the drawings or as directed by the Engineer. Finish edges to a 6-mm radius. Vertically trim the existing concrete by sawing at least 50 mm deep and breaking. Leave the joint form in place until the concrete has set, then remove the joint form without damaging the concrete.

.7 Protection and Curing

a) Protect freshly placed concrete from premature drying, temperature extremes, adverse weather conditions, and physical disturbance to CSA-A23.1, and as supplemented below:

b) **Moist Curing:** Use where specified or directed by the Engineer. After the concrete has set, maintain exposed surfaces continuously moist using wet burlap or polyethylene film in contact with the concrete for a minimum of 48 consecutive hours after placing.

.8 Opening to Traffic

a) Open the pavement to vehicular traffic after the concrete compressive strength exceeds 20.7 Mpa or when accepted for opening to traffic.

.9 Field Quality Control

a) The contractor and the concrete supplier shall assist the field technician in obtaining samples for quality assurance testing.

b) The contractor shall suspend pouring operations after sampling until the results of the field quality tests are known.

c) Deficient Slump

i) For any load of concrete, if the measured slump is outside the specified limits, a check test is taken on another portion of the load, or a retest is done if re-tempering with water is permitted by the Engineer. If the second test fails, the Engineer may reject that load of concrete including removal of the portion already poured.

d) Deficient Air Content

i) For any load concrete, if the tested air content is outside the specified limits, the Engineer will require one of the following:

1. Air content below 5.0%: Concrete poured from the load shall be removed and the rest of the load shall be discarded.
2. Air content above 7.0%: Concrete poured from the load shall be removed and the rest of the load discarded.

ii) If the measured air content is below the specified minimum air content, then the contractor may elect to re-temper with air entraining agents in accordance with Section 4.3.3.2.2 - Cement Concrete, Clause: Re-tempering with Air-Entraining Admixtures.

iii) **When Air Void Examination Is Required:** The quality assurance laboratory will drill cores from the hardened concrete for air void examination to Section 4.3.3.2.2 - Cement Concrete, Clause: Quality – Air-Void Examination at a frequency of at least one core for each 2,000 m of residential and collector sidewalk, curb and gutter or monolithic walk, curb and gutter, or as requested by the city for arterial, industrial or commercial streets or small residential subdivisions.

iv) Where concrete has been rejected and is to be removed for not meeting the spacing factor requirement in Section 4.3.3.2.2 Cement Concrete, Clause: Quality Assurance – Air-Void Examination, the Contractor at the Contractor's expense shall prove that the concrete left in place at both ends of the removal meets the specified spacing factor by air void examination to be performed by a qualified laboratory to Section 4.3.3.2.2 Cement Concrete. The test results shall be submitted to the Engineer.

e) Deficient Strength

i) Concrete work for roadways represented by a strength test result which is less than specified may be accepted subject to a pay factor according to Table 4.3.91. If strength deficiencies persist, the Engineer will require changes in the concrete mix design for the remainder of the work.

Table 4.3.91: Concrete Strength Pay Factors

CYLINDER STRENGTH (% of Specified Strength)	PAY FACTOR (% of Contract Price)
97.0	100.0
96.0	99.2
95.0	98.2
94.0	96.9
93.0	95.4
92.0	93.6
91.0	91.7
90.0	89.4
89.0	86.7
88.0	83.5
87.0	79.7
86.0	75.5
85.0	70.0
Under 85.0	No Payment

ii) Optional core strength test:

1. The Contractor has the option at the Contractor's expense of providing evidence of strength by coring and testing to CSA-A23.2-14C by a qualified laboratory within 7 days of a failed 28-day cylinder test or within 3 days of a failed 7-day cylinder test. Three cores shall be drilled from the hardened concrete represented by the failed cylinder strength tests at locations approved by the Engineer.
2. The average strength of the 3 cores shall equal 100% of the specified cylinder strength; otherwise, the concrete will be subject to the pay factors of Table 4.3.91 on the basis of the cylinder strength tests alone.
3. No reduction in the specified 28-day strength for cold weather or air content will be applied to the core strength test results when high early strength concrete is specified.

4.3.3.2.11 Concrete Forms and Accessories (32 16 13)

.1 Fabrication and Erection

a) Verify lines, levels and centres before proceeding with formwork and falsework, and ensure dimensions agree with drawings.

b) Obtain Engineer's approval for use of earth forms.

c) Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.

d) Fabricate and erect falsework in accordance with CSA-S269.1.

e) Do not place shores and mud sills on frozen ground.

f) Provide site drainage to prevent washout of soil supporting mud sills and shores.

g) Fabricate and erect formwork in accordance with CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1-04

h) Align form joints and make watertight. Keep form joints to a minimum.

i) Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners of concrete members, unless specified otherwise.

j) Form chases, slots, openings, drips, recesses and expansion and control joints as indicated.

k) Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections. Assure that all anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

.2 Slipforming

a) Set and maintain grade line by establishing taut string line or wire, based on Engineer's survey control datum.

b) Provide stable support for travelling slipform machine. Protect adjacent work and repair if damaged.

c) Coordinate concrete delivery and placing to ensure uniform progress of slipform machine without stoppage. If machine is stopped for any cause, immediately stop vibrating and tamping elements.

d) Maintain proper slump to ensure slipformed concrete does not sag.

e) Slipformed surfaces shall be smooth, dense, and free of pockets and honeycomb. Apply a minimum of hand finishing to correct minor irregularities.

.3 Form Removal

a) Review the proper timing of form removal with the Engineer in all cases.

b) Loosen all wall or beam side forms within the first 24 hours after placing for the purpose of spraying water between the concrete and the forms. Strip wall and column forms within 48 hours to facilitate finishing.

c) Remove underside of slab or beam forms only after 28 days, or after concrete has attained a minimum of 75% of the specified 28 day strength, with results indicated by field cured test cylinders, and only as approved by the Engineer.

d) Re-shoring to remove forms will be permitted provided it is in accordance with CSA-S269.1.

.4 Construction Joints

a) Prior to commencing construction, the Engineer shall approve, in writing, the locations of all construction joints required for construction but not shown on the drawings.

b) Construct joints in accordance with the details shown on the drawings.

c) Roughen all formed construction joints to expose the aggregate of the hardened concrete. Method of roughening to remove laitance to be approved by the Engineer.

Alternatively, apply a suitable retardant to the forms of the construction joint and remove retarded surface mortar with low pressure jets of water or stiff brushes.

d) No vertical construction joints will be allowed within 3 m of wall intersections without prior written approval from the Engineer.

e) Limit the length of any single wall pour to a maximum of 18 m and allow a minimum of seven days before placing any adjoining sections

4.3.3.2.12 Fillcrete

.1 Production and Delivery

a) Fillcrete shall be produced in accordance with CSA-A23.1 and shall conform to the approved mix design.

b) Prior to loading fillcrete onto rotating drum trucks, the supplier shall ensure that the drum is clean and free of any paste or concrete materials remaining from previous concrete batches

.2 Production Facilities

a) The supplier shall maintain a minimum stockpile of 100 tonnes of cement powder at the production plant site at all times.

b) Suppliers shall have a computerized batching system that provides computer printed reports and load tickets. Hand written loading times will not be accepted.

c) Plant scale certification shall be maintained to CSA-A23.1.

d) Protection of Finished Work

e) Protect fillcrete from freezing or other adverse weather conditions for a minimum of 24 hours after placement.

f) Fillcrete that is exposed to significant infiltration of water within 24 hours of placement must be removed and replaced.

g) A minimum 150mm granular base course must be placed on the fillcrete surface before allowing any vehicular traffic over the fillcrete. The granular base course must be placed to Section 4.3.2.2.10 - Granular Base Course, a minimum of 24 hours after fillcrete placement.

.3 Field Quality Control

a) The City will conduct an initial plant inspection prior to the production of any fillcrete. This inspection shall include, but not be limited to, an inspection of production and quality control facilities, as well as a review of supplier’s quality control program.

.4 Required Strength

a) The result of each compressive strength test shall be within the specified compressive strength range.

4.3.3.2.13 Reinforcing Steel

.1 Field Bending

a) Do not field bend or field weld reinforcement except where indicated or authorized by the Engineer.

b) When field bending is authorized, bend without heat, applying a slow and steady pressure.

c) Replace bars that develop cracks or splits.

.2 Placing Reinforcement

a) Place reinforcing steel as indicated on approved drawings and in accordance with CSA-A23.1.

b) Place sufficient chairs, and supports to adequately maintain the position of the reinforcing steel during placement of concrete, to within tolerances specified in the referenced CSA/CAN guidelines. Use tie wire to prevent the moving or dislodging of reinforcing steel during placement of the concrete.

c) Use plain round bars as slip dowels in concrete. Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint. When paint is dry, apply a thick even film of mineral lubricating grease.

d) Prior to placing concrete, obtain the Engineer's approval of reinforcing material placement.

e) Ensure cover to reinforcement is maintained during concrete pour.

f) Reinforcing steel, anchor bolts, or other required inserts shall not be inserted into concrete during placement.

.3 Field Touch-Up

a) Touch up damaged and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

4.3.3.2.14 Slabjacking

.1 Preparation

a) **Utilities:** The Contractor is responsible for obtaining the locations of underground utilities, including but not limited to buried electrical lines, cables, telephone lines and water and drainage pipes.

b) **Site Protection:** Provide hoarding or suitable protection around the work site for public safety and to minimize disruption to adjacent residences and businesses.

c) **Equipment Support:** Ensure that site conditions can support equipment for drilling and grouting.

d) **Air Temperature:** Work shall not proceed when the air temperature is less than 5^{o}C.

.2 Jacking

a) Remove sheet asphalt or grout on previously repaired walk.

b) Mark strategic locations for drill holes on the walk. Drill holes through the slab to a grouting depth of 50 mm to 300 mm as required.

c) Sawcut the slab where required to free it from binding.

d) Pump grout to fill all voids below the slab while lifting it to a controlled elevation.

e) Ensure that lifting of the slab is done in small increments to prevent slab cracking or damage.

f) After grouting, fill the drill holes with 25 MPa at 28 days concrete grout, having 10 mm maximum size aggregate.

g) Record Keeping: For each location, record the volume of grout pumped below the slab and the slab elevations on 3 m grid points before and after grouting. Submit records to the Engineer upon completion of the work at each location.

.3 Field Quality Control

a) **Tolerances along Centreline of Walk:** 6mm maximum variation under a 3 m straightedge or taut string line parallel to centreline of the walk.

b) **Tolerances between Sections of Walk:** 6mm maximum differential level at a construction joint between adjacent sections of walk.

.4 Correction of Deficiencies

a) Change the grout mix proportions and/or change the composition or source of the aggregate to correct deficiencies in the grout strength.

b) Continue jacking and grouting until the tolerances in .3 are met.

c) Repair cracks □3 mm in width caused by jacking, to the satisfaction of the Engineer.

d) Remove broken or damaged slab and replace with new concrete walk to Section 4.3.3.2.3 - Concrete Sidewalk, Curb and Gutter, and Slabs.

.5 Cleanup

a) If the slab jacked walk crosses an alley, do not open the alley to vehicle traffic until the grout has cured for at least 24 hours.

b) Remove all surplus material and debris from site.

c) Remove hoarding, barricades and signs no longer needed.

4.3.4 Pathways and Trails

4.3.4.1 Materials

4.3.4.1.1 Examination

.1 Report to the City, in writing, any conditions or defects encountered in the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigated and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencement of work.

.4 Protect all existing trees and planting areas in accordance with Appendix C.

4.3.4.1.2 Samples

.1 Samples of sub-base and asphalt may be requested by the City. Sieve analysis (ASTM-D698) will be required for sand and crushed gravel. Submit one test result per 1,000 tonnes of material.

.2 Retain approved samples on site until work has been inspected and approved.

.3 All work shall conform to approved samples.

4.3.4.1.3 Inspection

.1 The contractor shall have an approved set of drawings and specifications available prior to calling the City for an inspection.

.2 The contractor shall obtain approval for the pathway alignment and sub-base (i.e. compaction and depth of gravel) prior to surfacing with asphalt.

.3 Regional pathway within the Streets right-of-way and doubling as sidewalks shall be inspected and maintained by the City.

.4 Regional pathway that are constructed in lieu of sidewalks and meander in and out of the streets right-of-way shall be inspected and maintained by the City.

.5 All Regional pathway, except those noted in items above, shall be inspected and maintained by the City.

4.3.4.1.4 Sub-Base

.1 Refer to article 4.3.1 and to the relevant drawings in Appendix A to include 150 mm depth of 20/25 gravel.

4.3.4.1.5 Asphalt Concrete

.1 Surface: Type SGC refer to relevant drawings in Appendix A.

4.3.4.1.6 Pavement Marking

.1 Refer to article 4.3.1.1.9.

4.3.4.1.7 Signage

.1 Coordinate to ensure all signs contain the City of St. Albert logo is consistent on all signage.

.2 Information Signs

a) Signboard shall be 19 mm Crezon. Signboard back and edges shall be primed with an exterior primer and painted using a white exterior alkyd paint.

b) Face shall be white Scotchcal vinyl film. Lettering, name panel, and signature to be screen printed using compatible ink or superimposed using die cut Scotch cal vinyl film. Alternate vinyl films will be considered provided the product has a written guarantee for a minimum life expectancy of five years. Lettering styles and sizes shall comply with the City of St. Albert Sign Guidelines, latest edition.

c) Park name panel to be burgundy, Pantone 209c or 207u, with a black border. Park name lettering to be white Helvetica medium.

d) SC signature to be black, PMT to be supplied as required.

e) Foundation post shall be 200 mm x 200 mm full dimension recycled plastic, 3.66 m long. Set post in 400 mm diameter concrete footing with fillcrete in accordance with Article 4.5.1.1.7.

f) Appearance post shall be 200 mm x 200 mm full dimension recycled plastic, 1.9 m long.

g) Fastening hardware to be galvanized steel.

h) Signboard cap to be 19 mm extruded aluminum channel, or approved alternate, and painted white to match the signboard.

.3 Playground Signs

a) Signboard shall be 19 mm Crezon. Signboard back and edges shall be primed with an exterior primer and painted using a white exterior alkyd paint.

b) Sign shall be 300 mm x 350 mm in size.

c) Wording and lettering to be submitted to the City for review and approval prior to fabrication.

d) Sign designs provided by manufacturers that match and attach to equipment may be considered.

4.3.4.2 Construction

4.3.4.2.1 Asphalt Pathway Paving

.1 Conform to the applicable requirements for asphalt paving outlined in Article 4.3.1.

4.3.4.2.2 Pavement Marking

.1 Conform to the applicable requirements for pavement marking outlined in Article 4.3.1.2.13.

4.3.4.2.3 Signage

.1 Refer to Engineering Standard Drawings in Appendix A for installation details.

.2 All signs are to be maintained free of defects for during the Warranty Period.

4.3.5 Roadway Signaling and Control Equipment (34 41 00)

4.3.6 Miscellaneous

4.3.6.1 Materials

4.3.6.1.1 Gabions

.1 **Content**

a) This section includes the supply and installation of gabion baskets and rock fill.

.2 **Definitions**

a) **Gabion:** a galvanized steel wire mesh basket filled with rock or broken concrete, and forming part of a larger monolithic structure of several such baskets, used for erosion control or other purposes.

b) **Selvedge:** the thicker perimeter and edge wires to which the wire mesh is securely tied to withstand stress from any direction.

c) **Corner Wire:** the thicker reinforcing wire built into each corner of a gabion basket fabricated as a single unit.

d) **Binding Wire:** wire used to tie together components forming a gabion basket and to tie together adjoining baskets.

e) **Connecting Wire:** internal wire used to connect opposite walls inside a basket cell to resist bulging.

f) **Diaphragm:** a wire mesh used to partition a gabion basket into equal-sized cells.

.3 Gabions

a) **Wire:** made of steel, hot-dip galvanized at a zinc coating of 256 g/m_2 minimum, with a tensile strength of 410 MPa minimum, capable of elongation of 10% minimum, and of the following diameters (±2%):

i) **Wire for Mesh:** 2.95 mm

ii) **Selvedge and Corner Wires:** 3.85 mm

iii) **Binding and Connecting Wires:** 2.20 mm

b) **Wire Mesh:** to be fabricated as follows:

i) Pre-galvanized wire woven in a double twist pattern with uniform hexagonal openings approximately 80 mm by 100 mm.

ii) To be non-raveling, that is, to resist pulling apart at any twist or connection forming the mesh.

iii) Perimeter edges of mesh to be securely selvedge, to ensure that joints formed by tying selvedges are as strong as the body of the mesh.

c) **Gabion Basket:** to be constructed as follows:

i) To be of single unit construction, or with joints having strength and flexibility equal to that of the mesh.

ii) For jointed construction, bases, sides, ends, lids, and diaphragms can be readily assembled at site into rectangular baskets of sizes detailed on drawings.

iii) When length exceeds 1.5 times the horizontal width, diaphragms of same mesh as gabion wall shall be securely placed to divide the basket into equal cells of a length not exceeding the width.

d) **Alternate Fasteners:** Galvanized steel wire fasteners may be used in lieu of binding wire for gabion basket assembly and fastening baskets to one another, subject to prior approval of the Engineer. Such fasteners shall conform to the following:

i) Wire Diameter and Coating: 3.05 mm (±2%) with zinc coating of 256 g/m^2 minimum.

ii) Wire Tensile Strength: 1 700 MPa minimum.

iii) Pull Strength: Fastener to remain locked and closed while resisting a pulling force of 110 kg minimum for assembling basket components, and 410 kg minimum for binding adjoining baskets.

.4 Rock Fill

a) Quality: Rock shall be clean, hard and durable, and may be broken rock, quarry rock, or broken concrete which will not disintegrate when exposed to water, wave action, wetting and drying, or freezing and thawing cycles.

b) Sizes: Rock pieces shall range from 100 mm minimum dimension to 300 mm maximum dimension.

4.3.6.1.2 Heavy Rock Rip Rap

.1 Content

a) This section includes the supply, delivery, and installation of heavy rock riprap. This work shall include all necessary trimming, excavation, and fill required to satisfactorily place the rock riprap, such as:

i) Excavation, trimming and shaping head slope

ii) Excavation at head slope toe, and for rock apron

iii) Excavation for rock in stream bank transition zone

iv) Supply and placing of geotextile filter fabric

v) Supply and placing of gravel or granular bedding material

.2 Rock Material

a) **Quality**: Rock shall be clean, hard, durable and angular in shape, and may be broken rock, quarry rock, or broken concrete which will not disintegrate when exposed to water, wave action, wetting and drying, or freezing and thawing cycles, free from overburden, spoil, shale or shale seams and organic material, and shall meet the gradation requirements for the class specified. No sandstone will be permitted for all classes. The minimum dimension of any single rock shall be not less than one-third of its maximum dimension. The minimum acceptable unit weight if the rock is 2.5 tonnes/m^3.

b) **Sizes:** The material provided for each class specified shall have a gradation that conforms to Table 4.3.91:

Table 4.3.91: Gradation Requirements

		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%	Kg	10	70	300	1100
	or mm	200	350	600	900
50% to 80%	Kg	7	40	200	700
	or mm	175	300	500	800
100% greater than	Kg	3	10	40	200
	or mm	125	300	300	50

**Percentages quoted are by mass.*
***Sizes Quoted are equivalent spherical diameters, and are for guidance only.*

c) Rip Rap shall meet the following minimum requirements for specific gravity, absorption and durability:

Table 4.3.92: Rip Rap Minimum Requirements

Method of Test	Requirements
California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregate (California Test 206)	Maximum Specific Gravity = 2.60 Maximum Absorption = 2.0%
California Department of Transportation Method of test for Durability Index (California Test 229)	Minimum Durability Index = 52 Durability Index may be less than 52 if DAR*>23

Durability Absorption Ratio (Dar) = Durability Index/ (absorption% = 1%)

.3 Sandbag Rip-Rap

a) Sandbag riprap is a “man-made” riprap consisting of burlap bags filled with fresh concrete and placed in a dense layer before the concrete has set.

.4 Geotextile Filter Fabric

a) 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.

b) Non-woven geotextile filter fabric shall be used under all riprap in accordance with the following table of minimum average roll value properties (MARVs) for each specific Class of riprap:

Table 4.3.93: Non-Woven Geotextile Filter Fabric Properties

Non-Woven Geotextile Filter Fabric		
Specifications and Physical Properties		
	Class 1M, 1 and 2	**Class 3**
Grab strength	650 N	875 N
Elongation (Failure)	50%	50%
Puncture Strength	275 N	550 N
Burst Strength	2.1 MPa	2.7 MPa
Trapezoidal Tear	250 N	350 N

Minimum Fabric Lap to be 300 mm

.5 *The non-woven geotextile filter fabric shall meet the specifications and physical properties as listed above.

.6 Placement:

a) 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.

b) 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.

c) 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.

d) 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 7 days for ultraviolet material and 14 days for ultraviolet protected and low ultraviolet susceptible polymer geotextiles.

e) 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

4.3.6.1.3 Box Beam Guard Rail

.1 Content

a) This section includes the supply and installation of box beam guard rail.

.2 Materials

a) Box Beam Rail: steel tubing to ASTM A501, size as specified on drawings.

b) Posts, Plates and Shapes: of steel conforming to ASTM A36M.

c) Fastenings: steel bolts, U-bolts, studs, nuts and washers conforming to ASTM A325M.

d) Zinc Coating: all steel products to be hot-galvanized according to ASTM A123.

e) Hot-Mix Asphalt: appropriate mix to Section 4.3.2.1.8 - Hot-Mix Asphalt Concrete.

f) Concrete: to Section 4.3.3.1.1 - Cement Concrete, class D.

.3 Fabrication

a) Welding: to CSA-W47.1 and CSA-W59-M.

b) Edges cut by a welding torch shall be ground to a smooth finish.

c) Galvanize steel products after fabrication and welding.

4.3.6.1.4 Concrete Barrier

.1 Content

a) This section includes the construction of median or roadside Cement concrete barrier by slipforming, by casting in place or with precast units.

.2 Submittals

a) Submit a concrete mix design for precast barrier units or precast mini barrier unit to the Engineer at least 14 days prior to delivery.

.3 Quality Assurance

a) Slump, air content, air-void examination, strength tests and acceptance criteria: to Section 4.3.3.2.2 - Cement Concrete

.4 Materials

a) Slipform or Cast-In-Place Concrete: Class C, to Section 4.3.3.1.1 - Cement Concrete and Section 4.3.3.1.3 - Concrete for Roadways.

b) Reinforcement and Tie Bars for Cast-In-Place Units: epoxy-coated, deformed, to Section 4.3.3.1.12 - Reinforcing Steel.

c) Preformed joint filler and curing compound for Slipformed or Cast-In-Place Units: to Section 4.3.3.1.3 - Concrete for Roadways.

d) **Precast Barrier Unit:** manufactured to CSA-A23.4 and to the following requirements:

i) **Dimensions:** 3 m long and cross-section as detailed on drawings, with tolerances to CSA-A23.4.

ii) **Concrete:** 30 MPa minimum compressive strength at 28 days, with 5.5% to 8% entrained air.

iii) **Reinforcement:** epoxy-coated, deformed, to Section 03210 - Reinforcing Steel.

iv) End connection: 2 vertical tongue and groove keys, dimensioned to a tolerance of ±5 mm for a tight fit.

v) **Surface finish:** steel form finish, not rubbed, smooth, dense, un-pitted and free from honeycomb.

vi) **Curing methods:** accelerated steam curing, moist curing, or membrane curing.

e) **Precast Mini-barrier Unit:** manufactured to CSA-A23.4 and to following requirements:

i) **Dimensions:** 3 m long and cross-section as detailed on drawings, with tolerances to CSA-A23.4.

ii) **Concrete:** 30 MPa minimum compressive strength at 28 days, with 5.5% to 8% entrained air. Submit concrete mix design to the Engineering Services Section at least 14 days prior to delivery.

iii) **Surface finish:** steel form finish, not rubbed, smooth, dense, un-pitted and free from honeycomb.

iv) **Curing methods:** accelerated steam curing, moist curing, or membrane curing.

.5 Equipment

a) Slipform Machine: to Section 4.3.3.1.10 – Concrete Forms and Accessories.

4.3.6.2 Construction

4.3.6.2.1 Gabions

.1 Site Preparation

a) Perform excavation and grading for the gabion structure to the indicated lines and grades according to Section 4.2 – Grading. Remove and dispose of stumps, roots, and debris.

.2 Placing Gabions

a) **Basket Assembly:** Assemble each gabion basket, if not of single unit fabrication, by tying the selvedge of components at the joints with binding wire.

b) **Binding Method:** Throughout the length of selvedge, loop the binding wire tightly around every other mesh opening, alternating single and double loops. Alternatively, place specified fasteners locked tight against the selvedge or seam.

c) **Use of Fasteners:** In lieu of binding wire, where permitted by the Engineer, install approved fasteners at a maximum spacing of 75 mm, using suitable manual pliers or a hand-held pneumatic gun with magazine feed. Wrap each fastener tight around the seam to prevent ravelling. The Engineer will withdraw permission to use fasteners if he finds them loose or ravelling.

d) **Placing Baskets:** Place the initial level of empty baskets into position. Secure adjacent baskets together with binding wire along corners and contacting selvedge edges as described above under Binding Method.

e) **Filter Fabric:** If specified in the contract Special Provisions, place geotextile fabric against the gabion wall and top in contact with surrounding ground. Lap the fabric at joints a minimum of 500 mm.

f) **Initial Filling and Stretching:** Partially fill the first basket in a row with enough rock to provide weight. Then stretch up to 4 or 5 baskets in a row taut, to the proper alignment.

g) **Succeeding Level of Gabions:** Secure each new basket to the top of a fully filled gabion with binding wire along the base perimeter. In each succeeding level of gabions, stagger vertical joints between baskets so that no vertical joint is directly in line with a vertical joint in the next lower level.

.3 Rock Filling

a) **Exposed Face:** On the exposed faces of gabion baskets, place rock by hand with flattest surfaces bearing against the face mesh to produce a satisfactory alignment and appearance. Fill the rest of the gabions by hand or by mechanical means, taking care to minimize voids and bulges.

b) **Lifts:** Fill each basket cell to a depth of 300 mm at a time.

c) **Connecting Wires:** After each 300 mm lift, connect opposite walls of cell with 2 connecting wires in each direction on top of lift. Loop each wire around 2 adjoining mesh openings, pull hand tight and twist the ends secure to prevent loosening.

d) **Staged Filling:** To prevent local deformation, fill a cluster of gabion baskets in stages so that no basket is filled more than 300 mm higher than the adjoining baskets.

e) **Securing Lids:** When a gabion basket is filled full, bend over the lid by hand and secure with binding wire to the basket rim and diaphragms in the same manner as 4.3.6.1.1 Binding Method.

f) **Backfill and Cover:** Backfill gaps between the gabions and surrounding ground, and place clay cover as indicated on the drawings or as directed by the Engineer.

.4 Workmanship

a) No wire ends shall be left projecting outside exposed surfaces.

b) All exposed geotextile fabric shall be trimmed flush with the cover material.

c) There shall be no voids left between adjacent baskets. The use of binding wire or wire mesh to correct voids is not permitted.

d) Joints between gabion baskets shall be as strong as the wire mesh, thereby making a monolithic structure.

e) The installed gabions shall have proper alignment and a neat, compact, square appearance.

4.3.6.2.2 Heavy Rock Rip Rap

.1 Site Preparation

a) Perform excavation and grading for the Rip Rap to the indicated lines and grades according to Section 4.2 – Grading. Remove and dispose of stumps, roots, and debris.

.2 Placing of Rock

a) The rock shall be handled, dumped or placed into position to conform to the specified gradation and to the cross section shown on the drawings. 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.

.3 Placing of Sandbag Rip-Rap

a) Sandbag riprap is to be placed on a surface that is trimmed and dressed to the lines and grades shown on the plans. A trench may be required at the base of the slope to receive the bags. Sandbag riprap is used mainly as drain trough terminal protection as detailed in the applicable specification*.*

b) The bags are to be filled approximately two-thirds full with concrete with the tops folded closed and they are to be placed immediately when the concrete is fresh.

c) The bags are to be the prepared surface with the ends in the same direction in a manner that results in a shingled effect.

d) The upstream end of any bag must be under the end of the bag placed next to it.

e) The bags are to be placed from the downstream edge towards the upstream edge, and from the bottom row towards the top.

f) The folded ends of the bags must be placed underneath.

g) The bags are to be rammed and packed against each other to leave a uniform surface, with the layer not less than 130 mm thick.

.4 Inspection of Rock

a) 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 Consultant 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:

i) Class Maximum 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

b) The Contractor shall provide, at no additional cost to the Department, whatever facilities are required to assist the Consultant in checking gradation and measuring riprap in place.

c) 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.

4.3.6.2.3 Box Beam Guard Rail

.1 Post Setting

a) Without Asphalt or Concrete Base: Drive post into the ground.

b) With Asphalt ≤75 mm and without Concrete Base: Drive post through the existing asphalt pavement. Patch with hot-mix asphalt concrete tamped around the post flush with existing surface.

c) With Asphalt >75 mm, or with Concrete Base: Drill a 300 mm diameter hole, or sawcut a 300 mm square hole, through the existing asphalt pavement or through the existing concrete base. Drive the post into the hole. Tamp clay or gravel into the remaining void around the post and cap with 50 mm of hot-mix asphalt concrete tamped flush with existing surface.

d) Each post shall have at least half of its length set below ground or pavement surface elevation.

.2 Field Cutting

a) Steel material may be cut with a saw or with a welding torch. Grind smooth and round all rough and sharp edges.

.3 Field Welding

a) Perform field welding if permitted by the Engineer. Remove slag and spatter and smooth surfaces.

.4 Touch-Up

a) Apply a coat of "Galvacon" to cut, welded and other surfaces where the galvanizing has been damaged.

.5 Concrete Anchor

a) **Precast Anchor:** Bury the anchor in a hole backfilled with clay compacted to a minimum 98% of maximum standard Proctor density according to ASTM D698 Method A.

b) **Cast-in-Place Anchor:** Dig a hole to the specified anchor dimensions and fill with concrete. Trowel exposed surface to a smooth finish.

c) **Surface Restoration:** Restore the surface around anchors with tamped hot-mix asphalt or with concrete to match the existing surface.

.6 Field Quality Control

a) **Elevation Tolerances:** 13 mm maximum variation from designated grade of top of guard rail.

b) **Alignment Tolerances:** 50 mm in 10 m maximum deviation from designated alignment of guard rail.

c) **Post Tolerances:** 13 mm maximum deviation from plumb position of post.

d) **Deficiencies:** Guard rail not meeting the above tolerances shall be removed and replaced.

4.3.6.2.4 Concrete Barrier

.1 Preparation

a) Construct base of barrier as detailed on drawings.

b) Light pole bases and conduits shall be in place prior to slipforming or casting in place.

c) Have Engineer inspect base before slipforming or installing precast units.

.2 Slipform Construction

a) Prior to slipforming, cast concrete in place for segments where slipforming is not practical.

b) Slipform concrete to Section 4.3.3.2.11 – Concrete Forms and Accessories.

c) Slipform over top of pole bases. Once machine is past, immediately remove concrete over pole base and clean thoroughly.

d) Finish: Slipformed surfaces shall be smooth, dense, un-pitted and free of honeycombing. Perform the minimum amount of work required to correct minor irregularities.

e) Joints:

i) **Crack-Control Joints:** Saw cut or tool vertically 12 mm wide by 50 mm deep at maximum 6 m spacing to Section 4.3.3.2.2 - Cement Concrete. Match with joints of curb, gutter, or pavement.

ii) **Isolation and Construction Joints:** vertical, to Section 4.3.3.2.2 - Cement Concrete.

f) **Protection and Curing:** to Section 4.3.3.2.2 - Cement Concrete.

g) Cast-In-Place Construction

h) Construct to Section 4.3.3.2.2 - Cement Concrete and Section 4.3.3.2.4 - Concrete for Roadways as supplemented below.

i) **Finish:** Formed surfaces shall be smooth, dense and free of honeycombing.

j) **Joints:** Saw cut or form crack-control joints to Section 4.3.3.2.4 - Concrete for Roadways. Place isolation and construction joints

.3 Precast Construction

a) Place precast units true to alignment.

b) Make tight tongue and groove connection between units.

.4 Precast Minibarrier

a) Place minibarrier units to designated alignment.

b) Make proper connections between units.

.5 Quality Control

a) **Slipform and Cast-In-Place Surface Tolerances:** 6 mm maximum variation under a 3 m straightedge.

b) **Slipform and Cast-In-Place Barrier Top Elevation Tolerances:** ±6 mm maximum variation from designated elevation.

c) **Slipform and Cast-In-Place Barrier Top Alignment Tolerances:** ±10 mm maximum variation from designated alignment in any 20 m length.

d) **Slipform and Cast-In-Place Barrier Shape Tolerances:** ±10 mm maximum variation from indicated cross-sectional dimensions.

e) In slipforming, continually check tolerances and immediately correct excessive variations while concrete is still plastic.

f) The Engineer will suspend the Contractor's operations if poor workmanship persists or is not corrected.

g) **Precast Barrier Top Elevation Tolerances:** ±10 mm maximum variation from designated grade elevations.

h) **Precast Barrier Top Alignment Tolerances:** ±10 mm maximum variation from designated alignment in any 20 m length.

i) **Tolerance for Lipping between Adjacent Precast Units:** 10 mm maximum.

.6 **Protection of Finished Work**

a) Protect finished work from damage. Repair if damaged.

b) Leave completed work clean and free of debris and remove signs and barricades no longer needed.

4.4 : Landscaping Specifications

Section No.	**Specification Title**	**Specification No.**
4.4.1	**Maintenance**	**32 01 90**
4.4.2	**Fences**	**32 91 00**
4.4.3	**Site Furnishings**	**32 33 00**
4.4.4	**Topsoil**	**32 91 00**
4.4.5	**Mulch**	**32 91 13**

4.4.1 Maintenance 32 01 90

4.4.1.1.1 General

4.4.1.1.2 Related Sections

.1 Mulches, Turf & Grasses, Trees Shrubs & Ground Covers

4.4.1.1.3 Reference Standards

.1 International Society of Arboriculture standards (current edition)

.2 Canadian Nursery Trades Association (current edition)

4.4.1.1.4 1.3: Regulatory Requirements

.1 Provide the City with copies of permits and licenses required by regulatory authorities, including applicator's current chemical license number for all herbicides, pesticides or any chemical application used on site.

4.4.1.1.5 1.4: Damage to Property

.1 The contractor shall repair and pay for damages caused by contractor's personnel and equipment during the maintenance period.

.2 The contractor shall immediately report any damage caused through maintenance activities to City.

.3 Obtain approval of City for repairs and replacements. Return grass areas, plant materials, equipment and buildings to their original condition prior to damage. Scalping of turf and mechanical damage to trees, including tearing of bark, shall be considered as damage.

.4 Complete repairs and replacements within seven (7) days from date of approval given for repair or replacement.

.5 The Developer shall be responsible to repair any third party damage to the development during the Maintenance Period.

4.4.1.1.6 1.5: Hours of Work

.1 Consult with the City to determine optimum times for landscape maintenance.

.2 The Contractor shall provide the City, in writing with at least three (3) days advance notice, of intent to spray for weed and insect control.

4.4.1.1.7 1.6: Maintenance Log

.1 The landscape contractor shall keep a daily maintenance log throughout the maintenance period.

.2 The contractor must submit maintenance logs & provide copies of permits and licenses required by regulatory authorities, including applicator's current chemical license number for all herbicides, pesticides or any chemical application used on site to City on a monthly basis.

.3 The following information shall be included in the log:

a) Detail of activities.

b) Areas in which the activities were carried out.

c) Approximate time for start-up and completion of each activity.

d) Outstanding issues to be dealt with.

e) Notes regarding any plant material to be replaced.

f) Details regarding applications of chemicals. Include target weed or insect, mode, type, and rate of application of chemical, date, time, weather conditions and results.

g) Daily entries are to be signed by a valid maintenance crew member for that day.

4.4.1.1.8 1.7: Maintenance Season

.1 The maintenance season, also referred to as the growing season, shall commence May 1st and end October 30th, or as otherwise determined directed by the City.

.2 Garbage pickup and litter control shall be undertaken year-round.

4.4.1.2 Products

4.4.1.2.1 Water

.1 Water shall be clean and free of any substance that may inhibit vigorous growth of the plants.

.2 If water supply is required for construction, apply to the City's Utilities department to use filling stations for access to water supply or permitted hydrant usage. Comply with all Utilities' requirements with respect to using City hydrants for water supply.

4.4.1.2.2 Fertilizer

.1 Plant Materials:

a) For the first application, soluble fertilizer shall be delivered mixed as specified for tree and shrub growth in the topsoil backfill report from an acceptable soils laboratory.

b) Fertilizer: complete commercial fertilizer, minimum of 50% of elements derived from organic sources.

c) Soluble fertilizer shall be mixed at the rate of 3.2 kg per 45 L of water.

.2 Seed and Sod:

a) Fertilizers shall be clearly labeled and supplied in unopened, moisture-proof containers.

b) Fertilizer requirements are as follows:

Type 1 – Rate 3.5 kg/100 m²	
Total Nitrogen	19%
Available Phosphoric Acid	19%
Potash	19%

Type 2 – Rate 3.5 kg/100 m²	
Total Nitrogen	10%
Available Phosphoric Acid	30%
Potash	10%

Type 3 – Rate 3.5 kg/100 m²	
Ammonia	12%
Phosphate	51%
Sulphate	0%

c) Fertilizers shall be granular, water-soluble type.

d) The City may require changes to the fertilizer type, blend, and feed rates if an analysis of the soil shows such to be necessary. Alternate fertilizer type, blend and feed rates may be approved at the discretion of the City.

4.4.1.2.3 Topsoil

.1 Refer to Section 4.4.4.2.

4.4.1.2.4 Plant Protection Materials

.1 Rodent protection: approved chemical repellent and/or tree wraps at the contractors expense.

4.4.1.2.5 Weed Control

.1 Chemicals: contractor responsibility as required by site conditions and in accordance with current regulations.

.2 Contractor to provide signage 48 hours prior to spraying. City to be given 72 hours notice prior to spraying. Signage to be removed no earlier than 48 hours after spraying.

4.4.1.2.6 Pest and Disease Control

.1 Chemicals: contractor responsibility as required by site conditions and in accordance with current regulations.

.2 Contractor to provide signage 48 hours prior to spraying. City to be given 72 hours notice, in writing, prior to spraying.

4.4.1.3 Execution

4.4.1.3.1 Schedule and Workmanship

.1 Schedule timing of operations to growth, weather conditions and use of site. The following minimum schedule should apply:

a) Mow every fifteen (15) days.

b) Pick-up onsite litter and debris every fifteen (15) days.

c) If required, apply chemical weed control three (3) times per growing season: June 15, July 15, and August 15. Use of non-chemical weed control is preferred.

d) Manual weed control a minimum of every fifteen (15) days.

e) Water trees and shrubs every fifteen (15) days, or more frequently when required.

f) Water seed/sod if required to ensure establishment and healthy growing conditions.

g) Waste receptacles to be emptied every seven (7) days, or more frequently when required. Within the months of January, February, March, April, November, and December, waste receptacles shall be emptied every fifteen (15) days, or more frequently when required.

h) Pruning as required during approved dates, or when requested by the City.

i) Fertilize as required during approved dates, see Article 15.16.

.2 Do each operation continuously and completely.

.3 Provide equipment and material necessary for maintenance to acceptable horticultural standards.

.4 Coordinate maintenance practices with the City. Maintenance schedules may have to be altered to deal with site activities.

4.4.1.3.2 Spring Clean Up

.1 Complete spring clean-up as soon as working conditions are favourable, and no later than May 15.

.2 Maintained Turf Areas:

a) Rake and remove dead vegetation, leaves, and debris.

b) Roll lightly where grass has lifted due to frost action.

c) Heavy rake with flexible grass rake on areas with "snow mold".

d) Power sweep all boulevards and turf areas to remove sand/gravel and salt. All sand/gravel and salt is to be removed from site.

.3 Planting Beds:

a) Clean shrub beds, tree pits, and tree wells of debris and dead plant material.

b) Loosen up top layer of mulch without mixing it into the soil beneath, ensuring that mulch is drawn approximately 250 mm from plant material.

4.4.1.3.3 Turf Maintenance

.1 Aerating

a) Aerate areas where the soil has become compacted due to pedestrian traffic and/or other causes.

.2 Topdressing and Reseeding:

a) The first cutting is to occur when grass has reached a height of 75 mm over 75% of the seeded area.

b) After mowing, rake thoroughly to remove all loose and dead grass, stones, and debris.

c) Spread topsoil to maximum thickness of 15 mm, filling any burned out, thin, washed out areas, and bare spots.

d) Over seed all damaged or burnt out areas with a seed mixture equivalent to existing grasses. Seed at rate of 3 kg/100 m2.

e) Rake seed into topsoil and roll lightly.

f) Water all seed to ensure penetration of 80 mm and at frequent intervals to maintain vigorous growth.

4.4.1.3.4 Fertilizing

.1 Use only mechanical equipment.

.2 Check calibration of spreader to ensure that specified rate is used.

.3 Spread 50% of fertilizer in one direction, then 50% at right angles.

.4 Apply 16-20-0 fertilizer at rate of 3 kg/100 m2, in early spring as soon as frost is out of ground, prior to May 31.

.5 Apply 27-14-0 fertilizer at rate of 3 kg/100 m2 during the first two weeks of July.

.6 Apply 16-20-0 fertilizer at rate of 3 kg/100 m2 during the last two weeks of August.

.7 Water immediately after fertilizing according to manufacturer's recommendations; obtain moisture penetration of 80 mm minimum.

4.4.1.3.5 Seed/ Sod Watering

.1 Apply sufficient water during growing season to ensure continuous healthy growth, with sufficient time between watering to promote deep root growth. Apply water in soft spray to avoid "packing" of soil. Do not impede use of sidewalks and other paved areas.

.2 Ensure all water trucks do not use the pathways/trails or grassed areas as access routes. Any damage resulting from the use of these surfaces shall be reported immediately to the City, and the contractor shall repair or have all the damages repaired at its own expense. If not reported, it will be treated as third party damage, and the repair shall be the responsibility of the Developer.

4.4.1.3.6 Mowing - Maintained Areas

.1 Maintain all turf with sharp mowers at 60 mm height during the growing season.

.2 Do not cut more then 1/3 of the blade in any one mowing.

.3 Remove papers, rocks, and other foreign material prior to cutting.

.4 Change direction of cut with each separate mowing, wherever practical.

.5 Do not remove grass clippings from turf areas unless volume is such as to be harmful to turf areas or unsightly.

.6 Remove clippings from sidewalks, roads, windows, and buildings during the same mowing.

.7 Remove all clippings from planting beds.

.8 The City shall be the "sole judge" for variations in mowing operations during dry or wet weather.

.9 Edge along hard surfaces and lawn abutments, once monthly during June, July, August, and September.

4.4.1.3.7 Tree and Shrub Maintenance

.1 Cultivation of Plant Beds

a) Remove weeds bi-monthly, including their roots.

b) Collect and dispose of paper, refuse, and dead plants.

c) Prune all suckers from the base trunk and inside crown of tree.

d) Top up all mulch in beds and trees wells as required to maintain a minimum depth of 100 mm.

e) Maintain edge of all beds with a 90-degree vertical edge cut, 100 mm deep around the perimeter of the bed.

f) Ensure that crowns of shrubs and bottom branches are not covered with mulch.

.2 Staking

a) Keep stakes and guy wires taut (where required), and plants plumb for the duration of the maintenance period.

.3 Pruning

a) Immediately following planting, any dead, broken, or interfering branches shall be pruned together with any diseased branches which have not caused the plant's rejection.

b) Pruning must be completed by a ISA certified arborist.

c) The amount of pruning shall be limited to the minimum necessary and exceed no more than 25% of the living foliage in one season.

d) One section of any bad fork or weak crotch which has not caused the plant's rejection shall be removed at transplanting time.

e) The manner of pruning shall preserve the natural character of the plant.

f) Due to the risk of Dutch Elm Disease, elm trees shall only be pruned between the period of October 1 and March 31, when the Elm Bark Beetle is inactive as per the most current Dutch Elm Disease Bylaw.

g) Pruning tools shall be clean and sharp.

h) All pruning cuts shall be clean and leave no stubs or rough wood and be in accordance to the ANSI Z133.1 Standards. Small cuts shall be close to the branch collar and parallel to the adjoining branch or trunk. On large limbs, flush cuts shall be avoided and cuts made at the collar shall have the lower part slanting slightly away from the trunk to leave a smaller wound.

i) Bark that is cut, bruised, or scarred shall be cut back to living tissue with a clean edge. The affected area shall be shaped with a sharp knife so as not to retain water.

j) Wound surfaces shall not be treated with wound-dressing products, unless otherwise specified or directed by the City.

k) As a rule, growth is maximized if pruning is done just before the period of rapid growth in the spring. Prune at proper times in accordance with the following:

   i) Shade Trees – October 15 to April 15
   ii) Birch and Maple – June 15 to July 15
   iii) Fruit trees – March 15 to April 15
   iv) Evergreens – April 15 to May 15
   v) Elm Trees – October 1 to March 31

l) Do not prune a leader unless a lateral can be trained to take its place prior to the end of the maintenance period.

.4 Fertilizing

a) Fertilizing of Spring-planted trees and shrubs shall commence the following Spring. For Autumn-planted trees and shrubs, fertilizing shall commence the second Spring following planting. Liquid fertilizer shall be injected in the topsoil backfill and slightly outside the area of the planting pit. Trees under visible stress shall be fertilized as necessary to encourage vigorous and healthy growth.

b) Soluble fertilizer shall be injected around the planting pit at 800 mm intervals, and at a depth of 300 mm. At each site, 4.5 L of fertilizer solution shall be injected. Following the initial fertilization, subsequent applications shall be made annually.

c) Fertilization shall occur a maximum of two (2) times within the two year maintenance period.

d) Fertilization shall occur before June 15 and after plant material is dormant after two hard frosts. Good times to fertilize are generally March and June, or mid-October when leaves are coloring.

.5 Watering

a) Ensure all water trucks do not use the pathways/trails or grassed areas as access routes. Any damage resulting from the use of these surfaces shall be reported immediately to the owner and the contractor shall repair or have all the damages repaired at their own expense. If not reported, it will be treated as third party damage, and the repair shall be the responsibility of the Developer.

b) Watering plants when required and in sufficient quantities to saturate the root system. During extended hot periods, with daily maximum temperatures exceeding 25ºC, watering of plant material shall be increased to maintain vigorous and healthy growth. The frequency of watering shall be gradually reduced over the maintenance period. All plants shall be thoroughly watered just before the ground freezes in the fall

c) Watering shall be conducting as necessary, subject to the following minimum schedule: once immediately following planting, once per week for the first month, once per month during the Summer, and three times in Autumn to freeze trees and underlying soil to prevent drying out.

d) As a general guide water shall be applied initially at a rate of 29 L per m2 of root ball. Care shall be taken to avoid over watering and drowning new root growth. A watering probe is required.

e) Trees shall be watered at a rate of 1.2 L per mm of caliper per week, consistent with the following table. Do not over water trees.

Tree Caliper	Litres per Week
60mm	72.0
75mm	90.0
100mm	120.0
125mm	150.0
150mm	180.0
175mm	210.0
200mm	240.0

.6 Replacements:

a) All plant materials found dead or not in a healthy, satisfactory growing condition or which, in any other way, does not meet the requirements of the specifications, shall be replaced immediately by the contractor at the contractor’s expense.

b) All required replacements shall be by plants of the same size and species as specified on the plant list and shall be supplied and planted in accordance with the approved landscape drawings and specifications.

c) Trees that settle more than 25 mm below the surrounding ground level shall be lifted, and the maintenance period shall reset for the full warranty term.

4.4.1.3.8 General Considerations for Chemical Applications

.1 Ensure proper, positive identification of infestations and consult with the City before taking corrective action.

.2 Prior to chemical applications, obtain written approval from City. Notify the City of intent at least three days in advance.

.3 Determine susceptibility of plant species to chemical damage prior to any chemical application.

.4 Use equipment and containers free of harmful residues not related to specific control measures applicable to situation.

.5 Perform disease, weed and insect control in accordance with Provincial chemical application regulations.

.6 Prepare and apply chemical according to manufacturer's instructions. Minimize drift at all times.

.7 Carry out treatment with due regard to climatic conditions' effect on surroundings and occupants of buildings.

.8 Confine application to the specific area to be treated.

4.4.1.3.9 Weed Control

.1 Apply chemical to eradicate weeds within site.

.2 Repair and pay for damage caused by application of herbicides.

.3 Effectiveness of treatment program is to be determined by inspection by the City's field representative.

.4 Repeat as required.

4.4.1.3.10 Insect and Disease Control

.1 Make weekly inspection of lawns and plants for insect and disease infestations. Apply chemicals based on development stage of insects' life cycles.

.2 Repair and pay for damages caused by application of chemicals.

.3 Effectiveness of treatment program is to be determined by inspection by the City's field representative.

.4 Repeat as required.

4.4.1.3.11 Autumn Preparations

.1 Rake all leaves and remove from site.

.2 Deep-water trees and shrubs between October 15 and 31, and as required during warm periods between November 1 and February 1 to prevent desiccation of plant materials.

.3 Protect plants from rodent damage. (Rodent protection to be removed prior to FAC)

.4 Protect coniferous plants with burlap wrap during winter months, if warranted.

.5 Ensure all catch basins, swales, and ditches within the landscape area are clear and draining freely.

4.4.1.3.12 Cleanliness of Grounds

.1 Keep grounds in clean and tidy condition.

.2 Immediately report vandalism and damage to the City.

4.4.2 Fences 32 31 00

4.4.2.1 General

4.4.2.1.1 Related Sections

.1 Portland Cement Concrete Section 4.3.3.1.1 Roadways

4.4.2.1.2 Examination

.1 Report to the City, in writing, any conditions or defects encountered on the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigate and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencing work.

4.4.2.1.3 Product Delivery, Storage, and Handling

.1 During transportation, protect fencing materials from damage and weathering.

.2 On delivery, store all materials off the ground and protect from adverse conditions to prevent deterioration, damage, or impairment of the structure.

.3 Handle carefully to prevent paint damage or breaking.

.4 Follow manufacturer’s delivery, storage, and handling instructions.

4.4.2.1.4 Samples

.1 Upon request provide product and material samples to the City.

.2 All work shall confirm to approved samples.

4.4.2.1.5 Substitution

.1 All requests for substitutions shall be vetted through the Consultant responsible for preparing the contract drawings. Such requests shall be forwarded to the City for approval prior to installation.

4.4.2.1.6 Inspection

.1 The City will inspect all fence installations.

.2 Give timely notice, in writing, to the Consultant when materials are available for inspection.

.3 Remove all rejected materials from site immediately.

.4 All optional fencing is subject to the approval of the City prior to installation.

4.4.2.2 Products

4.4.2.2.1 Wood Fencing

.1 All lumber shall be #1 Construction Grade Spruce, Pine or Fir (SPF) dressed, conforming to C.S.A. 0141 – 1970 for nominal size. All timber and lumber must be straight sound and free of splits, warps, checks, large knots or other defects. Rough sawn lumber will be used only where detailed and shall be sawn straight, square and true. All lumber in contact with the ground must be pressure treated.

.2 Posts and rails to be ACQ pressure treated wood.

.3 Screws to be hot dipped galvanized or all weather treated for pressure treated applications.

.4 Nails, spikes, bolts, lag screws, etc. are to be hot dipped galvanized in accordance with CSA- G164 – M1981, and the size and/or weigh specified.

.5 Fillcrete for post footings shall be in accordance with Article 4.3.3.1.11.

.6 Solid fences shall have no gaps between boards, or between posts and boards, and shall a 75 mm gap between the bottom of the fence board and finished grade. Refer to the Engineering Standard Drawings in Appendix A.

4.4.2.2.2 Chain Link Fencing

.1 Chain link fence shall be constructed and installed in accordance with the Engineering Standard Drawings in Appendix A.

.2 Chain Link Fabric

a) Chain link fabric to be galvanized or vinyl-coated, in accordance with the following:

i) Galvanized: Pre-galvanized wire to 490 g/m², 3.5 mm diameter (9 gauge).

ii) Vinyl-Coated: Pre-galvanized wire to 490 g/m², 4.26 mm diameter after coating.

b) Fabric height: 1.2, 1.5, 1.8, 2.1 or 2.4 m as specified.

c) Selvage: knuckled and knuckled bottom.

.3 Fence Framework

a) Conforming to CGSB CAN2-138.2M.

.4 Posts and Rails

a) Hot-dip galvanized welded steel pipe, standard weight (Schedule 40, ASTM A120), zinc- coated at minimum 550 g/m² and with the following minimum dimensions:

b) Caps – only rounded caps are accepted.

Post and Rail Minimum Dimensions					
Fabric Height (m)	1.2	1.5	1.8	2.1	2.4
Line post outside diameter, OD (mm)	48.3	48.3	60.3	60.3	60.3
Length (m)	2.0	2.3	2.6	2.9	3.2
Terminal Post (End, gate, corner, straining) OD (mm)	73.0	73.0	88.9	88.9	88.9
Length (m)	2.3	2.6	2.9	3.2	3.5
Rail and brace OD (mm)	-	-	42.2	42.2	42.2

.5 Bottom Tension Wire

a) 5 mm diameter (6-gauge) steel wire, zinc-coated at minimum 490 g/m².

.6 Fittings

a) Conforming to ASTM F626, as follows:

.7 Gate Fabric

Fitting Standards			
Component	Min. Dimensions (mm)	Min. Zinc Coating g/m^2	Fabricated From:
Post Cap and Rail End	Varies	366	Pressed steel or cast iron
Top Rail Sleeve	2.0 thick x 175 long	366	Round steel tubing
Tie Wire and Clip	3.5 diameter (9 gauge aluminum)	122	Round steel tubing
Tension and Brace Bands	2.0 thick x 19.0 wide	366	Pressed steel
Tension Bar	5.0 thick x 16.0 wide	366	Steel strip
Turnbuckle	Varies	366	Steel
Barb Arm	2.0 thick (14 gauge)	366	Pressed steel

.8 Gate Fabric

a) To match fence fabric in Article 2.2.2

.9 Gate Frame

a) Conforming to Article 2.2.2 with minimum 42.2 mm outside diameter.

b) To be electrically welded at all joints and hot-dip galvanized after welding.

c) If braces are required, use truss rod and turnbuckle adequate for gate size.

.10 Gate Fittings

a) Malleable iron hinges, latch and latch catch, all galvanized as specified in Article 2.2.2.

b) Latch catch to have provision for a padlock that can be attached and operated from either side of gate.

c) Hinges shall permit gate to open 90° or 180° as specified.

.11 Double Gate

a) To have centre rest with drop bolt for closed position and chain hook to hold gates open, all galvanized in accordance with Article 2.2.2.

.12 Concrete for Post Footing

a) Fillcrete for post footings shall be in accordance with Article 4.3.3.1.11.

4.4.2.3 Execution

4.4.2.3.1 Fencing

.1 Uniform fencing, if provided, shall be subject to the review and acceptance of the City. Such fencing shall be located 150 mm inside of the residential lot property line and shall be consistent in appearance throughout the Subdivision.

.2 All fencing to be installed in accordance with the applicable Engineering Standard Drawings in Appendix D and the approved construction documents.

.3 Wood Fences

a) Posts will be rejected when structural integrity is compromised, or when the following conditions apply:

i) Cracks are 50% of the depth of the post in the face it occurs;

ii) Cracks exceed 25% of the width of the post on the face it occurs, or are wider than 12 mm; or if

iii) Mechanical damage is evident.

b) Cracks from 6 to 12 mm are to be re-stained with fence stain, ensuring that the stain penetrates the wood.

c) Board spacing shall be tight, ensuring that the spacing between boards does not exceed 12 mm when the boards are dry.

d) Fence boards, including stringers, shall be stained prior to installation.

e) Fence posts shall be stained prior to installation of the stringers and fence boards.

f) Nailer strips shall be fastened to the posts.

g) On double-board fencing, fascia boards shall be fastened to the fence boards.

h) For noise attenuation, on double-board fencing, adjust yard side pressure treated bottom stringer to provide no gap on ground. Bottom of double-board fencing on road side to be 75 mm above ground.

i) Standard wood screen fence to be 75 mm above grade.

.4 Chain Link Fences

a) Maximum spacing of posts shall be 3 m on centre.

b) Install line, corner, and terminal posts plumb, set is concrete footings in accordance with the following table:

Fence Height	Component	Concrete Depth	Hole Dia. at Top
1.2, 1.5, and 1.8 m	Line Posts	760 mm	250 mm
	Gate and Corner Posts	900 mm	300 mm
2.4, 3.0, and 3.6 m	Line Posts	900 mm	250 mm
	Gate and Corner Posts	1060 mm	300 mm

c) Set top of concrete flush with finished grade. Slope and trowel-finish top to ensure water runoff.

d) Position bottom of fabric 25 mm above finished grade with bottom tension wire between posts.

e) Align top of posts to ensure that the top rail varies gradually with changes in ground elevation.

f) Pass top rail through line post tops to form continuous bracing. Install 150 mm long couplings mid-span at pipe ends.

g) For fences 1.8 m and taller, brace each gate and corner post back to adjacent line post with horizontal brace rail. Install brace rail, one bay from corner and gate post.

h) Attach fabric to corner and gate posts with tension bars and clips. Stretch fabric between posts at maximum intervals of 3.0 m.

1. Install straining posts every 90 m.

i) Install gates with fabric to match the fence. Install two hinges per leaf.

j) Install centre rests set in concrete, and cane bolts at centre of double-gate openings.

k) Welded gate frame joints shall be painted with one coat of zinc paint.

l) Cut fabric for crawl holes, selvage knuckle end closed top and bottom. Place two-part frames around opening in fabric and bolt together.

4.4.2.3.2 Construction Completion Inspection

.1 The Construction Completion Certificate for fencing shall be issued following a satisfactory inspection by the City's representative, developer's representative and contractor which all material has been supplied and installed in accordance with the approved drawings and any approved substitutions. The maintenance and warranty period commences from the date of the issuance of the CCC.

4.4.2.3.3 Maintenance (On Public Land Only)

.1 During the maintenance and warranty period, the contractor shall maintain the fencing and site amenities and repair all damage immediately upon notice.

4.4.2.3.4 Final Acceptance Inspection (On Public Land Only)

.1 Final inspection of fencing will be made prior to the end of the maintenance period. All fencing shall conform to the construction documents and be free of deficiencies.

.2 Wood fences shall have touch ups completed and board replaced as required at time of FAC inspection (paint to match existing fence colour).

4.4.3 Site Furnishings 32 33 00

4.4.3.1.1 General

.1 Refer to Section 3.4.15 for required locations of site amenities.

.2 Site amenities are to be designed to compliment other proposed architectural and urban amenities, and meet the following objectives:

a) Safety and security;

b) Delineation of private and public lands;

c) Pedestrian barrier; and

d) Visual continuity.

.3 All site amenities, including site furniture, must be reviewed and approved by the City prior to installation.

.4 All site furnishings should be of a consistent style and type within the community and/or development phase.

.5 Optional amenities are non standard infrastructure development (i.e. ornamental fencing, water features, gazebos, sculptures, entrance features / signs, decorative fixtures etc.) in a public park or road right-of-way. City branding may be required to be included on the amenity, as per direction from the City.

a) The intent to construct optional amenities must be identified at the Preliminary design stage via a letter of intent or other mechanism.

b) If a Developer or homeowners'/community association intends to construct an optional amenity they must enter into a Maintenance Agreement with the City. The Maintenance Agreement must be executed prior to FAC approval. Encroachment agreements of License of Occupation may also be required.

c) Maintenance manuals shall be submitted to the City prior to FAC approval for all optional amenities associated with irrigation and/or water systems.

d) Under the Municipal Government Act, Community Entrance Features that contain the name, logo, address of the community, or the Developer's identification cannot be placed on Municipal Reserves. Community Entrance Features with this type of information must be placed on private lands or within wider road right-of-ways upon approval of the City. Encroachment agreements or a License of Occupation may also be required.

4.4.3.1.2 Related Sections

.1 Portland Cement Concrete Section 4.3.3.1.1 Roadways

4.4.3.1.3 Examination

.1 Report to the City, in writing, any conditions or defects encountered on the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigate and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencing work.

4.4.3.1.4 Product Delivery, Storage, and Handling

.1 During transportation, protect site amenities and fencing materials from damage and weathering.

.2 On delivery, store all materials off the ground and protect from adverse conditions to prevent deterioration, damage or impairment of the structure.

.3 Handle site furnishings carefully to prevent paint damage or breaking.

.4 Follow manufacturer's delivery, storage, and handling instructions.

4.4.3.1.5 Samples

.1 Upon request provide product and material samples to the City.

.2 All work shall confirm to approved samples.

4.4.3.1.6 Substitution

.1 All requests for substitutions shall be vetted through the Consultant responsible for preparing the contract drawings. Such requests shall be forwarded to the City for approval prior to installation.

4.4.3.1.7 Inspection

.1 The City will inspect all site amenity installations.

.2 Prior to the commencement of installation, all materials may be inspected at the discretion of the City. Previous approval will not impair the right of the City during the course of construction to reject amenities which has been damaged or which, in any way, does not conform to the specifications. Any rejected amenities will be noted on a site instruction form and be presented to the contractor for follow-up.

.3 Give timely notice, in writing, to the Consultant when materials are available for inspection.

.4 Remove all rejected materials from site immediately.

4.4.3.2 Products

4.4.3.2.1 General

.1 Site amenities to be provided within the Red Willow Park shall conform to the City's standards established for this area.

4.4.3.2.2 Benches

.1 DuMor, Inc. Model 88 Series PL, frame color: Deep Red, recycled plastic colour: Cedar.

4.4.3.2.3 Trash Receptacles

.1 Surface mount: DuMor, Inc. model 70-22PL/46-00, frame color: Deep Red, recycled plastic colour: Cedar.

.2 In ground installation: Alfa maxi 30 model 1867 or Rocky Mountain Recreation Equipment Canada Ltd. ALC-4. Red with grey skirting for Red Willow Park areas, colour as approved by the City for all other areas.

4.4.3.2.4 Picnic Tables

.1 DuMor, Inc. Model 76 Series PL, frame colour: Deep Red, recycled plastic colour: Cedar.

4.4.3.3 Execution

4.4.3.3.1 Site Amenities

.1 All site amenities to be installed in accordance with the applicable Engineering Standard Drawings in Appendix D and the manufacturers' instruction.

4.4.3.3.2 Construction Completion Inspection

.1 The Construction Completion Certificate for site amenities shall be issued following a satisfactory inspection by the City's representative, developer's representative and contractor which all material has been supplied and installed in accordance with the approved drawings and any approved substitutions. The maintenance and warranty period commences from the date of the issuance of the CCC.

4.4.3.3.3 Maintenance

.1 During the maintenance and warranty period, the contractor shall maintain the site amenities and repair all damage immediately upon notice.

4.4.3.3.4 Final Acceptance Inspection

.1 Final inspection of site amenities will be made prior to the end of the maintenance period. All site amenities shall conform to the construction documents and be free of deficiencies.

4.4.4 Topsoil 32 91 00

4.4.4.1 General

4.4.4.1.1 Related Sections

.1 Turf & Grasses, Trees Shrubs & Ground Covers

4.4.4.1.2 Limits

4.4.4.1.3 Examination

.1 Report to the City, in writing, any conditions or defects encountered in the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigated and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencement of work.

.4 Protect all existing trees and planting areas in accordance to Appendix E, 3 Steps to Tree Preservation.

4.4.4.1.4 Qualifications

.1 All work shall be done by experienced, qualified personnel, under the direction and supervision of a foreperson with at least 5 years of experience.

4.4.4.1.5 Product Delivery, Storage & Handling

.1 Stockpile topsoil in locations designated by the City.

.2 Stockpiling on future MR lands is not permitted, unless written permission is granted by the Director of Planning and Engineering Services.

.3 Do not spread topsoil in muddy or frozen conditions.

4.4.4.1.6 Chemical Analysis & Physical Soil Testing

.1 Topsoil samples must be provided in a technical memorandum to the City for approval.

a) Soil sample analysis and testing report(s) must be provided to the City prior to construction as a technical memorandum.

b) Submit required samples of topsoil to the geotechnical testing laboratory and indicate intended use, type of mulches applied, type of sub-soil and quality of drainage.

c) Obtain approval for topsoil use in writing from the City prior to construction. Topsoil testing shall take place at the source location and shall be conducted by a professional engineer or geoscientist. Four samples shall be taken (i.e. one within every 25% vertical increment of the stockpile) at a depth of 300mm. The location of the samples within each vertical increment shall be determined by the City.

d) Chemical soil analysis must be completed by an accredited laboratory and results provided in a report to the City.

e) Topsoil analysis and tests must include NPK, particle size (soil texture), soluble salt content, organic matter, pH, and micro/macro nutrient status. Two (2) copies of the analysis and testing report must be provided to the City and include the location of the topsoil stockpile or source. If required, recommendations should clearly state the type, quantity, and application procedure for amendment.

f) If additional topsoil from alternate source is required, the same topsoil analysis and testing, as listed above, must be completed and approved.

.2 The City reserves the right to collect additional topsoil samples once in place.

4.4.4.1.7 Substitutions

.1 A topsoil substitute may be accepted when it is more appropriate for the planting site than natural topsoil or un-altered topsoil. The specification for the material proposed shall be submitted to the City's representative for review. Such documentation shall be supplemented by research from a recognized horticultural agency or institution supporting the topsoil substitute's use and effectiveness and including guidelines for its long-term management. Topsoil substitutes shall only be used after written approval

.2 The following information shall also be provided:

a) The status for the topsoil substitute or its components of all the characteristics listed under the Samples section above.

b) Grading analysis of the mineral content.

c) Identify and rate of use of any tackifier of gluing agent.

4.4.4.1.8 Inspections

.1 The Contractor shall have an approved set of drawings and specifications available prior to calling the City for inspection

.2 The City shall approve both rough grade prior to placing of topsoil and finished grade at appropriate times before contractor proceeds with next phase of work. For all joint use sites and community parks, as well as dry ponds containing sports field in MR sites, the Contractor shall:

a) At Sub-grade Inspection:

i) Supply grade stakes at all corners of sports fields as well as along their centre line if requested by the City.

ii) Supply grade stakes at the toe and heel of all slopes and swales. Spacing of the stakes is to be determined by the City prior to their installation.

iii) Be available for a joint site inspection with the City and have on site a survey crew fully equipped to provide any additional elevations as may be requested.

b) At Finished Grade Inspection:

i) Supply grade stakes at the corners, centre and quarter points of sports fields, break of slopes and along drainage channels. See 3.1.4 Swales for minimum allowable slopes.

4.4.4.2 Products

4.4.4.2.1 Peat Moss

.1 Peat moss shall be of good horticultural quality, homogeneous, and free of foreign material, lumps, clay, wood, stumps, rocks, quack grass, and noxious weeds.

.2 Peat moss shall be pulverized and shall pass through a 37 mm screen.

.3 The peat moss shall have a pH between 4.5 and 6.0, conductivity not exceeding 1.5 mS/cm, maximum sulphate of 200 ppm, and no lime present.

4.4.4.2.2 Sand

.1 Sand for horticultural use when tested by laboratory sieves shall be uniformly graded and meet the following grading requirements:

Passing	Cumulative % by Weight
2.5 mm	100
1.25 mm	90-100
0.8 mm	80-90
315 micro-m	30-60
160 micro-m	2-10
63 micro-m	1 maximum

.2 Sand shall be natural and coarse (except for the removal of very fine particles and gravel). Sand shall be free from vegetation, clay balls and other foreign material. Care shall be taken in the selection of material from the pit to produce a uniform product.

4.4.4.2.3 Crushed Gravel

.1 If found in topsoil source crushed gravel shall be maximum size 25 mm complying with the following gradation.

Sieve Size	Percent Passing
25 mm	100
19 mm	95-100
9.50 mm	60-80
4.75 mm	40-60
2.00 mm	25-45
425 micro-m	10-25
75 micro-m	2-10

.2 Volume of rock in topsoil not to exceed 20%.

4.4.4.2.4 Topsoil Composition

.1 The following topsoil requirements are for boulevard and parks projects. For projects with specialized plant communities including, for example, species demanding unusually acid or alkaline soils an appropriate soil specification shall be submitted to the City for review and acceptance.

.2 Topsoil shall be loose, loamy soil, free from subsoil, refuse, roots, stones > 25mm, slag, clay, stones, lumps, quack grass and other perennial weeds and roots, rhizomes, noxious odors, chemical contaminants, live plant roots, or other foreign materials.

.3 If the seed bank of an imported topsoil yields quack grass, noxious weeds, or restricted weeds as designated by the Weed Designation Regulation of the Weed Control Act of the Province of Alberta, or sufficient weeds of any type to choke the desired vegetation, up to three repetitions of cultivation, germination and appropriated translocated herbicide application will be required.

.4 Topsoil pH to be between 6.0 and 7.5. Use lime or sulphur, as indicated by analysis of topsoil, to bring pH to the required range.

.5 Stone content shall not exceed 10% by dry weight. The maximum stone size, in any direction, shall not exceed 25 mm.

.6 Topsoil shall be free from weeds and weed seeds.

.7 Topsoil shall be capable of sustaining vigorous plant growth.

.8 Soil mix for tree, shrub, and flower beds shall consist of black topsoil, a fertile friable natural loam containing not less than 5-10 % of organic matter for clay loams and not less than 2-4% for sandy loams.

.9 Recommended Soil Composition

Soil Type	Composition
Sand:	Minimum 25% by dry mass
Clay/ Silt Combined:	Maximum 75% by dry mass
Organic Matter:	5% - 10% by dry mass
Toxic Chemicals	None
Electrical Conductivity	Max. 1.5 dS/m
pH Value (saturated paste):	6.0 to 7.5
Sodium Absorption:	Less than 6

Note: All soils must fall within the Loam Classification

4.4.4.3 Execution

4.4.4.3.1 Topsoil Placement

.1 Do not place topsoil when sub-grade or topsoil is frozen, excessively wet or dry, or in a condition that inhibits proper grading, cultivation, or compaction.

.2 Spread topsoil uniformly over prepared sub-grade to achieve a minimum compacted depth of 150 mm for sodded and 200 mm seeded areas, unless otherwise specified or directed by the City. Apply topsoil to the following minimum depths measured at right angles to the Sub-grade after leveling with a tolerance of 25 mm over a distance of 2.4 m:

a) Min 200 mm for seeded areas.

b) Min 150 mm for sodded areas.

c) Min 650 mm for planting beds

.3 Cultivate topsoil, breaking down lumps. Remove stones larger than 25 mm, weeds, roots, and other foreign material from the site.

.4 Manually spread topsoil around trees and plants to prevent damage by grading and leveling equipment.

.5 Fine grade to eliminate rough or low areas and to ensure positive drainage.

.6 Boulevards – The finished topsoil level shall match the adjacent curb and sidewalk elevations and must provide for adequate drainage of sidewalk areas after turf establishment.

.7 Buffer Strips - The finished topsoil level shall slope uniformly from the property line towards the back of the sidewalk at not less than 2%.

.8 Public Utility Lots and Walkways – Where a sidewalk is present, a swale shall be provided at a distance of at least 1m from the edge of the sidewalk. The grade must be sloped away from the sidewalk at a minimum grade of 2%.

.9 Medians and Islands – The finished topsoil level shall be even from curbs to curb with crowning to accommodate drainage.

.10 Compact topsoil with rollers.

.11 Final topsoil grades for seeded areas shall be flush to finished grades at surface structures (i.e. manholes, sidewalks, driveways, and curbs).

.12 When abutting an existing turf area, cut the existing turf to form a straight, non-jagged joint with the new seeded or sodded area.

.13 Rehabilitate any damage caused by topsoil spreading activities.

.14 Control dust so as to have no impact on surrounding land uses.

.15 Clean all adjacent walks, streets and properties as a result of work done under this section at the end of each working day or as directed.

.16 The Consultant shall inspect the topsoil preparation prior to the Contractor proceeding with seeding or sodding.

4.4.4.3.2 Topsoil Placement - Natural Areas, ER's

.1 In addition to the requirements provided in Article 9.22, comply with the following:

.2 In restoration areas the depth and finish grade of the topsoil should be tied to the depths and finish of the pre-existing native profile. This should be specified in the restoration plan and approved by the City.

.3 Grade topsoil to ensure positive drainage and to emulate the pre-development drainage patterns and rates.

4.4.5 Mulch 32 91 13

4.4.5.1 General

4.4.5.1.1 Related Sections

.1 4.4.6 Trees Shrubs & Groundcovers

4.4.5.1.2 Examination

.1 Report to the City, in writing, any conditions or defects encountered on the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigated and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencing work.

4.4.5.1.3 Product Delivery, Storage, and Handling

.1 Supply mulch as specified on approved landscape drawings and specifications.

.2 Protect mulch stockpile on site from contamination of airborne herbicides, pesticides, fertilizers and other hazardous chemicals.

.3 Avoid the placement of mulches in excessively wet conditions or when frozen.

.4 All organic mulches shall be free of diseases, moulds, fungi and insect infestations.

.5 All organic mulches shall be free of inorganic materials such as metal, glass, rock and other foreign materials.

4.4.5.1.4 Samples

.1 Samples of mulch may be requested for approval by the City.

.2 Retain approved samples on site until work has been inspected and approved.

.3 All work shall conform to approved samples.

4.4.5.1.5 Substitutions

.1 All requests for substitutions of mulch shall be vetted through the consultant responsible for preparing the contract drawings. Such requests shall be forwarded to the City for approval prior to installation.

.2 All mulches shall be supplied and installed as specified Substitutions will not be allowed unless approved by the City

4.4.5.1.6 Inspection

.1 Samples of mulch shall be approved by the City prior to installation.

.2 Retain approved samples on site until work has been inspected.

.3 All work shall conform to approved samples.

.4 Give timely notice, in writing, to the Consultant when materials are available for inspection.

.5 Remove all rejected materials from site immediately.

4.4.5.2 Products

4.4.5.2.1 Organic Mulches

.1 Deciduous/coniferous wood chip mulch shall consist of chipped ash, elm, maple, poplar, birch, and other deciduous woods plants or coniferous wood containing bark, wood, and may contain needles.

.2 Mulch may contain bark, wood (and leaves in summer) and/or needles and may contain seed. Needles and seed are not encouraged.

.3 Mulch shall be free of non-organic material, wood preservatives, and diseased wood.

.4 Chip size shall be 50 to 75 mm.

.5 Mulch shall contain no more than 5% by dry weight of soil, sawdust, and peat moss.

.6 Add top-up mulch as needed prior to FAC.

4.4.5.2.2 Inorganic Mulches

.1 Clean crushed gravel, pea gravel, crushed clay brick, and crushed shale to a minimum sieve size of 25mm. The city will determine the maximum sieve size.

.2 Inorganic mulches shall be free of organic material/vegetation.

4.4.5.2.3 Prohibited Mulches

.1 The following mulches are prohibited: sawdust and shavings, peat moss, manures or raw composts, paper products, plastics, rubbers, aluminum foils, gelatinous sprays, plywood and other lumbers containing chemical adhesives or wood preservatives.

4.4.5.3 Execution

4.4.5.3.1 Installation

.1 Plants must be watered before mulch is installed.

.2 During application all mulches shall be kept at least 250 mm away from tree trunks and bases of shrubs.

.3 Apply mulches in areas as per drawings and spread by hand rake to a settled depth of 100 mm.

4.4.5.3.2 Preparation

.1 Tree wells and planting beds shall be free of weeds prior to mulch installation.

4.4.5.3.3 Clean Up

.1 Immediately after installation, remove all mulches and other debris from the roadways, walkways and surrounding areas, leaving the area neat and tidy. Clean all areas, which are contaminated as a result of landscape construction operations.

.2 Maintain all areas neat and tidy at all times until acceptance.

4.4.6 Turf & Grasses 32 92 00

4.4.6.1 General

4.4.6.1.1 Related Sections

.1 4.4.3 Topsoil

.2 4.4.6 Trees Shrubs & Groundcovers

4.4.6.1.2 Examination

.1 Report to the City, in writing, any conditions or defects encountered on the site before or during any construction upon which the work of this section depends and which may adversely affect its performance.

.2 Do not commence work until those conditions or defects have been investigate and corrected.

.3 Commencement of work shall imply acceptance of existing surfaces and conditions and no claims for damages or extras resulting from such conditions or defects will be accepted later, except in cases where such conditions could not have been known prior to commencing work.

4.4.6.1.3 Product Delivery, Storage, and Handling

.1 Deliver seed in the original containers, tagged with identification as to the analysis of the seed mixture, percentages of seed, year of production, net weight, and date.

.2 Deliver seed to the site only when ready for seeding.

.3 During transportation, protect sod with tarpaulins to prevent sun scalding and drying out, and to ensure arrival in the site in a healthy condition.

.4 All manufactured items subject to deterioration shall be stored in a weatherproof place on site in such a way that their effectiveness is not impaired.

.5 Sod must be installed on the day of arrival at the site. If delays in installation occur due to weather, protect sod on the site from sun, keep moist, and store in a cool location until installation.

.6 Handle sod carefully to prevent tearing or breaking.

.7 Fertilizer shall be delivered mixed, in standard size unopened containers, showing weight, analysis, and name of manufacturer. These containers shall be stored in a weatherproof place to keep the fertilizer dry.

.8 Follow manufacturer’s delivery, storage, and handling instructions.

4.4.6.1.4 Samples

.1 Samples of grass seed may be requested for approval by the City.

.2 Retain approved samples on site until work has been inspected.

.3 All work shall confirm to approved samples.

4.4.6.1.5 Substitution

.1 All requests for substitutions of seed mixes shall be vetted through the Consultant. Such requests shall be forwarded to the City for review and approval prior to installation.

4.4.6.1.6 Inspection

.1 The City will inspect all seed and sod installations.

.2 Prior to the commencement of installation, all materials may be inspected and approved whether at the source of local supply or on site at the discretion of the City. Previous approval will not impair the right of the City during the course of construction to reject sod which has been damaged or which, in any way, does not conform to the specifications. Any rejected seeding or sodding will be noted on a site instruction form and be presented to the contractor for follow-up.

.3 Give timely notice, in writing, to the Consultant when materials are available for inspection.

.4 At the time of inspection, all turf shall be alive and in a healthy, satisfactory growing condition.

.5 Remove all rejected materials from site immediately.

4.4.6.2 Products

4.4.6.2.1 Grass Seed

.1 All grass seed mixes shall have a minimum purity of 98% and minimum germination of 95%.

.2 All seed must be from a recognized seed firm having membership in the Canadian Seed Trade Association. Seed must meet the requirements for the Seeds Act for Canada No. 1 grade seed and seed shall be certified No. 1 grade. The City may request germination tests, purity tests, and/or weed seed analyses to confirm conformance.

.3 Seed Mixes:

i) Percentage content of seed blends is by weight.

Sturgeon Riparian Blend		
Botanical Name	**Common Name**	**Percent of Mixture**
Agrostis scabra	Rough hair grass	20%
Beckmannia syzigachne	Slough grass	20%
Bromus ciliatus	Fringed brome	20%
Elymus trachycaulus ssp. subsecundus	Awned wheatgrass	20%
Nassella viridula	Green needle grass	10%
Poa palustris	Fowl bluegrass	10%
Meadow Mix		
Botanical Name	**Common Name**	**Percent of Mixture**
Poa palustris	Fowl Bluegrass	25%
Elymus trachycaulus ssp. Subsecundus	Awned Wheategrass	20%
Deschampia caespitosa	Northern Tuffed Hairgrass	15%
Bromus ciliatus	Fringed brome	15%
Puccincelia distans	Alkali Grass	15%
Beckmania syzigachne	Beckmann's Sloughgrass	10%
Parks and Boulevards Mix		
Botanical Name	**Common Name**	**Percent of Mixture**
Poa pratensis ssp.	Blend of three varieties of certified Kentucky Bluegrass	55%
Festuca rubra sp.	Creeping Red Fescue	35%
Lolium perenne	Perennial Ryegrass	10%
Low Maintenance Mix		
Botanical Name	**Common Name**	**Percent of Mixture**
Festuca ovina	Sheep Fescue	35%
Festuca duriuscula L. var Duriuscula	Hard Fescue	35%
Poa compressa L. var Rubens	Ruben's Canada Bluegrass	30%
Salt Tolerant Mix		
Botanical Name	**Common Name**	**Percent of Mixture**
Puccinellia distans 'Fults'	Fults Distans Alkali Grass	50%
Poa secunda	Sandberg Bluegrass	15%
Lolium perenne L.	Citation III Perennial Rye	15%
Agropyron cristatum L.	AC Parkland Crested Wheatgrass	20%

Naturalization Mix		
Botanical Name	**Common Name**	**Percent of Mixture**
Festuca saximontana	Rocky Mountain fescue	20%
Hesperostipa curtiseta	Western porcupine grass	20%
Festuca hallii	Plains rough fescue	15%
Koeleria macrantha	June grass	10%
Nassella viridula	Green needle grass	10%
Bromus ciliatus	Fringed brome	10%
Avenula hookeri *	Hooker's oat grass	5%
Pascopyrum smithii**	Western wheatgrass	5%
Elymus trachycaulus **	Slender wheatgrass	5%
* If Hooker's oat grass (Avenula hookeri) is not available then increase the contribution of green needle grass by 5%. **If a seed source is available, then substitute purple oat grass (Schizachne purpurascens) or hay sedge (Carex siccata) for the wheatgrasses.		

.4 Acceptable cultivars

Seed	Acceptable Cultivar
Kentucky Bluegrass	A34, Able 1 Alpine, America, Banff, Baron, Challenger, Cheri, Cynthia, Midnight, Nugget, Ram 1, Touchdown, Washington
Creeping Red Fescue	Jasper, Fortress, Boreal, Shademaster, Flyer
Wheat Grass	AEC Hillcrest Awned, Elbee Northern, Walsh Western Streambank, Sodar Streambank
Perennial Ryegrass	Fiesta II, Palmer, Manhattan

4.4.6.2.2 Sod

.1 Sod shall conform to the specifications of the Canadian Nursery Sod Growers of Landscape Alberta Nursery Trades Association, be vigorous and healthy with a strong fibrous root system, free from disease, insect pests, stones, burns, dry or bare spots, and tears.

a) Sods shall be machine stripped at a uniform thickness of 15 mm (± 5 mm), delivered and installed within a period of 24 hours, unless a suitable preservation method is authorized prior to delivery. Sod thickness shall be determined at the time of stripping and shall exclude top growth and thatch.

b) Sod shall conform to the following mix:

Seed	Percent of Mixture
Kentucky Bluegrass[1]	70-90%
Creeping Red Fescue	10-30%

c) Other grasses and clover shall not be apparent in the sod and there shall be no more than one broadleaf weed or ten other weeds for every 45 m2.

d) Wooden pegs required to hold sod in place shall have dimensions of approximately 15 mm x 35 mm x 300 mm. Metal pegs will not be accepted.

4.4.6.2.3 Binder

.1 Use Turfmaster Hydro Seal or equivalent, compatible binder additive at the manufacturer's recommended rate, sufficient to mix a consistent slurry.

.2 Binder shall be mixed and supplied by a recognized supplier and shall have tested rates of purity.

4.4.6.2.4 Mulch

.1 Mulch shall be wood cellulose fibre containing no contaminants.

a) Fibre shall be supplied by a recognized supplier and shall a certified weight and composition.

b) Minimum application rate is 16.0 kg of air dry fibre per 100 m2.

c) Fibre shall be measured as it is fed into the seeder.

4.4.6.2.5 Fertilizer

.1 Use standard commercial fertilizers with guaranteed chemical analyses.

.2 Fertilizers shall be clearly labeled and supplied in unopened, moisture-proof containers.

.3 Fertilizer requirements are as follows, alternate rates to be pre-approved by the City:

Type 1 – Rate 3.5 kg/100 m^2	
Total Nitrogen	19%
Available Phosphoric Acid	19%
Potash	19%
Type 2 – Rate 3.5 kg/100 m^2	
Total Nitrogen	10%
Available Phosphoric Acid	30%
Potash	10%
Type 3 – Rate 3.5 kg/100 m^2	
Ammonia	12%
Phosphate	51%
Sulphate	0%

.4 Fertilizers shall be granular, water-soluble type.

.5 The City may require changes to the fertilizer feed rates if an analysis of the topsoil shows this to be necessary.

4.4.6.2.6 Water

.1 Water shall be clean and free of any substance that may inhibit vigorous growth of the plants.

.2 The Contractor prior to submission of their bid or quotation shall investigate the type and distance of water supply available.

.3 If water supply is required for construction, apply to the City's Utilities department to use filling stations for access to water supply or permitted hydrant usage. Comply with all Utilities' requirements with respect to using City hydrants for water supply.

4.4.6.3 Execution

4.4.6.3.1 Preparation

.1 Remove weeds and debris from topsoil.

.2 Verify grades and check that topsoil has been placed as required.

.3 Notify the City prior to commencing seeding or sodding operations. Installation of fertilizer, seed or sod indicates acceptance of topsoil conditions.

.4 Apply fertilizer according to the manufacturer's instructions or as directed by the City.

.5 Apply fertilizer with a spreader at the designated rate.

.6 Mix fertilizer thoroughly into the upper portion of the topsoil.

.7 Float and level out the finished topsoil surface.

4.4.6.3.2 Seeding

.1 Seeding or sodding must be done between May 1 and September 30, unless otherwise approved by the City in writing depending on weather conditions.

.2 Do not seed when prepared topsoil is covered with frost, snow, or standing water.

.3 Conduct seeding operations in low wind conditions only. Do not carry out seeding operations when wind velocities pose the risk to cause seed mix to be blown. Suspend and delay seeding operations if the City determines wind conditions are unsuitable.

.4 Proceed with seeding operations in accordance with sound horticultural practices.

.5 Hand broadcast seeding is unacceptable except for site-specific repair work and pre-authorized work in naturalization areas.

.6 Mechanical Seeding:

a) For slopes flatter that 3H:1V, apply Parks and Boulevards Mix, unless otherwise specified, by mechanical dry spread (Brillion or Cyclone type) at a rate of 24 kg/1,000 m2. More may be needed depending on germination.

b) Apply in two passes, each pass at a rate of 12 kg/1,000 m2 and perpendicular to each other.

c) Lightly roll seeded area after seed application is complete.

d) Spread Type 3 fertilizer evenly over the area and at the rate specified.

e) Thoroughly harrow the site after fertilizing.

.7 Hydro Seeding

a) For slopes 3H:1V or steeper, apply Low Maintenance Mix, unless otherwise specified, by hydro seeder.

b) Mix seed with water, mulch, and fertilizer in the following application rates:

Ingredient	Quantity
Grass Seed	2.0 kg/100 m^2
Mulch	16 kg/100 m^2
Water	160 L/100 m^2
Fertilizer	3.5 kg/100 m^2

c) Thoroughly mix seed, water, mulch, fertilizer, and binder (where specified) in a slurry.

d) Uniformly apply the slurry mixture and cover with an acceptable mulch.

.8 Seed Germination, Dry Seed, and Hydro Seed Applications

a) If 95% of seed fails to germinate within two (2) growing months, re-cultivate and re-seed until germination takes place.

b) Approximately six (6) weeks after germination, apply supplementary fertilizer 27-14-0 at a rate determined by topsoil analysis, or such other fertilizer as may be required by the City.

4.4.6.3.3 Sodding

.1 Firm the sod-bed by rolling before application.

.2 Sod shall not be laid on soil that is dry and powdery.

.3 Cut sod by suitable methods and in accordance with the recommendations of the Landscape Alberta Nursery Trades Association.

.4 Handle sod carefully when loading and installing to prevent tearing or breaking.

.5 Slopes Flatter than 3H:1V.

a) Lay sod evenly in staggered rows with edges and ends butted tightly.

b) On slopes, lay sod with the longer dimension oriented downhill.

c) Blend edges of sod with existing grass or cultivated areas.

d) Where sod butt joins surface paving or other surface features (i.e. manholes, catch basins, sidewalks, curbs, driveways, roads), position the sod turf crown flush with the finished hard surface.

e) Top dress seams as required with topsoil.

f) Let sod and soil dry out sufficiently to prevent damage, and then roll sod with a roller to ensure good bonding between the sod and the topsoil, and to smooth out humps and depressions.

g) Immediately after rolling, saturate sod and upper 150 mm of topsoil with fine spray. To prevent grass and soil from drying out, continue adequate watering for 8 to 10 days after laying, or until roots are well established.

h) Four (4) weeks after laying, and following initial cutting, apply organic supplementary fertilizer 27-14-0 at a rate determined by topsoil analysis, or such other fertilizer as may be required by the City.

.6 Slopes 3H:1V or Steeper

a) If sodding is required on any slope 3H:1V or steeper, sod may be pegged with short wooden pegs, or staples, 25 pegs per 10 m2, to prevent sod from slipping.

b) Pegs to be set flush with the ground.

c) In addition, the provisions of Article 3.3.4 shall duly apply to sodding on slopes 3H:1V or steeper.

4.4.6.3.4 Clean-up

.1 Immediately after planting, remove all debris and excess material from the site, leaving the area neat and tidy. Clean all areas, which are contaminated as a result of planting operations.

.2 Maintain all areas neat and tidy at all times until acceptance.

4.4.6.3.5 Construction Competition Inspection

.1 At time of the construction completion inspection, all sodded areas shall have a healthy, even stand of grass, free of diseases, weeds, thin, burned-out patches or non-flush joints and shall be not more than 65 mm in height.

.2 At time of the construction completion inspection, all areas to have been seeded must have evenly spread topsoil, and seed and spread evenly. See Section 2.7.6.13c.

4.4.6.3.6 Maintenance

.1 During the Warranty Period, areas showing deterioration, bare spots, or thin areas shall be re-seeded or re-sodded. Seed shall be properly germinated and/or sod properly knitted prior to final inspection.

4.4.6.3.7 Final Inspection

.1 Final inspection of seeded or sodded areas will be made prior to the end of the Warranty Period.

.2 At the time of inspection, all the areas shall be alive and in a healthy, satisfactory growing condition, and free from weeds. Any deficiency in this respect shall be remedied at the contractor’s own expense.

.3 Seeding

a) Grass shall be cut to 65 mm at the time of the inspection throughout the area for which the FAC is sought.

b) No bare soil visible when the grass if observed from a standing position, nor burned spots.

c) Grass shall be free of disease and growing vigorously with no footprints, deep ruts, soil lumps or grass clippings visible.

d) No restricted weeds, noxious weeds, or prohibited noxious weeds, as defined by the Weed Control Act of Alberta, shall be present. No more than one broadleaf weed or ten other weeds per 45 m2.

e) City Pest Control Officers (780-459-1557) shall be notified of damage by burrowing animals in time for their eviction, repair of damages, and maintenance to develop the conditions required for FAC, before the inspection takes place.

f) Third party damage that occurs within the maintenance period is the responsibility of the Developer and their contractor.

.4 Sod

a) Grass shall be cut to 65 mm at the time of the inspection throughout the area for which the FAC is sought.

b) No bare soil visible when the grass is observed from a standing position, no burned spots.

c) Grass free of disease and growing vigorously, no footprints, deep ruts, soil lumps or grass clippings visible.

d) Sod has knitted and no cracks are visible between joints.

e) No restricted weeds, noxious weeds, or prohibited noxious weeds, as defined by the Weed Control Act of Alberta, shall be present. No more than one broadleaf weed or ten other weeds per 45 m2.

f) Third party damage that occurs within the maintenance period is the responsibility of the Developer and their contractor.

4.4.7 Trees Shrubs & Ground Covers 32 93 00

4.4.7.1 General

4.4.7.1.1 Related Sections

.1 4.4.3 Topsoil

.2 4.4.4 Mulch

.3 4.4.5 Turf & Grasses

4.4.7.1.2 Scope

.1 Supplying trees, shrubs, groundcovers and other associated materials; planting, transplanting, plant maintenance and inspection.

4.4.7.1.3 Product Delivery, Storage, and Handling

.1 Plant material shall be handled with care and skill to prevent injury to trunk, branches and roots.

.2 All branches shall be carefully tied-in in such a way as to prevent damage, breakage or bruising before transporting and the plants protected during shipment by tarpaulin(s) or other suitable covering to prevent excessive transpiration. All points of contact between plant material and conveyance vehicle shall be padded.

.3 When the temperature exceeds 25°C, planting of plant material is not permitted. If trees are shipped at the above referenced temperature follow best practices of Canadian Nursery Landscape Association (CNLA).

.4 Plants shall be transported at a reasonable speed to prevent transpiration.

.5 Plants with broken or abraded trunks or branches or with broken or cracked root balls, or which are badly desiccated, or bare root plants that have broken dormancy are subject to rejection.

.6 Roots or root balls of all plants shall always be adequately protected from the sun and from drying winds and frost.

.7 All balled and bur lapped plants which cannot be planted immediately upon delivery shall be set on the ground and shall be well protected with soil, wet moss or other acceptable material not longer than 24hours. Bare root plants that cannot be planted immediately shall be planted or heeled-in in trenches, immediately on delivery. All plants shall be kept moist until planting begins.

.8 Damaged plants supplied by contractors shall be replaced at no cost to the City.

4.4.7.1.4 Substitutions

.1 All requests for substitutions of mulch shall be vetted through the consultant responsible for preparing the contract drawings. Such requests shall be forwarded to the City for approval prior to installation Interim.

4.4.7.1.5 Inspections

.1 The Consultant may inspect the marked tree locations upon 24 hours notice and notify the Landscape Contractor of any revisions that may be required or will approve the proposed tree locations as marked.

.2 The Landscape Contractor shall notify the Consultant prior to the start of a planting project to provide opportunity for interim inspections during the process. The Landscape Contractor shall also notify the Consultant when the planting project is completed. The Consultant will conduct an inspection of the planted trees, upon 24 hours notice, and notify the Landscape Contractor of any deficiencies that may require correction.

4.4.7.2 Products

4.4.7.2.1 Plant Materials

.1 Trees, Shrubs, Vines, Groundcovers

a) All plants shall be nursery grown under cultural practices recommended by the Canadian Nursery Trades Association unless specific instructions have been issued by the landscape architect and accepted by the City, for the collection from native stands, woodlots or other unmaintained areas.

b) All nursery-grown material shall meet the horticultural standards of and comply with all applicable sections of the latest edition of the Canadian Standards for Nursery Stock, by the Canadian Nursery Trades Association. All such material shall have been transplanted and/or root pruned regularly to create a fibrous ball but neither transplanted nor root pruned within the nine (9) months prior to delivery.

c) Any trees dug from native stands, wood lots, orchards or neglected nurseries and which have not received proper cultural maintenance as advocated by the Canadian Nursery Trades Association, shall be designated as “collected plants”. The use of “collected plants” will not be permitted, unless approved by the City of St. Albert.

d) All plants shall be typical of their species or variety and shall have a single central leader and balanced branching habit. They shall be structurally sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall be free from disease and insect pests, eggs or larvae, rodent damage, sunscald, frost cracks and other abrasions or scars to the bark. They shall show vigorous bark on all edges and all parts shall be moist and show live, green cambium tissue when cut.

e) All plant materials shall have been grown in the climate of Canadian Horticultural Zone 2 or 3 for at least two (2) years. Plant material brought in from other provinces and/or states must be accepted by the City prior to planting.

f) Trees purchased from outside Northern Alberta (north of Red Deer) must be grown on for two years prior to planting.

g) Plant sources and history must be supplied to the City prior to planting.

h) Trees shall have one sturdy, reasonably straight, and vertical trunk and a well-balanced crown with a fully developed leader, unless that would be uncharacteristic of the species and with the exception of Malus baccata plus associated hybrids and cultivars (flowering crabapples) single, central leaders. Prunus padus commutata (Mayday) and Prunus virginiana ‘Schubert’ (Schubert Chokecherry) shall have leaders which are single for at least 1.5 m. All trees with weak crotches shall be rejected.

i) All trees shall be free of disease, insect infestation, rodent damage, sunscald, frost cracks, and other abrasions or scars to bark. All trees must be certified pest and disease free. All parts of the tree shall be moist and show live, green cambium tissue when cut. No more than 1/3 of the total height of the tree shall be clear trunk.

j) Trees with branches which may grow to interfere with vehicular or pedestrian traffic are not acceptable in boulevards where the clear stem shall be not less than 1.8 m.

k) Shrubs shall have a natural form typical of the species with interfering branches removed and shall have the number of canes as specified in the Canadian Standards for Nursery Stock, by the Canadian Nursery Trades Association.

l) Vines shall have at least three runners, each of 300 mm minimum length. See Canadian Standards for Nursery Stock, by the Canadian Nursery Trades Association.

m) Ground covers shall have well developed tops of a size proportional to the roots, typical of the species.

n) Plants that have been sheared to produce an untypical shape or shoot density are not acceptable.

o) All plant dimensions shall be measured when the branches are in their normal position. 'Height' and 'spread' refer to the main body of the plant and not the dimension from base of root ball to branch tip or from branch top to branch tip. The 'Caliper' of a tree shall be measured as per ISA standards above the soil collar of the tree as it stood in the nursery and refers to the diameter of the tree at breast height (DBH).

p) All plant material shall conform to the measurements specified in the landscape plan, unless the City authorizes a substitution. If larger plants are used, the ball of earth shall be increased in proportion to the size of the plant. Refer to Canadian Standards for Nursery Stock (CSLA).

.2 Digging of Plants

a) Dry soil shall be watered two or three days before digging trees or shrubs.

b) All plants shall be dug and delivered to the site as specified on the Plant List.

c) Tree spades used for lifting plants shall have sharp blades.

d) Immediately after digging, the root systems of all plants shall be kept moist to prevent drying out until planted on the site.

e) Deciduous trees and shrubs in full leaf and dug in late spring or early summer shall be hardened off before replanting by placing in a cool, sheltered area as soon after digging as possible, placed close together, tops kept moist by syringing and balls by sprinkling or wetting down with water. Root balls shall be covered with wood chips, damp straw or canvas and held in this position for 24 to 48 hrs before planting.

f) All plants specified as 'Balled and Bur lapped' (B/B) shall be dug while dormant and moved with solid balls wrapped in burlap.

g) No plants shall be used when the ball of earth surrounding the roots has been cracked or broken preparatory to or during the process of planting, or when the burlap, staves and ropes, required in connection with their transplanting, have been removed.

.3 Root Ball

a) The size of root ball for trees must be greater than the minimum size below

b) Deciduous trees:

Caliper	Root Ball Diameter
60m	800mm
75mm	900mm
100mm	1200mm
125mm	1500mm
150mm	1800mm
200mm	2300mm
250mm	2440mm

For this table, the caliper shall be measured 150 mm above the soil collar of the tree. For deciduous trees of caliper exceeding 250 mm, root ball diameter shall be increased 150 mm for every additional 25 mm of caliper.

c) Coniferous trees:

Height	Root Ball Diameter
2.25-2.50m	1200mm
2.50-2.75m	1400mm

The height shall be measured from the root flare of the tree. For coniferous trees over 2.75m in height, root ball diameter shall be increased 150 mm for every 300 mm in height.

4.4.7.2.2 Edger

.1 Manicured planting beds shall incorporate a spade cut edge.

.2 Weed liner will not be permitted.

4.4.7.2.3 Fertilizer

.1 For the first application, soluble fertilizer shall be delivered mixed as specified for tree and shrub growth in the topsoil backfill report from an acceptable soil's laboratory.

4.4.7.2.4 Tree Stakes, Ties, and Guys

.1 Tree stakes shall be "T" bars of steel, 40 mm x 40 mm x 5 mm thick and 2.1 m in length. "U"- bar stakes may be used where accepted by the City.

.2 Stakes shall be primed with one brush coat of zinc-rich paint to CGSB1-GP-1816 and the top 300 mm shall be color coded in accordance with the City's rotating annual-color schedule.

.3 Tree ties shall be 10-gauge galvanized wire inserted into a 200 mm length of 10 mm diameter polyethylene tubing to protect the tree at the support point.

.4 Guys shall be double lengths of 9-gauge galvanized wire.

4.4.7.2.5 Water

.1 Water shall be clean and free of any substance that may inhibit vigorous growth of the plants.

4.4.7.3 Execution

4.4.7.3.1 Planting Operations – Trees and Bare Root Plants

.1 Plants shall be installed in accordance with the Engineering Standard Drawings in Appendix A, as applicable.

.2 Tree pits in boulevards shall be dug in such a way that the minimum separation between the edge of the sidewalk and the edge of the excavation is 225 mm. In narrow boulevards pits may be elliptical rather than circular in plan and dug two to three times wider than the root ball.

.3 The depth of planting beds and pits shall be adjusted to permit a layer of native soil under balls or roots of all plants to ensure they are firmly bedded. If the sides and bottom of the planting pit are glazed or consist of dry and heavy clay, a hand spade shall be used to scarify the soil to encourage root elongation before planting.

.4 Planting pit surfaces, whether sides or base, which are of dry clay or glazed shall be scarified to facilitate root elongation and moisture movement.

.5 In poorly drained sites, trees and shrubs shall be planted so the top of the root ball is above grade.

.6 All trees shall be planted in the same orientation as they were in the nursery.

.7 Plants shall be set in the center of pits, plumb, straight, and at such a level that after settlement the crown of the plant will be no lower than the surrounding finished grade.

.8 Topsoil backfill of tree pits shall be carefully tamped around the root ball for the first one third to half of the hole depth to help stabilize the ball. The loose soil shall be worked down into the remainder of the pit with a hand spade while being flooded with water to ensure all air pockets are eliminated and filled with muddy soil.

.9 If the sides of the root ball have become crusted through drying-out or digging under wet conditions, the top half of the affected area shall be slit with a sharp spade or shovel to facilitate root extension from the ball surface into the backfill soil.

.10 After a burlap wrapped root ball is in the planting pit, half backfilled, the wire basket shall be cut back to expose the top third of the root ball, and basket and burlap shall be removed. The remaining burlap shall be slit along the sides with a sharp knife. No burlap shall be allowed to remain visible after planting to wick moisture away from the soil ball into the atmosphere. Heavy or treated burlap or plastic shall be removed before the tree is planted to prevent formation of a moisture barrier around the ball. When burlap wrapped plant material is being planted in clay soils, all the burlap shall be removed. The wire basket may be removed completely contact City Public Works for details.

.11 After the tree is planted, a circular soil dike, 100 mm in height, shall be constructed just outside the root ball's surface area to prevent run-off during watering.

.12 For all trees with trunks exposed to lawn mowing operations, a 100 mm depth of deciduous wood chip mulch shall be placed around the trunk base and extended a further 300 mm radially from the trunk to avoid mower damage, pest disease, and bark rot from occurring.

.13 Install 100 mm depth of mulch over the top of the root ball and extended a further 300 mm radially from the tree trunk to discourage winter damage of the bark by rodents and to allow air circulation to the root system.

.14 If trees must be relocated, conform to the guidelines attached in Appendix E Tree Preservation.

4.4.7.3.2 Planting Operations – Shrubs

.1 Shrubs shall be planted in topsoil beds of minimum 650 mm depth.

.2 Planting topsoil shall be firmly tamped in place around root balls of shrubs and bare root plants while ensuring that the plant remains vertical. Particular care shall be taken to ensure that no air pockets remain under or around the roots. Planting topsoil shall be thoroughly watered immediately after tamping.

.3 No planting, except ground covers, vines, and herbaceous plant material, shall be placed closer than 400 mm at maturity to the edge of shrub beds, hard surfaces, or building foundations.

4.4.7.3.3 Stakes, Ties, and Guys

.1 Trees shall be supported by stakes and ties or by guy wires in accordance with the following schedule:

a) Coniferous Trees:

Height	Staking Method
< 1.5 m	2 steel stakes and 2 ties
1.5-3.0 m	2 steel stakes and 2 ties
3.0-3.5 m	3 guy wires and 3 anchors
3.5-4.5 m	*4 guy wires and 4 anchors*
> 4.5 m	*Refer to deciduous trees > 200 mm*

b) Deciduous Trees – Bare Root

i) To 75 mm caliper, use 2 steel stakes and 2 ties.

c) Deciduous Trees – Balled and Burlapped or Tree Spade

Caliper	Staking Method
< 75 mm	2 steel stakes and 2 ties
75-200 mm	3 guy wires and 3 anchors
≥ 200 mm	4 guy wires and 4 anchors

.2 Connection of Ties and Guy Wires to Trees:

a) All exposed portions of tree stakes are to be rust free, scaled, primed and painted brown. Tree stakes are to be a minimum of 2.0 linear metres in length, plain T-posts (1.33 lbs/ft) complete with 1 1/2” x 1 3/8” x 84” punched with 7 holes.

b) All ties and guy wires shall be looped in a figure-eight at least 3 times around the tree trunk and attached to stakes or anchors in such a way that they can be kept taut to form an open “Figure-8”, branches are protected from undue strain, and the tree’s bark is protected from damage.

c) Where the guy wires encircle the trunk or branches they shall be encased in new, 12 mm diameter, two-ply, reinforced, black-rubber hose.

d) Turnbuckles shall be factory galvanized and shall have eyes with a length of 150 mm and threaded openings of 10 mm diameter for tightening.

e) Fluorescent warning flags shall be attached to guy wires.

.3 Bare Root Tree Staking

a) The stakes shall be driven vertically a minimum depth of 600 mm into the undisturbed soil of the base of the tree pit before the plant is placed in position.

b) When two stakes are used they shall be located at northwest and southwest of the tree.

.4 Balled and Burlapped Trees and Tree Spade Plants Staking

a) The stakes shall be driven vertically a minimum depth of 300 mm into the undisturbed soil and shall be located just outside the root ball or tree plug to avoid any root damage.

b) When two stakes are used they shall be located at northeast and southwest of the tree.

.5 Tree stakes and guy wire shall be removed following the maintenance period after combined review by City and Consultant. They shall be removed by the contractor prior to the FAC inspection.

.6 Color Coding of Stakes

a) The tops of all stakes shall be painted with a color code in accordance with the following, rotating schedule:

2021	2022	2023	2024	2025	2026
White	Yellow	Green	Blue	White	Yellow

4.4.7.3.4 Pruning

.1 Immediately following planting, any dead, broken, or interfering branches shall be pruned together with any diseased branches which have not caused the plant's rejection. No plants having disease are to be planted and may be rejected by the City.

.2 Pruning must be completed by a fully ISA certified arborist.

.3 The amount of pruning shall be limited to the minimum necessary and exceed no more than one third of the living foliage in one season. Under no circumstances shall more than 25% of the foliage from an individual tree be removed.

.4 One section of any bad fork or weak crotch which has not caused the plant's rejection shall be removed at transplanting time.

.5 The manner of pruning shall preserve the natural character of the plant. This is subject to pruning 25 % of crown maximum.

.6 Due to the risk of Dutch Elm Disease, elm trees shall only be pruned between the period of October 1 and March 31, when the Elm Bark Beetle is inactive.

.7 Pruning tools shall be clean and sharp.

.8 All pruning cuts shall be clean and leave no stubs or rough wood and be in accordance to the ANSI Z133.1 Standards. Small cuts shall be close to the branch collar and parallel to the adjoining branch or trunk. On large limbs, flush cuts shall be avoided, and cuts made at the collar shall have the lower part slanting slightly away from the trunk to leave a smaller wound.

.9 Tree trunks conduct moisture and nutrients from the roots to the crown of the tree. This function takes place in the outer part of the woody stem called the sapwood. If the sapwood is cut, bruised, or scarred in such a way that it may affect the uptake of moisture and nutrients, the tree shall be replaced. If the affected area is small enough not to limit the uptake of moisture and nutrients, the affected area shall be shaped with a sharp, clean knife so as not to retain water, which may cause decay.

.10 Bark that is cut, bruised, or scarred shall be cut back to living tissue with a clean edge. The affected area shall be shaped with a sharp knife so as not to retain water.

.11 Wound surfaces shall not be treated with wound-dressing products unless otherwise specified or directed by the City.

.12 As a rule, growth is maximized if pruning is done just before the period of rapid growth in the spring. Prune during proper times in accordance with the following guidelines:

a) Shade Trees – October 15 to April 15

b) Birch and Maple – June 15 to July 15

c) Fruit trees – March 15 to April 15

d) Evergreens – April 15 to May 15

e) Elm Trees – October 1 to March 31

4.4.7.3.5 Construction Completion Inspection

.1 The Construction Completion Certificate (CCC) for subdivision landscaping shall be issued following a satisfactory inspection by the City's representative, developer's representative and contractor which all plant material has been supplied and installed in accordance with the approved drawings and any approved substitutions and is alive and healthy. The maintenance period of two (2) years begins to run from the date of the satisfactory inspection. All plant material requiring wood chip mulch shall be installed prior the Construction Completion Certificate and topped up prior to the Final Acceptance Certificate.

.2 The Construction Completion Certificate (CCC) for commercial, institutional/Industrial, multi-family and capital projects shall be issued following a satisfactory inspection by the City's representative, owner or project manager and landscape contractor, at which all plant material has been supplied and installed in accordance with the approved drawings and any approved substitutions are alive, healthy, disease and pest free. The maintenance period of one (1) year on private property and two (2) years on public property begins to run from the date of the satisfactory inspection. All plant material requiring wood chip mulch shall be installed prior the Construction Completion Certificate and topped up prior to the Final Acceptance Certificate.

4.4.7.3.6 Warranty

.1 Replace any plants that die or appear to be dying during the Warranty Period. In case of any doubt regarding the condition and satisfactory establishment of a rejected plant, the Developer may elect to maintain such a plant through another complete growing season at the end of which the rejected plant, if found to be dead or in an unhealthy or badly impaired condition, shall be replaced by the Developer. Any replaced plant material shall have a maintenance period of one 1) year, unless otherwise authorized the City.

4.4.7.3.7 Maintenance

.1 Maintenance shall include all measures and activities necessary to establish and maintain plants in an acceptable, vigorous, and healthy growing condition for the duration of the Warranty Period.

.2 Refer to Section 2.7.7.4.

4.4.7.3.8 Final Inspection

.1 At the time of final inspection, all the plants shall be alive, healthy and in good condition, root balls and shrub beds shall be weed-free with the specified depth of mulch throughout.

.2 Tree stakes and guy wires shall be removed immediately prior to final inspection.

4.5 Underground

4.5.1 Water System (33 14 00)

4.5.1.1 Materials

4.5.1.1.1 Water Mains (33 14 00)

Water mains shall be polyvinyl chloride (PVC) pipe, or accepted alternate. PVC fittings may be used for water mains. Any proposed alternative pipe must conform to all applicable American Water Works Association (AWWA), American Standards for Testing and Materials (ASTM), Canadian Standards Association (CAN/CSA), and National Sanitation Foundation (NSF) standards.

.1 Pipe

a) PVC pipe shall meet CAN/CSA-137.3.

b) Pipe from 100 mm to 300 mm in diameter shall conform to AWWA-C900 with a minimum pressure class of 1,034 kPa (DR18).

c) Pipe from 350 mm to 900 mm in diameter shall conform to AWWA-C905 with a minimum pressure class of 690 kPa (DR25).

d) Strength design, considering trench and road loading, shall be integral to pipe design process.

e) PVC pipe shall have a joint with an integrally thickened bell end and flexible elastomeric gasket. Joints shall conform to ASTM-D3139 with gaskets conforming to ASTM-F477.

f) Joint lubricants shall be in accordance with NSF Standards 14 and 61, and shall be compatible with gasket materials.

g) Pipe shall be installed within two years from the production data indicated on the certification. Uninstalled pipe shall remain capped during transport and while awaiting installation. Any pipe displaying discoloration from exposure to the elements will not be accepted and will not be approved for installation.

.2 Fittings

a) Polyvinyl Chloride (PVC)

b) PVC injection-molded fittings shall conform to AWWA-C900, C905, and C907, as applicable, and shall be certified to CAN/CSA-B137.3.

c) Fitting diameter, class, and pressure rating shall match the water main.

d) Use push-on type ends complete with one gasket for each bell.

e) Gaskets shall conform to ASTM-F477.

4.5.1.1.2 Hydrants (33 14 19)

.1 Hydrants shall conform to AWWA-C502.

.2 Post-type, dry-barrel fire hydrant with compression shutoff, cast iron body, bronze-mounted, and bottom connection with drip valve and drain.

.3 One-piece hydrant body. No above-grade segmented body designs shall be accepted.

.4 The minimum height from flange to bonnet shall be 600 mm.

.5 Three-sided, #6 operating nuts, counterclockwise to open.

.6 All external nuts and bolts, including the ground flange and all buried connections, shall be Type 304 stainless steel.

.7 New hydrant installations shall have a ‘quick connect’ 100 mm diameter Storz pumper connection and two 63.5 mm diameter hose connections to conform to Alberta Mutual Aid Thread standard. Connections must be a minimum of 415 mm above the ground flange. Hose connections must be at 90-degrees to each side of the pumper connection. Note that older hydrant models have a threaded 146 mm diameter pumper connection designed for a pressurized connection. Do not attempt a pressurized connection to the outer threads (> 146 mm) of a ‘quick connect’ 100 mm diameter Storz pumper connection. These threads are designed exclusively for the dust cap and are not pressure rated to support a pressurized hose connection. The operation of each hydrant connection shall be checked by the City during CCC & FAC inspections as well as during routine hydrant testing operations.

.8 Nipples shall be provided with caps, without chains or cables. Nipples shall be threaded into the hydrant head, rather than leaded in, unless a positive locking device is provided to prevent blowout of the nipples.

.9 The valve stem in the hydrant head shall be equipped with “O”-ring seals and a thrust bearing.

.10 The barrel of the hydrant shall be a minimum of 150 mm inside diameter. One-piece barrels shall be used wherever possible. If extension is necessary, it shall be placed on the top of the barrel, not the bottom. Barrels shall be of sufficient length to provide a minimum of 2.65 m of cover over the water main.

.11 Provide a bottom connection, flanged to the barrel, with a single-ring gasket and push-on joint suitable for connecting to PVC pipe, and complete with harnessing lugs. Bottom inlet connection to match size and type of water main.

.12 The valve shall be mechanically connected to the barrel with mechanical joint restraints conforming to Article 4.5.1.1.1.

.13 A gravel drainage pit, covered with polyethylene, shall be provided at the bottom of the hydrant as shown on the Engineering Standard Drawings in Appendix A.

.14 A gate valve, in accordance with Articles 3.2.1.4 and 4.5.1.1.3, shall be provided with each hydrant lead.

.15 Hydrant exterior must be factory coated with an asphaltic or epoxy coating.

.16 All hydrants shall be painted Tremclad Yellow (No. 270-97X). Storz port caps shall be painted BL-6-OSHA Safety Blue.

.17 McAvity, Mueller/Canada Valve, or AVK.

.18 Where geotechnical or other studies identify a high water table the hydrants must be consist of an all stainless steel operating shaft such as those produced by AVK or accepted alternative.

.19 Cathodic protection to be applied as per *section 4.5.1.2.12*.

4.5.1.1.3 Water Main Valves (33 14 19)

.1 Gate Valves

a) Gate valves shall be used for water mains 400 mm in diameter or smaller. Butterfly valves shall be used for pipes larger than 400 mm in diameter.

b) Gate valves shall be resilient-seated type conforming to AWWA-C509.

c) Epoxy-coated cast iron body and disc.

d) All external nuts and bolts shall be Type 304 stainless steel.

e) Non-rising stem.

f) Bell ends, single-ring gasket, and push-on joints suitable for connecting to PVC pipe.

g) Valve size shall be equivalent to the pipe size.

h) Operating pressure shall be minimum 1,200 kPa, (170 psi) cold water service.

i) Provide a 50 mm square operating nut that turns counterclockwise to open.

j) Valve stem to be Type 304 stainless steel or accepted brass alternate for valves up to 400 mm in diameter.

k) Provide “O”-ring valve stem seals.

l) Valve Box and Extension

m) Valve boxes shall be cast iron Type B valve box/casing by Trojan. Refer to the Engineering Standard Drawings. PVC valve boxes may be acceptable if pre-approved by St. Albert Utilities group and if it satisfies the manufacturer’s requirements.

n) Valve box extensions shall be cast iron, suitable for use with the valve boxes installed.

.2 Butterfly Valves

a) Butterfly valves shall be used for pipes larger than 400 mm in diameter. Unless otherwise authorized by the City, butterfly valves do not require a vault chamber. Transitions to butterfly valves shall be by flange adaptor. Bevel gearing shall be specified for butterfly valves.

b) Butterfly valves shall be rubber-seated type conforming to AWWA-C504, Class 150 B.

c) Wafer, short body flanged, or fully lugged in accordance with AWWA-C504.

d) Epoxy-coated cast iron body and disc.

e) All external nuts and bolts shall be Type 304 stainless steel.

f) Use a valve size equivalent to the pipe size.

g) Provide “O”- ring shaft seals in a removable, corrosion-resistant recess to allow seals to be replaced without removing the valve shaft.

h) Actuator

i) Provide a manual gear actuator conforming to AWWA-C504.

j) Counterclockwise to open.

k) 50 mm square operating nut or handwheel.

l) Type 304 stainless steel actuator input shaft.

m) Actuator to transmit required valve opening and closing torque at an input torque of 135.6 Joules (100 ft-lb).

n) Actuator to display valve disc orientation through full range of operation.

o) Actuator to be third party certified to AWWA-C504.

4.5.1.1.4 Pressure Reducing Valves (33 14 19)

.1 Singer 106/206-PFC PRV, or accepted alternate.

4.5.1.1.5 Water Service Connections (33 14 00)

.1 Standard Water Service Pipe

a) Water service pipe shall be copper, PEXa (cross linked polyethylene), PEX-AL-PEX (x-linked polyethylene and aluminum), or accepted alternate.

b) For pipe diameters greater than 25 mm, and up to 50 mm diameter, water service pipe shall be copper, or accepted alternate.

c) Copper water service pipe shall be Type K copper pipe conforming to ASTM-B88, and complying with AWWA-C800.

d) PEX-AL-PEX water service pipe shall conform to ASTM-F1281 and CAN/CSA-B137.10, or accepted alternate.

e) PEXa water service pipe shall conform to AWWA C 904, ASTM F876, CSA B137.5, NSF 14, NSF 61 and PPI TR-4, and shall be:

i) Manufactured using the high-pressure peroxide method of crosslinking.

ii) Rated for 200 psi @ 73.4°F (1379 KPa @ 23°C)

iii) Compatible for use with AWWA C800 when using the manufacturers recommended stainless steel insert.

iv) Having the minimum markings: PEXa 3306, CSA B137.5, ASTM F876, F2023 and F2080, NSF-pw.

v) For water services larger than 50 mm nominal diameter, use pipe, fittings, and valves that are of the same pressure rating and material as the water main, in accordance with the applicable requirements of Articles 4.5.1.1.1 and 4.5.1.1.3.

vi) Water service connections may require insulation if crossing storm or sanitary lines, and/or other shallow utilities. Urecon or accepted alternate. If Insulation is required, design detail of insultation must be provided to the City for review.

.2 Service Saddles

a) Service saddles shall be bronze or Type 304 stainless steel, tapered inlet thread, conforming to AWWA-C800.

b) Fasteners to be treated to prevent binding.

c) "O"- ring gaskets to be constructed of synthetic rubber suitable for potable water use, and shall provide pressure-tight seal on the water main.

.3 Couplings

a) Couplings to be compression type, conforming to AWWA-C800. Must meet NSF 61 requirements.

.4 Corporation Main Stops

a) For copper pipe, corporation main stops shall be compression type, conforming to AWWA-C800. Must meet NSF 61 requirements.

b) For PEX-AL-PEX and PEXa pipe, corporation main stops shall conform to AWWA-C800. Cambridge Brass, or accepted alternate.

.5 Curb Stops

a) For copper pipe installations, use non-draining curb stops, copper-to-copper type, conforming to AWWA-C800. Must meet NSF 61 requirements.

b) For PEX-AL-PEX and PEXa pipe installations, use non-draining curb stops conforming to AWWA-C800.

c) ¼ Turn for ON / OFF operation.

d) Must operate counterclockwise to the off position and installed with the arrow pointed in the direction of flow.

e) Service Box

i) Service boxes shall be in accordance with prior approved specifications/consistent with the Trojan Service Box for the two varying sizes.

ii) Service boxes shall be two-section, epoxy-coated, galvanized iron, 2 section sliding, adjustable type. Epoxy coated boot is to be denso-wrapped prior to placement of drainage pit washed rock.

iii) The top section of the service box (35 mm inner diameter) shall be 2,150 mm in length, threaded at the top for the City of St. Albert brass cap, and shall provide a sliding fit inside of the bottom section of the service box (25 mm inner diameter) for adjustments of 300 mm in the up or down direction.

iv) The top section shall be installed to allow a minimum of 150mm adjustment both above and below finished grade without contacting either the lower service box section or the operating rod.

v) The bottom section shall rest on a minimum 40 mm thick by 200 mm wide by 200 mm long channelized recycled plastic block.

vi) The service box brass cap shall be labeled City of St. Albert (86 mm in diameter for 25 mm service & 102 mm for 50 mm service), threaded to allow connection to the box, and shall include a brass plug. The brass plug, shall be circular with a 6 x 19 x 9 mm slot and threaded to match the cap.

vii) The operating rod shall be Type 304 stainless steel, top of operating rod to be sized to be brought to 300mm from finished grade.

viii) The bottom 25 mm of the rod cold-forged square and connected to a stainless steel or manganese bronze clevis by a cotter pin. The manufacturer’s name shall be embossed onto the clevis.

ix) Trojan.

x) If a chair is utilized to support the curb stop, then the chair must be denso wrapped if it is metallic to prevent metal on metal contact and secured with stainless steel screws to the recycled plastic block.

4.5.1.1.6 Cathodic Protection (40 46 42)

.1 All fittings, hydrants, and valves shall be denso-wrapped and cathodically protected with a 5.5 kg zinc anode.

.2 Zinc anodes shall conform to ASTM B418, Type 2.

.3 Lead wires shall be 2 m long, No. 10A WG/7.

.4 Lead wires shall be connected with suitable clamps or welds in accordance with the manufacturer’s recommendations.

.5 All buried flange connections to be denso wrapped for additional protection.

4.5.1.1.7 Backfill Zone (31 23 00)

.1 Classes of Trench Backfill

.2 Type 1: Backfill with native or imported fill material over bedding up to the designated subgrade or existing ground elevation , whichever is lower, in lifts not exceeding 300 mm when compacted. Compact each lift compacted to 98% of the maximum density as determined by the Standard Proctor Compaction Test.

.3 Type 2: Backfill with specified granular fill over bedding up to existing ground elevation if lower than the designated subgrade depth, in lifts not exceeding 300 mm when compacted and compact each lift to 95% of the maximum density as determined by the Standard Proctor Compaction Test. If designated subgrade elevation is level with or lower than the existing ground, place native or imported fill material as the topmost 300 mm lift compacted to 98% of the maximum density as determined by the Standard Proctor Compaction Test.

.4 Type 3: Cut trench sides above bedding to slopes flat enough to allow road compaction equipment to operate transversely across the trench. Backfill with native or imported fill material over bedding up to the designated subgrade or existing ground elevation, whichever is lower, in lifts not exceeding 150 mm when compacted and compact each lift to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

.5 Type 4: Fillcrete over bedding to designated subgrade elevation.

.6 Uniformly place fillcrete from the top of bedding to the designated or pre-existing sub-grade elevation.

.7 Protect fillcrete from freezing or other adverse weather conditions for a minimum of 24 hours following placement.

.8 Fillcrete that is exposed to significant infiltration of water within 24 hours of placement must be removed and replaced.

.9 A minimum of 150 mm of granular base course must be placed on the fillcrete surface before allowing any vehicular traffic over the fillcrete. Granular base course may be placed 24 hours following the placement of the fillcrete.

.10 Refer to Engineering Standard Detail in Appendix A.

4.5.1.2 Construction

4.5.1.2.1 General

.1 The following articles represent the minimum requirements for some typical, key construction procedures for water system construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

.2 Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Article 2.3.1.

4.5.1.2.2 Quality Assurance (33 14 00)

.1 The Developer must maintain detailed records of all inspections and testing as evidence of compliance of the work with these Standards. These records shall be provided to the City upon request.

.2 The City may at any time require the Developer to provide evidence of certification by the testing agency the materials and performance of the work meet these Standards.

4.5.1.2.3 Quality Control Testing (33 14 00)

.1 The Contractor shall retain the services of independent testing laboratories or agencies to conduct all quality control testing. The proposed testing laboratory or agency shall be subject to the acceptance of the City.

   a) Minimum quality control test frequencies, specified as follows, are the minimum number required. The Contractor shall ensure that as many tests as necessary are performed to ensure that the work conforms to the requirements of these Standards, regardless of the minimum number specified.

.2 Field densities (ASTM-D2167 or ASTM-D2922):

a) Pipe Bedding - one for each 25 m of pipe installed.

b) Pipe Zone Backfill - one for each 25 m of pipe installed.

c) Trench Backfill - one for every 100 m of trench of 1.0 m fill depth.

d) If any density test results in less than the required compaction, two more tests shall be taken for the depth and length of backfill or bedding represented by the failed test. If the average of the three tests results in a density less than required, the depth and length of backfill or bedding represented by the failed tests shall be reworked, the soil moisture modified as necessary, re-compacted, and re-tested until the required compaction is met.

.3 Moisture density curves (ASTM-D698):

a) Pipe Bedding - one for each 1000 tonnes or change in material.

b) Pipe Zone Backfill - one for each 1000 tonnes or change in material.

c) Trench Backfill - one for each 1000 tonnes or change in material.

.4 Sieve analyses (ASTM-C136):

a) Pipe Bedding - one for each 1000 tonnes or change in material.

b) Pipe Zone Backfill - one for each 1000 tonnes or change in material.

c) Trench Backfill - one for each 1000 tonnes or change in material.

4.5.1.2.4 Operating Existing Valves and Hydrants

.1 City of St. Albert Utilities crews are the only authorized personal that are authorized to operate existing valves and hydrants.

.2 Apply to the City's Engineering Services Department and complete a Site Servicing Permit form for any valve or hydrant operations at least five (5) business days in advance. Upon acceptance of the application, Utilities personnel shall be dispatched to open or close existing valves or hydrants.

.3 If water supply is required for construction, apply to the City's Utilities department to use filling stations for access to water supply or permitted hydrant usage. Comply with all Utilities' requirements with respect to using City hydrants for water supply.

4.5.1.2.5 Alignment and Grade (33 14 00)

.1 Lay pipe to the required alignment and grade, with fittings, valves, hydrants, and all other appurtenances at the locations identified on the construction drawings or otherwise directed by the City.

.2 Provide minimum 2.65 m depth of cover on water mains, unless otherwise authorized by the City in writing. Where depth of cover is less than 2.65 m, provide insulation and identify all insulated areas on plan of record drawings. Refer to Engineering Standard Details in Appendix A. It is mandatory that applicable City personnel be onsite during installation of insulated pipes and/or services.

.3 Acceptable tolerances are as follows:

a) Alignment - the centreline of the pipe shall not be more than 100 mm off the given alignment.

b) Elevation - the pipe invert shall not be more than 50 mm off the elevation indicated on the construction drawings.

.4 Maintain, and provide to the City upon request, grade sheets for the installation of the pipe.

.5 No deviation shall be made from the required alignment or grade without the written consent of the City.

4.5.1.2.6 Pipe Bedding and Pipe Zone Backfill

.1 Refer to the Engineering Standard Drawings in Appendix A for pipe bedding details.

.2 For Bedding details refer to section 4.5.1.1.7:

a) Place a cradle of concrete bedding under the pipe and the full width of the trench to the depth shown on the Engineering Standard Drawings in Appendix A.

b) Place sand bedding under the pipe and the full width of the trench to the depth shown on the Engineering Standard Drawings in Appendix A and compact to 95% of Standard Proctor Density.

c) Place selected native soil or sand above the bedding and compact to 95% of Standard Proctor Density to 300 mm above the top of the pipe.

.3 Provide bell or coupling holes as required and support the pipe uniformly and continuously throughout its length.

.4 Backfill in the pipe zone shall be sand complying with the gradation specified in section 4.5.1.1.7.

.5 Granular bedding and pipe zone backfill shall be placed and compacted in uniform lifts not exceeding 150 mm in depth.

4.5.1.2.7 Pipe Installation (33 14 00)

.1 General

a) Follow manufacturer's instructions for pipe installation. Where manufacturer's instructions and these specifications are in conflict, notify the City who will provide judgment on which method will govern the Work.

b) Lay and join PVC pipe in accordance with AWWA-M23.

c) Disinfect in accordance with article 4.5.1.2.5, in accordance with Article 4.5.1.2.14.

.2 Laying Pipe

a) Lay pipes on prepared bedding with excavated joint holes that allow the joint ends to be kept clean of soil and bedding material, to facilitate completing the joint and to avoid load concentration on the bells or couplings. Pipe end caps to be kept in place until time of connection.

b) Lay pipes with the bell ends facing in the direction of the laying operations.

c) Cut pipes where necessary to install fittings and valves. Make cuts in accordance with the manufacturer's recommendations using recommended cutting tools. Cut pipes squarely and accurately.

d) Test bolting of all mechanical couplings and restraints on completion using a torque wrench. Torque shall conform to the pipe or fitting manufacturer's recommendations.

e) Pipe deflections at joint shall not exceed those specified by the pipe manufacturer.

f) Do not lay pipe in water or when, in the opinion of the City, trench conditions are unsuitable.

g) Cover open ends of installed pipe, when pipe laying is not in progress, to keep out trench water.

.3 Joining Pipe

a) Join pipe in accordance with the manufacturer's recommendations.

b) Clean and check the sealing surfaces to ensure that they are smooth, concentric, and free from imperfections that might affect the sealing performance of the gasket.

.4 Connecting to Existing Mains

a) Notify the City in writing at least five (5) business days prior to connecting to an existing water main.

b) Provide the City with a work plan and contingency plan detailing the procedures to be observed in the event of problems during the connection process or other emergency.

c) Prior to connection to existing infrastructure and an approved Site Servicing Permit (SSP) must be obtained and an On Street Construction Permit (OSCP) is required.

d) Quality Assurance/Control of connection methods shall be in accordance of the latest AWWA standards.

.5 Plugging of Dead Ends

a) Insert standard plugs into the bell ends of fittings or pipe bells at dead ends.

b) See Appendix A for standard details outlining pipe restraints / thrust blocks.

4.5.1.2.8 Setting Hydrants: (33 14 19)

.1 Install hydrants at the required locations and at the required directions.

.2 Set hydrants plumb with hose nozzles parallel or at right angles to the street centreline.

.3 Set hydrants with ground flanges above final curb and sidewalk grades.

.4 The body to barrel flange connection to be a minimum 50 mm and maximum 150 mm above finished grade.

.5 Provide a coarse gravel drainage pit, complete with filter cloth, where hydrant barrels can be drained to the surrounding soil.

.6 Hydrant ports shall be left open except where the hydrant is located in areas of high water tables and/or where the possibility of contamination exists, as indicated by the geotechnical report. At these locations, the port shall be closed and the hydrant shall be labeled “No Drain”.

.7 Construct hydrant thrust blocks so that drains are not plugged and does not cover flanges, nuts or bolts. See Appendix A for standard details.

.8 Support hydrants with suitable concrete blocking.

.9 Provide compacted backfill, in accordance with Article 4.5.1.1.7, for a minimum 1.5 m radius around all hydrants.

4.5.1.2.9 Setting Fittings and Valves (33 14 19)

.1 Install fittings and valves at the required locations as designed in the approved engineering drawings.

.2 Support all fittings and valves with blocking as shown on the Engineering Standard Drawings in Appendix A.

.3 Install valve boxes plumb and support valve boxes to prevent the transmission of strain or shock to the valve.

.4 Set the top of valve boxes flush with finished grades in unpaved areas and 5 to 15 mm below grade on paved areas.

.5 Provide compacted backfill, in accordance with Article 4.5.1.1.7, for a minimum 1.5 m radius around all valves.

4.5.1.2.10 Thrust Blocks

.1 Install thrust blocks at all dead ends and at all fittings, valves, and hydrants, in accordance with the Engineering Standard Drawings in Appendix A, or where otherwise directed by the City.

.2 Place concrete thrust blocks against solid ground with a minimum bearing area as shown on the Engineering Standard Drawings in Appendix A, or as directed by the City.

.3 Pour the concrete in a manner that will leave pipes, fittings, valves, and hydrants accessible for repair.

.4 Valve and fittings shall be mechanical restricted if required and should be installed as follows:

Working Pressure	Diameter Requiring Restraint
Up to 700kPa	300 mm and up
700 to 1,000 kPa	200 mm and up
1,000 to 1,380 kPa	All sizes

4.5.1.2.11 Water Service Connections (33 14 00)

.1 Single-family residential water services, in accordance with Article 3.2.1.6, shall conform to the following.

.2 At a minimum, the uniform backfill zone shall extend from property line to property line and be at least 1.5 m in vertical depth across the full right-of-way. The uniform backfill zone shall have maximum 300 mm lift thickness and achieve minimum 98% S.P.D. as monitored and tested by the Geotechnical Engineer.

.3 Services shall be bedded in accordance with Article 4.5.1.2.7.

.4 Pipe zone backfill shall be placed to 300 mm above the crown of the highest service in the trench.

.5 Water service connections shall be extended beyond the gas line into the lot to place the curb stop at 0.15 m inside the lot easement boundary. Extend the house water service whip to surface and cap the end of the service in accordance with the Engineering Standard Drawings in Appendix A.

.6 Install red-painted stakes, 50 mm by 100 mm in size, extending from the termination point of the service point to a minimum of 0.5 m above the finished surface elevation.

.7 Backfill trenches in accordance with Article 4.5.1.1.7.

.8 Tapping Water Mains

a) Tapping of PVC water mains shall be in accordance with AWWA-C605 and AWWA-M23 and in accordance with the specific pipe manufacturing guidelines.

b) Drill and tap water mains that are under pressure using a tapping machine.

c) Dry-tapping may be used for service connections to new water mains with written approval from the City Engineer. Wet-tapping may be used to tie-in a new service to an existing water main; all coupons must be recovered from the main and accounted for.

d) Direct taps to water mains may be used where the tap diameter is 25 mm diameter or smaller and the water main is 300 mm diameter or smaller. Service saddle taps must be used where the tap diameter is greater than 25 mm diameter or where the water main is larger than 300 mm diameter.

e) Do not tap a curved pipe where the bend radius is less than 300 times the pipe outside diameter.

f) Tap into the upper half of water main and incline upward 0° to 30° from the crown of the main. Stagger multiple taps at least 600 mm apart; with adjacent taps offset 30° with respect to each other. Taps shall be greater than 300 mm from any coupling or saddle.

g) Insert the main stop in accordance with the manufacturer's instructions.

.9 Pipe Installation

a) Provide 300 mm diameter "goose-necks" in the water service at the corporation main stop and as required to maintain a minimum 300 mm clearance over wastewater and stormwater service pipes. Refer to the Engineering Standard Drawings in Appendix A.

b) Lay pipe slack in the trench.

c) Copper services should be one continuous section of pipe. In the event that the service pipe length exceeds the length of a standard roll of copper pipe, use only double union couplings to connect two sections of copper pipe. No connections shall be permitted between the main stop and CC. Record drawings must identify the services which contain unions.

.10 Curb Valves and Services Boxes

a) Shall be in accordance with details of the curb chair as provided by Trojan.

b) Support curb valves on a minimum 40 mm thick by 200 mm wide by 200 mm long recycled plastic block.

c) Set the services box plumb and adjusted to grade.

d) Brace service boxes sufficiently during backfilling operations.

e) Mark the curb stop location with a 50 mm x 100 mm x 1,500 mm, fluorescent red painted marker, set 1 m into the finished ground surface.

.11 Testing

a) The water service pipe, from the main to the curb stop, will be included in the hydrostatic pressure test, as specified in Article 4.5.1.2.13.

b) Record of Services

c) Maintain red-line markups as the as-constructed location and elevation of all service connections for preparation of the record drawings. Record drawings must indicate the locations and elevations of water mains, corporation main stops, curb valves, and pipes in relation to property lines.

4.5.1.2.12 Cathodic Protection (40 46 42)

.1 Install cathodic protection on all fittings, valves and hydrants in accordance with the Engineering Standard Drawings in Appendix A, and the manufacturer's instructions.

.2 Embed zinc anodes into the trench wall to provide a minimum 50 mm native material compacted around the anode.

.3 A minimum of 3 L of water shall be poured on each anode to initiate operation of the anode prior to backfilling.

4.5.1.2.13 Inspection and Testing

.1 Before Backfill:

a) Before coating and backfilling over the joints, the Contractor may, for the Contractor's own assurance, carry out a low pressure air test (welded steel pipe only), a water test or any other test deemed necessary. Any such testing will be at the sole risk and cost of the Contractor.

b) Before backfilling over the joints do the following inspection and testing:

i) Visual inspection of mortared joints for structural integrity and absence of cracking or spalling.

ii) 100% coverage of the joint coatings (other than mortar) with an approved Holiday detector.

.2 Pressure and Leakage Testing:

a) Pressure testing consists of slowly charging a new section of water main to the distribution system pressure from a boundary main. The valves are then closed on the test section. A tank of water and a purpose-specific pump are used to pressurize the main to the specified test pressure. The main is typically left in this condition for 1 to 3 hours. The pressure is normally measured at the lowest elevation on the section of water main being tested.

b) Leakage testing is normally conducted at the same time as pressure testing using the same apparatus. The test is conducted for 2 h during which time the pump is periodically operated to maintain the pressure at the specified level. The volume of water added to the water main from the tank is presumed to be equal to that which has leaked from the water main during the test. Figure 4.5.1 illustrates the conceptual layout of the apparatus required for pressure and leakage testing.

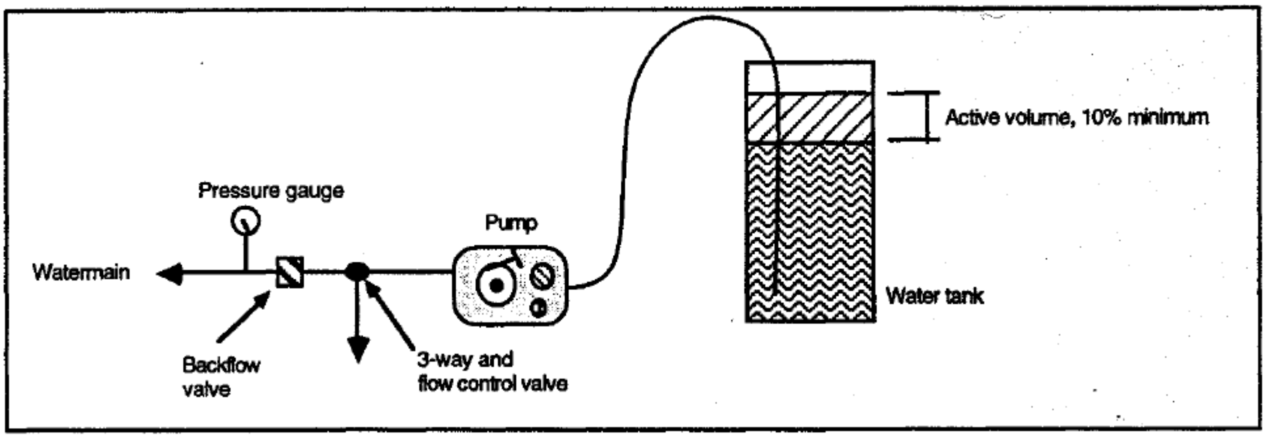


Figure 4.5.1: Apparatus For Pressure Leakage Testing

.3 Required Equipment for Pressure and Leakage Testing:

a) ANSI Standard B40.1-1974 Grade A, or equivalent, Bourdon tube pressure gauge, range of 0 to 1 400 kPa, with an accuracy of 1% of the full-scale reading, 7 kPa divisions, a minimum diameter of 90mm, and a scale which can be read in an arc of 270° (Walski, 1984). The pressure gauge calibration shall be certified by the consulting engineer.

b) Hand or motor-powered pump capable of meeting required test pressures including necessary plumbing accessories for preventing backflow and for enabling the flow rate to be controlled. The pump should be provided with a pressure relief valve or should have an upper pressure limit of 1 400 kPa. The pump will be dedicated to water-main pressure testing and will not be used for other construction activities.

c) Water storage tanks will be of non-corrosive material dedicated to water main testing. The volume of the tank shall not be more than 10 times the allowable leakage for the duration of the test. A depth gauge will be attached to the inside of the tank and will be calibrated for the volume of the tank.

.4 Procedure for Hydrostatic Pressure and Leakage Testing:

a) If there are transitions within the project between pipe materials, pressure and leakage of each pipe material must be tested separately prior to connection with other materials, excepting PVC to steel spool pieces for valve assemblies. Fused PVC and jointed PVC are not considered like materials for the purposes of pressure and leakage testing.

b) General Procedure:

i) Install all water services, air relief services, and blowoffs.

ii) Partially or completely backfill the excavation before testing.

iii) Ensure that main stops are open and curb stops are closed.

iv) Inform St. Albert inspectors of the date, time, and location of the hydrostatic tests at least five (5) business days prior to the test time. Failure to notify inspectors may result in the tests being unacceptable.

v) Open all main valves in the test section.

vi) Open all hydrant control valves in the test section and be sure hydrants are closed. (All hydrants should be inspected prior to pressure testing to ensure that they are properly installed and that nipples are threaded or locked in place.)

vii) Inform other construction crews or contractors and check that no valves are being operated during the test.

viii) Test duration will be 2 h.

ix) Maximum length of distribution water main test sections will be 450m unless otherwise directed by St. Albert.

x) Maximum length of transmission water main test sections will be 800 m unless otherwise directed by St. Albert.

xi) Ensure air is expelled from the section of water main by exhausting trapped air at high points and deadends. Air relief valves are essential at high points on mains larger than 450mm in diameter. Hydrants are not useful for removing all of the air.

xii) Raise the water-main pressure to the appropriate test pressure using either a hand or motor-powered pump located at a hydrant or approved blow-off. The hydrant valve will be completely opened and the flow rate will be controlled by the valve at the pump.

xiii) Mark the gauge and the level of water in the storage barrel at the beginning of the test. Take care in these marks since it is the basis for calculating water loss.

xiv) Maintain the test pressure within ± 20 kPa of the specified test pressure for the duration of the test.

xv) Pump the test section back to the test pressure at the end of the first 30 min. If the allowable leakage is exceeded, air may be trapped. Remove trapped air and repeat the test.

xvi) During the test, walk along the test section and check for signs of leakage or distress at all exposed appurtenances or fittings.

xvii) No allowance can be made for services or in-line valves. (Water main renewal projects may be exempt under some circumstances.)

xviii) When testing against closed metal-seated valves, add an additional leakage allowance of:

$$\frac{0.0012\ \text{L}}{\text{h}\bullet\text{mm of valve size}}$$

xix) Calculate the allowable leakage and record this with the observed leakage.

c) Polyvinyl Chloride (PVC):

i) Refer to AWWA standard C605 and AWWA manual M23 for information on pressure and leakage testing.

ii) Pressure capacity of PVC pipe involves of two types of pressure: internal hydrostatic pressure; and pressure transients during operation. Temperature greatly influences the ability of PVC pipe to contain hydrostatic pressure. The AWWA C900 and C905 specifications are based on 23°C. Temperatures lower than this increase the hydrostatic pressure capacity. Alternatively, temperatures greater than 23°C decrease the pressure capacity. PVC differs from other materials in that it can resist momentary excessive pressures better than sustained long-term excessive pressures.

iii) Specific procedures for PVC pipe include all of the General Procedures above plus the following:

iv) Test pressure will be 150% of the working pressure or 1036 kPa, whichever is greater, at the point of test but not less than 125% of normal working pressure at the highest elevation on the test section (AWWA,M23).

v) Allowable leakage will be calculated from the following formula:

$$Lm = \frac{\text{HJD}\sqrt{\text{P}}}{128300}$$

Where:
J = number of joints
D = diameter of the pipe in mm
P = average test pressure, kPa
H= test duration in hours

.5 Deflection Testing of Flexible Water Transmission Mains:

a) A mandrel shall be pulled through flexible pipe greater than or equal to 600 mm diameter and less than 1200 mm diameter to demonstrate that the pipe deflection does not exceed the maximum allowable in the applicable AWWA Standard or Manual.

b) Alternative methods of pipe deflection determination must be approved by the City prior to testing.

c) The device shall be pulled manually through the pipe 24 hours or more after the completion of backfilling to surface for roadway subgrade, prior to the installation of main line valves and in conjunction with the closed circuit television inspection.

.6 <u>Inspection of Larger Diameter Pipes</u>

a) For pipes 1200 mm diameter or larger, assist the Engineer in performing a physical walk-through inspection to ensure all interior joints are satisfactorily completed and no visible damage to the pipe is evident. Vertical and horizontal measurements will be taken at mid-length of each pipe length to confirm that any pipe deflections are less than the maximum allowed by the applicable AWWA Standard. A report will be prepared by the Engineer describing the observed pipe condition and discussing the implications of the pipe measurements taken. Colour photographs will be taken by the Engineer to show general pipe condition and any abnormalities encountered. All confined space entry safety procedures shall be observed. Inspection must be carried out in clean and sanitary conditions.

4.5.1.2.14 Flushing and Disinfecting

.1 <u>Disinfection consists of the following tasks:</u>

a) Preventing contamination of the new pipe during shipping, storage, and construction;

b) Flushing the water main to remove loose debris and dirt which may have entered the water-main during construction. (Do not flush if hypochlorite tablets have been placed);

c) Chlorination of the water main to destroy pathogenic microorganisms; and

.2 <u>Specific Requirements for Flushing Strategies:</u>

a) Flushing runs must be less than 450 m in length. The ideal flushing run length is 200 m.

b) Water mains less than or equal to 300 mm in diameter should have a flush velocity of 1.5 m/s.

c) Water mains greater than 300 mm in diameter should have a flush velocity of 0.9 m/s.

d) Water must be exchanged a minimum of five times to achieve a completed flush.

e) During a flush, the source water should flow from larger pipe to smaller pipe, whenever possible.

f) Use the table below to find the number of ports required to achieve the requisite velocity. (Source AWWA C651-14):

Table 4.5.1: Flushing Velocity

	Required flow (L/s)	Hydrant nozzles required	Required flow (L/s)	Hydrant nozzles required

Pipe Diameter (mm)	For 0.9 m/s Velocity	Assumes Residual Pressure of 280kPa		For 1.5 m/s Velocity	Assumes Residual Pressure of 280kPa	
		2.5"	4.5"		2.5"	4.5"
100	7.1	1	N/A	11.8	1	N/A
150	15.9	1	N/A	26.5	1	N/A
200	28.3	1	N/A	47.1	1	N/A
250	44.2	1	N/A	73.6	2	1
300	63.6	1	1	106.0	2	1
350	86.6	2	1	N/A	N/A	N/A
400	113.1	2	1	N/A	N/A	N/A
450	143.1	2	1	N/A	N/A	N/A
With 280kPa residual pressure a hydrant flowing to atmosphere will discharge 63 L/s from a 2.5" nozzle and 158 L/s from a 4.5" steamer (Source: After AWWA C651-14)						

.3 Chlorination:

a) The choice of chemical to use for chlorination is limited to sodium hypochlorite or calcium hypochlorite. Free chlorine is the most potent form of chlorine in water. It is formed when hypochlorite is added to water. When hypochlorite is added in the presence of ammonia, combined chlorine is formed. Combined chlorine is much slower acting than free chlorine.

b) There are three accepted methods for adding the chlorine chemicals to new water mains (AWWA C651-99):

i) Calcium hypochlorite tablets placed during construction. This method provides an average dose of 25 mg/L.

ii) Continuously fed sodium or calcium hypochlorite solution. This method provides a minimum chlorine residual of 10 mg/L for 24 h.

iii) A slug of high concentration chlorine solution. This method provides a high concentration of chlorine, 100 mg/L, for a contact time of greater than 3h.

.4 Calcium Hypochlorite Tablets:

a) Calcium hypochlorite tablets are placed in the water main during construction. The tablets are usually 5 g and are placed at the beginning of the new main, at 150 m intervals, at each hydrant lead, in each hydrant, and at other appurtenances. The required number of 5 g tablets can be calculated from:

No. of tablets = $6.28 \times 10^{-6} D^2 L$

where;

D = pipe diameter, mm

L = length of pipe being disinfected, m

b) The tablet method cannot be used with solvent-welded plastic or screwed-joint steel since the joint chemicals are incompatible with calcium hypochlorite.

c) The water main is slowly filled after construction keeping the velocity below 0.3 m/s to prevent disturbing the tablets. Removal of air from the water main requires particular care as was noted in the section on pressure and leakage testing. The contact time should be 24 h at water temperatures greater than 5°C, and should be increased to 48 h when the water temperature is less than 5°C.

.5 Continuous-feed:

a) A solution of calcium hypochlorite or liquid bleach (sodium hypochlorite) may be continuously fed as the watermain is discharged at the end of the section being disinfected. The objective is to fill the water main with a uniform concentration of chlorine so that at the end of 24 h, a minimum chlorine residual of 10 mg/L remains. The usual dose to achieve this residual is 25 to 30 mg/L.

b) The following equipment is required when performing continuous-feed hypochlorination:

i) A gasoline or electrical chemical-feed pump designed for feeding chlorine solutions. The usual type is a positive-displacement diaphragm pump that is available in two styles; mechanically or hydraulically actuated. The chemical feed rate can be adjusted by altering either the stroke length or stroke speed.

ii) Maintenance of chlorine feed equipment is important since the high pH, which characterizes hypochlorite solutions causes valve seats to fail from scaling, hardening, or swelling. Calcium carbonate scale (lime) can be removed from the equipment by passing 5% hydrochloric (muriatic) acid through equipment. **Be sure to flush chlorine from equipment with water first since HIGHLY TOXIC CHLORINE GAS can be produced.**

iii) All hose and fittings should be constructed of material, which is oxidant resistant and strong enough to withstand the maximum pressure of the chemical-feed pump.

iv) A high concentration chlorine test kit should be used to make chlorine residual determinations at the discharge end of the water main being tested.

c) The chlorination procedure consists of the following steps:

i) Calcium hypochlorite tablets may be placed in the water main during construction as an option. This permits a strong chlorine solution to flow down the pipe during filling, penetrating annular spaces at pipe joints. See the above section for the procedure for placing calcium hypochlorite tablets.

ii) Prepare 1% chlorine feed solution from dry calcium hypochlorite or sodium hypochlorite bleach solution. Refer to Table 4.5.2 for information on the amounts of solution which are required for various pipe sizes. Wear protective clothing, face shield, and filter facemask. **CHLORINE IS EXTREMELY HAZARDOUS.** Do not store chlorine near acid or petroleum products. **EXPLOSION HAZARD.**

Table 4.5.2: Chlorine Required to Produce 25 mg/L Concentration in 100 m of Water Main

Pipe Diameter, mm	100% Chlorine, g/100m ‡	1% Chlorine Solution, L/100 m * ‡
50	5	0.5
100	20	2.0
150	45	4.5
200	81	8.1
250	130	13
300	180	18
450	323	33
Source: (After AWWAC65 1-86)		
* 1.5 kg $Ca(OCl)^2$ per 100 L		
‡ adjust for available chlorine of chemical used		

iii) Ensure all boundary valves are closed. Use a water distribution system drawing to highlight all valves and pipes involved in the area to be disinfected.

iv) Set-up chlorination equipment in such a way that the feed point is not more than 3 m downstream from the beginning of the new water main.

v) **DO NOT** use fire hydrants for chemical feed. The high concentration chlorine solution will damage the hydrant.

vi) Notify Development Engineering five (5) business days prior to commencing activities. Under the supervision of the Inspector, open the discharge point and one boundary valve permitting water from the distribution system or other approved source to flow through the new water main at a constant, measured rate. Use a pitot gauge or a container of known volume and stop watch to calculate the rate of discharge. Valves can only be operated by St. Albert Water Operations Staff. The City Water Inspector must be contacted a minimum of five (5) business days in advance to make arrangements for the operation of these valves. More notice may be required on a case by case basis.

vii) Adjust the chemical feed pump rate to produce a chlorine dose of 25 mg/L free chlorine. For example, if the water flow rate in the water-main is 40 L/min., the chemical feed pump should be set to deliver 1.0 g/min. (100 mL/min. if a 1% solution is being used).

viii) Frequently monitor the discharge location for chlorine residual using an approved field test kit.

ix) Once the 25 mg/L residual has been achieved, stop the flow and chlorine feed. Retain the chlorinated water in the test section for 24 h or more.

x) Operate all valves and hydrants in the test section to ensure they are disinfected.

xi) After 24 h check the free chlorine residual. If the residual is less than 10 mg/L, flush and rechlorinate.

.6 Slug:

a) The slug method involves slowly flowing a slug of high concentration chlorine, 100 mg/L, through the water main, exposing all surfaces to the chlorine for a minimum time of 3h.

b) The procedure for slug chlorination is as follows:

i) During construction, place calcium hypochlorite tablets in the water main. This permits a strong chlorine solution to flow down the pipe during filling, penetrating annular spaces at pipe joints. See the section on calcium hypochlorite tablets for details.

ii) Ensure all boundary valves are closed. Use a water distribution system drawing to highlight all valves and pipes involved in the area to be disinfected.

iii) Set-up chlorination equipment in such a way that the feed point is not more than 3 m downstream from the beginning of the new water main.

iv) DO NOT use fire hydrants for chemical feed. The high concentration chlorine will damage the hydrant.

v) Notify Development Engineering five (5) business days prior to commencing activities. Valves can only be operated by City Water Operations Staff. Development Engineering must be contacted a minimum of five (5) business days in advance to make arrangements for the operation of these valves. More notice may be required on a case by case basis.

vi) Adjust the chemical feed pump rate to produce a chlorine dose of 100 mg/L free chlorine. For example, if the water flow rate in the water main is 10 L/min., the chemical feed pump should be set to deliver 1.0 g/min. (100 mL/min. if a 1% solution is being used).

vii) The flow of the slug, which moves along the water main, should be controlled so that the pipe and appurtenances are exposed to 100 mg/L for 3h.

viii) Frequently monitor the free chlorine residual in the slug using an approved field test kit. If it falls below50 mg/L, move the chlorination equipment to the head of the slug and start the flow again, increasing the concentration to 100 mg/L.

ix) Operate all valves and hydrants as the slug passes to ensure they are disinfected.

.7 Dechlorination and Discharge:

a) All dechlorination agents must be sulphate free to ensure any discharge does not adversely affect environment;

4.5.1.2.15 Sampling

.1 The purpose of sampling a water main is to obtain information on the water quality in the pipe. The underlying assumption which is important is that the sample is representative of the water in the water main. Good sampling procedures are intended to provide the best opportunity for obtaining a representative sample.

.2 Chlorine:

a) Sampling for chlorine residual includes two basic tests: high concentration chlorine residual at the beginning and end of the primary disinfection period; and sampling for low concentration chlorine residual once the water main has been flushed. The best location for sampling residual chlorine during the primary disinfection period is at the discharge blowoff and at the service connections intended for bacteriological sampling. Low level chlorine can be determined at the bacteriological sampling locations, at an approved blowoff, and, as a last resort, at fire hydrants.

.3 Water Quality Test Strips:

a) Follow the procedure as described by the manufacturer.

b) Test strips must be pre-approved by the City before use.

.4 Bacterialogical

a) Sampling for bacteriological water quality parameters requires a great deal of care since it is very easy to contaminate a sample. Of utmost importance is to recognize that bacteria are organisms which live everywhere including air, soil, water, clothing, and all parts of the human body. Therefore, good sampling protocol is necessary to ensure reliable results. The following procedure will ensure reliable results are obtained in the laboratory (Standard Methods for the Examination of Water and Wastewater):

i) Obtain approved bacteriological sample bottles from the Provincial Laboratory of Public Health or the local Health Unit.

ii) Keep the bottles closed until immediately prior to obtaining the sample. These bottles are sterilized and contain a tablet of dechlorination reagent. NEVER rinse the sample bottles.

iii) DO NOT sample from fire hydrants. Use a service connection or blowoff especially designed for sampling the new water-main. Sample taps should be one-piece brass without aerators or other types of screens.

iv) Flow the sample line at high rate for a minimum of 5 min. to flush the line thoroughly before sampling.

v) While the sample line is flowing, complete the Provincial Laboratory of Public Health Form PH 108.

vi) Reduce the flow rate in the sample line, but maintain a water flow.

vii) Carefully break the seal on the sample bottle cap and unscrew. Take great care not to contaminate the cap or the neck of the bottle with fingers or dirt.

viii) Avoiding splashes, cut the water stream with the sample bottle and fill it until there is a head-space of approximately 20 mm in the sample bottle (roughly to the shoulder of the sample bottle). Replace the cap securely.

ix) Shake the bottle 5 times to help the dechlorination reagent to dissolve.

x) Remove the sample identification number from the Provincial Laboratory of Public Health Form PH 108 and attach it to the sample bottle.

xi) Bacteriological samples cannot be stored. If the sample cannot be delivered to the Provincial Laboratory within 1 h of sampling, use an iced cooler for storage during transport. In no case, should the samples be delivered to the Provincial Laboratory more than 6 h after the sample was collected. NEVER leave sample bottles in the sunshine or expose them to elevated temperatures.

4.5.1.2.16 Inspection of Valves and Hydrants (33 14 00)

.1 Upon completion of backfilling and surface restoration, check the operation of all valves and hydrants.

.2 Hydrants are required to pass a pressure test at time of inspection.

4.5.1.2.17 Placing Water Mains into Service (33 14 00)

.1 The following shall be applied when placing water mains into service for all types of sites.

.2 Testing and cleaning, in accordance with Article 4.5.1.2.13 must be completed prior to placing a new water main into service.

.3 Chlorine residual and turbidity values must be meet the requirements provided by the Guidelines for Canadian Drinking Water Quality and Alberta Environment before placing the main into service.

.4 Notify and arrange for a representative of the City’s Utilities Department to conduct all necessary valve operations. Only the City may operate boundary valves; there are no exceptions. Open one boundary valve slowly, releasing air from the new main through hydrants or air release valves until the pressure is equalized and stable, then slowly open other boundary valves.

.5 Maintain a watch for a break in the new water main. In such an event, isolate the water main so that service interruptions will be minimal.

.6 The Contractor is required to obtain water samples for bacteriological testing.

.7 In cooperation with the City, maintain a watch for leaks on the water main within 3 days of commissioning. Promptly repair any leaks which are detected.

.8 If any water sample fails bacteriological testing, the City will issue directions for remedial action.

4.5.1.2.18 Hydrant Flow Testing (33 14 00)

.1 The Developer shall be responsible for providing all labour and materials to complete selective hydrant flow testing of new water mains to verify available flows and pressures within the new water distribution network in comparison with the design calculations and hydraulic analyses.

.2 The Consultant must be present for all testing and shall be responsible for preparing and endorsing the test results.

.3 The City must be notified at least five (5) business days in advance of hydrant flow testing. Utilities to be contacted for assistance in operating the hydrant(s).

.4 The results of the hydrant flow testing shall be summarized in a written report in a format acceptable to the City, and submitted to the City with the Developer's application for the Construction Completion Certificate.

.5 Where the actual flows do not meet minimum fire and service requirements, all hydrants installed under the Design must be flow tested and the Developer shall be responsible for completing all necessary corrective measures to meet the required service level.

4.5.1.2.19 Environmental Protection

.1 The Contractor shall comply with the City's Environmental Sustainability Policy (Policy C-EUS-01)

.2 The Contractor shall comply with all provincial and federal regulatory requirement relating the environment.

.3 The Contractor shall immediately notify the City of any conflicts between any provision of applicable safety requirements or authorities. The City shall direct the Contractor on which provision shall apply to the Work in question.

.4 The Contractor shall submit the following material to the City at least ten (10) business days (two (2) weeks) prior to work commencing on the Site:

a) Contractors Environmental Responsibility Package (CERP) and Acknowledgment Form: The CERP must be reviewed and a signed copy of the Acknowledgement Form returned to City representative;

b) An Environmental Construction Operations (ECO) Plan: The Contractor may be required to develop and implement a project and site-specific ECO Plan in accordance with the City's ECO Plan Framework. The ECO Plan must be accepted by the City Environment Department prior to the start of construction;

.5 Any mandatory reports for the Site required by any provincial and/or federal regulatory authority must be provided to the City.

.6 Spills and releases

a) The Contractor shall ensure that all spills and releases are immediately reported to the appropriate regulatory agencies (Alberta Environment 1-800-222-6514) as required by law.

b) For environmental emergencies please call 911 first then the City after hours Utilities Emergency Dispatch by phone at 780 458 2020. Finally, notify the City representative by phone at 780-459-1500 or by email at environment@stalbert.ca

c) If a spill or release has entered into the environment, the Contractor shall satisfactorily clean the affect media and surrounding area. If required, the affect media and area shall be remediated. The level of clean up and/or remediation will be subject to municipal, provincial, and federal regulations and the Contractor must complete those activities in accordance with those regulations. Removal of released material, spent spill kit materials, and other affect media must be disposed of in an approved hazardous waste disposal site. Copies of disposal manifests and other documentation will be provided by the Contractor to the City.

d) Water Management

i) Water management includes all storm runoff, dewatering, wastewater and potable water releases into the environment.

ii) When working near a water line the Contractor shall have on site at all times an appropriate method for de-chlorination that will sufficiently reduce the chlorine levels to 0.0 mg/L by the time the potable water reaches an active body of water.

iii) The discharge of wastewater into the sanitary/stormwater system or water bodies is regulated by a number of federal, provincial and municipal laws or bylaws. The requirements in the Sewers Bylaw have been adopted and are enforced by Alberta Environment and the City of St. Albert. The contractor shall identify applicable permit requirements from the City and the Alberta Capital Region Wastewater Commission.

iv) The Contractor is responsible to implement proper wastewater management practices, and comply with all regulatory requirements.

4.5.2 Wastewater Collection System (33 30 00)

4.5.2.1 Materials

4.5.2.1.1 Gravity Sewer Mains (33 31 00)

Gravity sewer mains shall be polyvinyl chloride (PVC) or concrete pipe.

.1 PVC Pipe and Fittings

a) Sewer mains that are 1200mm or smaller in diameter shall use PVC pipe. PVC installed must be within two (2) years of manufacture with maintained proper storage and limited UV exposure.

b) PVC pipe and fittings shall meet CAN/CSA-B182.2 with locked-in elastomeric ring gasket and integral bell system joint type.

c) Minimum pipe dimension ratio shall be DR35. Strength design, considering trench and road loading, shall be integral to pipe design process.

d) Pipe shall be installed within two years from the production date indicated on the certification. Any pipe displaying discoloration from exposure to the elements must be discarded and will not be approved for installation.

e) Joint lubricants shall be compatible with gasket material. Concrete Pipe and Fittings

.2 Concrete Pipe and Fittings

a) Reinforced Circular Concrete Pipe and Fittings

i) Reinforced concrete pipe shall be acceptable for sewer mains with a diameter greater than 1200 mm.

ii) Pipe and fittings shall meet CAN/CSA-257.2, concentric reinforcing, designed for flexible rubber gasket joints to CAN/CSA-257.3, and constructed with Type HS sulphate resistant Portland cement to CAN/CSA-A3000 complete with liner or approved alternate.

iii) Strength design, considering trench and road loading, shall be integral to pipe design process. D-load shall be as determined by load analysis.

iv) Reinforced concrete pipe and fittings shall be protected from damage or defects including, but not limited to chipping, cracking, spalling or other fractures; All pipe and fittings shall conform to manufacturer specifications and must be installed without any damage or defects. The City may inspect or reject the installation of any concrete pipe or fittings deemed by the City to be defective.

4.5.2.1.2 Manholes (33 31 00)

.1 Manholes shall be minimum 1,200 mm in diameter and in accordance with the Engineering Standard Drawings in Appendix A.

.2 Manhole materials shall be reinforced concrete, constructed of Type HS sulphate resistant cement.

.3 Precast manhole sections, adjusting neck rings, and manhole steps shall conform to CAN/CSA-A257.4 and ASTM-C478.

.4 New installation wastewater manholes shall be supplied with pre-benched manhole bases and pre-cored service connections complete with watertight gaskets, Duraseal or accepted alternate. The only exceptions to the requirement for pre-benched or pre-cored wastewater manholes are perched manholes and pipe diameters that are greater than 525 mm.

.5 Manhole joints shall meet the requirements of CAN/CSA-257.3 and ASTM-C443. Furthermore, all joints shall be sealed with a non-shrink grout on the inside surface for the full circumference of the manhole. All joints shall be sealed with a watertight gasket or pre-approved alternate as per manufacturers requirement.

.6 Manhole steps shall be standard safety type, constructed of aluminum, forged of 6061-76 aluminum alloy, with a minimum tensile strength of 200 MPa. Manhole steps shall conform to CAN/CSA-A257.4.

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

.8 Frames and Covers

a) Type NF-80 frame and covers shall be made from ductile iron, conform to ASTM A536, be Class 60-40-18 and conform to the Engineering Standard Drawings in Appendix A. (Class 80-55-06 is an acceptable alternative).

b) Type NF-39 manhole frame and covers shall be made from grey cast iron, conform to ASTM A48, be Class 20B and conform to the Engineering Standard Drawings in Appendix A. (Class 35B is an acceptable alternative).

c) Frames for manholes on paved surfaces that are in sag locations shall be Type NF-39S complete with rubber gasket seal and solid cover.

d) Frames for manholes on concrete paved surfaces that are not in sag locations shall be Type NF-80 floating type with solid cover. Asphalt paved surfaces not in sag locations shall utilize type F-39.

e) Frames for manholes not on paved surfaces shall be Type NF-39S with solid cover.

f) All Type F-39, F-80, and F-39S covers shall be imprinted with the City of St. Albert's name and coat-of-arms. Use of the coat-of-arms shall not be permissible for manholes in private sites.

g) All frame and covers shall be supplied by Trojan Foundry Ltd., Norwood Foundry Ltd., or accepted alternate.

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

i) Section 2.3 – Referenced Documents - Federal Specifications, is deleted

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

iii) Section 6 – Proof-Load Testing - Section 6.1 - First article inspection and proof-load testing is defined as a single representative test of a design being required in any of the following cases: a) any product that the City specifies that is subject to loads, (b) any revision to an original design including any those where material changes are proposed, (c) any new manufacturer who has not supplied to the City previously and (d) any manufacturer who has had their products rejected due to failures and wish to reenter the supply market.

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

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

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

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

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

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

x) Section 10 - Markings - Section 10.1.1 – The AASHTO standard shall be superseded by Section 1.9 of this standard. "Made in …" is not required.

xi) Section 10 – Markings – Section 10.1.6 shall be deleted.

.9 Perched manholes, or accepted alternate, are required for sewer mains from 600 mm to 1,050 mm in diameter and shall be in accordance with the Engineering Standard Drawings in Appendix A.

.10 Tee-riser manholes, or accepted alternate, are shall be used for sewer mains greater than 1,050 mm in diameter and shall be in accordance with the Engineering Standard Drawings in Appendix A.

.11 For manholes exceeding 7 m in depth, the City may stipulate requirements for additional manholes.

.12 The City may require lockable covers be provided where safety or security risks may be a concern.

4.5.2.1.3 Wastewater Service Connections (33 31 00)

.1 Single-family residential sewer services shall be PVC pipe conforming to Article 4.5.2.1.1.

.2 Wye-type in line fittings shall be used to connect service connections to sewer mains for all new construction. Tee-type fittings may be permitted provided that the fitting is position such that the service connection discharges into the upper half of the sewer main. Strap-on or inserted tee type service saddles shall be permitted for service connections to existing mains.

.3 Sewer services for all other developments, in accordance with Article 3.2.2.4, shall comply with Article 4.5.2.1.1.

.4 Wastewater service stubs must be painted red for identification.

.5 For infill projects and/or lot splitting, new services and any existing lines that are tied into must be reviewed with CCTV to the specifications outlined under Article 4.5. The CCTV report will then be reviewed by the Utilities group for any deficiencies and/or damage to existing infrastructure. Any required repairs to existing infrastructure and any new services both on public and private lands will be at the cost of the property owner.

4.5.2.1.4 Bedding and Backfill (31 23 00)

4.5.2.2 Construction

4.5.2.2.1 General

.1 The following articles represent the minimum requirements for some typical, key construction procedures for wastewater collection system construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

.2 Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Article 2.3.1.

4.5.2.2.2 Quality Assurance (33 30 00)

.1 Refer to *article 4.5.1.2.2.*

4.5.2.2.3 Quality Control Testing (33 30 00)

.1 Refer to *article 4.5.1.2.3.*

4.5.2.2.4 Alignment and Grade (33 30 00)

.1 Lay pipe to the required alignment and grade, with manholes and all other appurtenances at the locations identified on the construction drawings or otherwise directed by the City.

.2 Provide minimum 2.6 m depth of cover on sewer mains, unless otherwise authorized by the City in writing. Where depth of cover is less than 2.6 m, provide insulation. Insulation details must be provided to the City, and City personnel must be onsite during installation of any pipes and/or services with insulation.

.3 Acceptable tolerances are as follows:

a) Alignment – the centreline of the pipe shall not be more than 100 mm off the specified alignment.

b) Elevation – the pipe invert shall not be more than 20 mm plus 0.01 mm per mm diameter of the pipe off the specified elevation. It is the responsibility of the design Engineer to ensure proper design capacities and flow velocities are met.

c) Joints – for concrete pipe, deflections at joints shall not exceed that specified by CAN/CSA-A257. For PVC pipe, deflections at joints shall not exceed those recommended by the manufacturer.

.4 All pipe shall be laid sloping in the desired direction with no reversed grades on any pipe lengths.

.5 Maintain, and provide to the City upon request, grade sheets for the installation of the pipe.

.6 No deviation shall be made from the required alignment or grade without the written consent of the City.

4.5.2.2.5 Pipe Bedding and Pipe Zone Backfill

.1 Refer to Article 4.5.1.2.6 of these Standards.

4.5.2.2.6 Pipe Installation (33 31 00)

.1 General

i) Follow manufacturer's instructions for pipe installation. Installation of PVC pipe and fittings shall be in accordance with CAN/CSA-182.11.

b) Do not allow contents of existing sewers or sewer connections to flow into the trench.

c) Do not use heavy vibratory equipment for compaction of backfill until at least 1 m of backfill has been placed over the pipe.

d) When pipelaying is complete, the sewer must be thoroughly cleaned of all dirt, stones, rubbish, and debris. Deleterious material shall be prevented from entering the installed lines and traveling into the existing system.

e) Do not install PVC pipe and fittings in areas that are, or may be, contaminated with organic solvents, petroleum products, or other materials which may negatively effect the structural integrity of the PVC product.

f) Only PVC products within 2 years of manufacture are suitable for use. Discolored pipe may be rejected at the discretion of a St. Albert representative.

.2 Laying Pipe

a) Lay pipe with the bells upgrade, and proceed upgrade.

b) Produce a smooth, uniform invert.

c) Plug lifting holes with non-shrink grout.

d) For connections to existing sewer pipes, submit a field-jointing plan to the City for review and acceptance prior to commencing the field joint.

.3 Joining Pipe

a) Join pipe in accordance with the manufacturer's recommendations.

b) Clean and check the sealing surfaces to ensure that they are smooth, concentric, and free from imperfections that might affect the sealing performance of the gasket.

c) Lubricate sliding surfaces and couple the pipes immediately.

.4 Connecting to Existing Mains

a) Notify the City in writing at least five (5) business days prior to connecting to an existing sewer main. Apply to the City's Engineering Services Department and complete a Site Servicing Permit (SSP). Include a work plan identifying necessary flow control and a contingency plan detailing the procedures to be observed in the event of problems during the connection process or other emergency. Written acceptance must be received from the City at least 24 hours before connecting to existing mains.

.5 Manhole Break-Ins

a) Break-in holes shall be made by a circular coring machine through the manhole wall. If use of a circular coring machine is not achievable, then upon prior approval of the City an alternate method of break-in may be considered.

b) Break-in holes shall not exceed a reasonable size to permit the smooth movement of the new pipe into the manhole.

c) All due care shall be taken to avoid damage to surrounding areas of the manhole. Any areas of the manhole that have been damaged during the break-in shall be repaired by the Contractor to the satisfaction of the City.

d) Following installation of the new pipe, the break-in area shall be suitably repaired and grouted, providing a watertight seal around the pipe.

e) The flow channel in the manhole shall be modified to provide a smooth continuation of flow from the break-in pipe through the manhole.

.6 Plugging of Dead Ends

a) Insert standard plugs into the bell ends of fittings or pipe bells at dead ends.

4.5.2.2.7 Setting Manholes (33 31 00)

.1 General

a) Bases shall be placed on solid, unfrozen ground.

b) Construct manhole unit plumb and true to alignment and grade.

c) External drop structure assemblies shall be encased in concrete.

d) Plug all lifting holes with non-shrink grout.

e) Seal all interior manhole barrel joints with suitable non-shrink grout.

f) Ladders shall installed plumb and be continuous from 300 mm above the manhole base benching up to 400 mm below the rim elevation (finished ground elevation).

g) Benching shall provide smooth inverts on regular curves through the manhole.

.2 Manhole Completion

a) Backfill around the manhole in the bedding zone with sand, as specified in Article 4.5.1.1.7, or fillcrete. Sand backfill shall be placed and compacted to minimum 95% Standard Proctor Density in uniform lifts not exceeding 150 mm in depth. Backfill up to the granular structure with clay or fillcrete.

b) Wherever possible, set the conical tops such that the vertical side is on the right hand side of the manhole, when looking upstream.

c) Ensure manhole rungs are aligned to one another and to access point.

d) In grassed areas, provide 300 mm depth clay cap around the manhole.

e) Place frame and cover on top section to elevation indicated, and adjust tops flush finished grades.

f) If vertical adjustment is required for final grade, use concrete grade rings to a maximum depth of 900 mm. Grade rings shall not deviate more than 50mm from the center of the manhole and/or 25mm from other grade rings.

g) Grade rings must not be staggered horizontally more than 100mm beyond plumb with the edge of the top barrel section.

h) Seal all interior and exterior grade ring joints with suitable non-shrink grout.

i) The application of water proofing membrane type is an acceptable alternative to grouting the exterior of grade ring joints.

j) Do not grout floating frame and covers (F-80 and F-39S) to grade rings.

4.5.2.2.8 Wastewater Service Connections (33 31 00)

.1 Single-family residential wastewater services, in accordance with Article 3.2.2.4 shall conform to the following.

.2 At a minimum, the uniform backfill zone shall extend from property line to property line and be at least 1.5 m in vertical depth across the full right-of-way. The uniform backfill zone shall have maximum 300 mm lift thickness and achieve minimum 98% S.P.D. as monitored and tested by the Geotechnical Engineer.

.3 Services shall be bedded in accordance with Article 4.5.2.2.5.

.4 Pipe zone backfill shall be placed to 300 mm above the crown of the highest service in the trench.

.5 Service connections shall be extended beyond the gas line into the lot to terminate at 0.15 m inside the lot easement boundary.

.6 Sanitary service connections shall be:

a) Minimum 100 mm diameter

b) The 150 mm diameter service from the main shall be reduced to 100 mm diameter and plugged/capped at 0.15 m inside the lot easement boundary.

.7 Install red-painted stakes, 38 mm by 89 mm in size, extending from the termination point of the service point to a minimum of 0.5 m above the finished surface elevation.

.8 Backfill trenches in accordance with Article 5.31.

.9 Connection to the Sewer Main

a) Install in-line tee-type fittings in accordance with the manufacturer's recommendations.

b) Where the use of strap-on type service saddles has been authorized by the City, install in accordance with the manufacturer's recommendations.

c) Apply construction adhesive or similar non-destructive sealant, to ensure a watertight seal.

.10 Pipe Installation

a) Refer to Article 4.5.2.2.6.

.11 Cleanouts

a) Install cleanouts in accordance with the Engineering Standard Drawings in Appendix A.

.12 Record of Services

a) Refer to Article 4.5.1.2.11.

4.5.2.2.9 Sewer Inspection and Testing

.1 Safety Procedures

a) The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act and Regulations and other construction safety measures.

b) Contractors shall provide a copy of their confined space entry procedures prior to commencing work.

c) All documents and safety equipment required shall be available for inspection on demand.

d) Any safety violation will be grounds for terminating the city led contract.

.2 Manual Visual Inspection

a) All sewers greater than 1200 mm in diameter, and all manholes, catch basins leads, catch basins and appurtenances shall be subject to visual inspection by the Engineer or an authorized inspector at C.C.C. and where feasible to do so, at F.A.C in addition to inspection by CCTV. Where manual walk-through inspections are not feasible to be carried out at F.A.C., sewer inspection shall be carried out only by CCTV methods. Manholes, catch basins and other appurtenances shall show no evidence of structural damage at C.C.C. nor no evidence or premature material degradation at F.A.C.

.3 Sewer Inspection by CCTV Methods

a) CCTV Equipment shall be at a minimum or greater quality/capabilities as described in the following and abide by current NASSCO standards and guidelines;

b) CCTV inspection of the sanitary and storm sewer improvements shall be completed in accordance with the Construction Specifications and the associated inspection results submitted to the Engineer prior to application for a construction completion certificate and a final acceptance certificate.

c) This shall include all sewers not subject to visual walk-through inspections. The Consultant shall review every CCTV inspection and provide to the Engineer a written summary indicating any deficiencies detected, including recommendations for repair. The interpretation of the CCTV inspection shall remain the responsibility of the Consultant.

d) Any additional CCTV inspection of sewers to verify the Consultant's interpretation or to inspect deficiency repairs shall be done at the Developer's expense.

e) The camera advance rate shall not exceed 40 metres per minute to allow adequate time for operator interpretation. The advance rate shall normally not be less than 15 meters per minute in a sewer with minimal defects. This is shall ensure digital files are not excessively large. A uniform rate of speed shall prevail.

f) The camera operator shall, during the inspection, pan the camera to focus on observable deficiencies in the pipe that may be located off-center to the direction of camera travel. This shall include all services, joints to the top, left or right, cracks and fractures or surface deterioration of the pipe walls.

g) All Manholes shall be inspected in accordance with NASSCO MACP latest standards and report provided per FAC.

.4 CCTV Equipment

a) CCTV Equipment shall be at a minimum or greater quality/capabilities as described in the following and abide by current NASSCO standards and guidelines;

b) Television equipment shall consist of a self-contained camera and a monitoring unit connected by a coaxial cable. This equipment shall be specifically designed and constructed for such inspection purposes. The camera shall be mounted on adjustable skids, or wheels, or have a height adjustment to facilitate the inspection of different sizes of pipe and to allow for visual judgement of ovality, by centring the camera within the pipe. The camera shall be waterproof and shall have a remote controlled self-contained lighting system capable of producing effective illumination for all sizes of pipe. The lighting system shall be capable of lighting the entire periphery of the pipe.

c) For inspection of existing sewers and new sewers the camera shall have pan and tilt capabilities

d) Recorded picture quality and definition shall be to the satisfaction of the City.

e) Location measurement of defects shall be made by devices having a proven accuracy of plus or minus 1.5% or 2 metres, whichever is greater. Cable markings, if used, shall not be spaced greater than 600 mm along the length of the cable. Distance measurement system used shall be regularly calibrated by the contractor, with records to be made available to the City. The City may reject equipment that cannot meet the accuracy requirements. The Contractor shall promptly inform the City of significant discrepancies between City record drawings and actual field observations.

f) Equipment shall be mounted in appropriate vehicle. Electrical power for the system shall be self-contained and shall not require removal for each set-up. External power sources from public or private residences shall not be permitted. Sound dampening shall be applied to the vehicle and equipment.

g) Stub lines and other locations where access is limited to one manhole shall be televised using a crawler equipped camera.

h) The City shall not be responsible for any loss or damage to the Contractor's equipment. The Contractor shall carry all necessary insurance to cover loss, damage, and/or retrieval during inspection. The Contractor shall be responsible for any damages due to sewer back-up or flooding that are caused by his cleaning or inspection operations. The Contractor shall promptly inform the City if any such damages occur.

.5 CCTV Inspection Reports

a) A digital video shall be provided accompanied by an inspection report. It shall be a record of the exact location of each leak or fault discovered by the television - e.g. open joints, broken, cracked, deformed or collapsed pipe, presence of grease, roots, debris, accumulation, obstruction, infiltration, water depth variations and other points of significance. The reference location for distance measurements shall be the centreline of the launch manhole (chainage 0+00). If the inspection includes an intermediate manhole, chainage shall be reset to 0+00 in the centre of the intermediate manhole.

b) The report shall include the location of all service connections together with a statement of opinion as to whether or not the service connections are subject to joint infiltration. Protrusions of service connections into the main line shall be noted with reference to the degree of protrusion.

c) Photographs of sewer defects shall be taken. The photographs shall be co-ordinated with the written report by reference numbers. A minimum of one photograph per line or manhole to manhole segment shall be taken to show a representative view of the workmanship.

d) Each manhole to manhole section of pipe shall be located on the report form in such a way as to be readily identifiable. Identify such items as name of subdivision, street names, manhole numbers, type of pipe, joint length, direction of flows, pipe diameter, manhole depth, inspection date, names of the inspection technician, persons viewing, and videotape identification numbers. Lot and block numbers for all services shall be provided.

e) Two copies of the final CCTV report with corresponding video shall be provided to the City within two weeks after the completion of the inspection. The report shall be submitted in digital format by USB, external hard drives, or acceptable cloud-based access. Media submitted shall become the property of the City.

f) All submitted media shall be numbered and cross-indexed to the written report. Video footage shall indicate the size of the sewer, the manhole to manhole segment being inspected, plus the street address or location.

.6 Visual Walk-Through Inspection of Large Diameter Sewers

a) Visual and video inspections will be required in lines where conditions will allow the Contractor's inspection crew to safely walk through the sewer. Visual inspections shall not be carried out for sewers less than 1200 mm diameter.

b) Special industrial grade colour inspection cameras, either hand-held or contained in waterproof housings shall be carried manually through the sewer during inspection work. The cameras shall be operable in conditions of 100% humidity. Camera lighting shall be sufficient for use with colour inspection cameras to clearly see details of the sewer interior. The complete video system (camera, lens, lighting, cables, monitors and recorders) shall be capable of providing a picture quality acceptable to the City. If the equipment does not produce an acceptable picture quality then it shall be removed. No payment will be made for unsatisfactory inspections.

c) Safety of the inspection crew is a prime concern. There shall be a minimum of two personnel in the sewer at any time. All crew members, whether assigned to the sewer or to assist at the surface, must receive confined space entry training.

d) The Contractor is responsible for obtaining all information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic flows and any other considerations that might affect the manner in which the inspection is undertaken. The Contractor’s tender price shall allow for completing the required inspections under existing conditions.

e) Whenever practical the video camera shall be used to look up sewer lines and services connected to the main line being inspected. Conditions in these sewer lines and services shall be noted on the inspection logs and videotapes. Accurate and continuous distance readings, the date of inspection and the City’s manhole number designation for each manhole shall be superimposed on the video recording for each line inspected.

f) No maximum flow depth has been established in this specification for manual walk-through inspections. However, Contractors shall use their own judgement before attempting any inspections. Special attention shall be paid to the current weather conditions when inspecting the combined sewers or storm sewers, as there may be a sudden increase in flow depth due to rain in the service area of the sewer.

.7 Line Cleaning

a) Prior to inspection sewers must be cleaned utilizing low pressure flushing.

b) If the amount of debris, roots or encrustation makes it impossible to determine the structural condition of the sewer, Contractor shall undertake high pressure flushing, as directed. Sludge, dirt, sand and other debris resulting from the cleaning operations shall be removed from the downstream manhole of the section being cleaned. Passing material from the section being cleaned to the downstream sewer section shall not be permitted.

c) Where the initial CCTV inspection indicates the presence of sags greater than 25% of the internal diameter of the sewer, the Contractor shall high-pressure flush that section of line. The section shall then be re-televised twice, firstly with a flusher a short distance ahead of the camera and then without a flusher active. All three records shall be forwarded to the City.

d) All debris flushed from the lines shall be removed and the contractor shall be responsible for the proper disposal of the material.

.8 Infiltration / Exfiltration Limits

a) Elastomeric gasket joints for pipe and fittings shall meet the requirements of ASTM D3212, except that the internal hydrostatic pressure shall be 100 kPa (15 psi).

.9 Leakage Testing Acceptance at FAC

a) As it is not feasible to conduct leakage tests at FAC, acceptance shall be based on visual acceptance criteria based on the results of the CCTV inspections. Any observed infiltration greater than the “seeper” level of infiltration shall be rectified at the Developer’s expense. Rectification of infiltration type deficiencies can be made utilizing approved grouting or trenchless point repair techniques. The Consultant shall make a recommendation to the City on an appropriate method of defect rectification. The method of rectification may not be applied without expressed written approval from the City Engineer.

.10 Deflection Testing of Flexible Pipe

a) The scope of work of the deflection testing includes cleaning, traffic control and CCTV inspection.

b) Where closed circuit television (CCTV) or visual walk-through inspections show evidence of excessive or non-symmetrical deflection (e.g. a non-elliptical deformation pattern), formal deflection tests shall be conducted. The location and number of deflection tests shall be at the sole discretion of the City.

c) Where formal inspection tests are required, inspect pipes up to and including 900 mm diameter with a “go/no - go” mandrel device or other suitable measuring device. Other suitable devices may include laser profiling equipment, or other methods. Other suitable measurement devices shall be approved by the City. Where required, pipes larger than 1050 mm diameter shall be inspected with a suitable measurement device such as a telescoping rod in conjunction with a walk-through inspection. These tests are to confirm that the vertical deflection does not exceed the allowable deflection limit stipulated below and that the nature of deflection observed is illustrative of natural anticipated flexible-pipe soil interaction.

d) Deflection tests for acceptance purposes shall be conducted not sooner than 30 days after all backfill has been completed.

e) Short term deflection shall be deemed to be any deflection measured not sooner than 30 days after backfilling.

f) Long term deflection shall be deemed to be any deflection measured after one year of backfilling.

.11 Mandrel

a) The mandrel shall be cylindrical in shape, constructed with nine evenly spaced arms and shall conform to the following schematic:

b) Mandrels larger than 450 mm in diameter shall be constructed with special breakdown devices to facilitate entry through standard access manholes.

c) The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the values indicated below for each specific pipe material, within a tolerance of +/- 0.25 mm. The contact length of the mandrel shall be at least 75% of the inside diameter of the pipe. The outside diameter of the mandrel arms shall be checked for conformance with proving rings.

d) Either an oversize or undersize proving ring shall be used to confirm the acceptability of mandrel dimensions. An oversize proving ring shall be of a diameter equal to the required outside mandrel size plus 1 mm. An undersize proving ring shall be of a diameter equal to the required outside mandrel size minus 0.30 mm. Both proving rings shall be manufactured to within 0.25 mm of the specified size. The proving rings shall be fabricated from 6 mm minimum thickness stainless steel.

e) Dimensions for mandrels for acceptance purposes shall conform to the table below:

Nominal Pipe Size (mm)	Radius of Test Mandrel (mm)			
	Solid Wall PVC Pipe SDR 35		Open Profile Wall PVC Pipe	
	Short Term	Long Term	Short Term	Long Term
100	47	45.9	47.1	45.9
150	70	68.3	70	68.3
200	93.7	91.4	93.7	91.4
250	117.1	114.3	117.1	114.3
300	139.4	136	139.3	136
375	170.6	166.5	170.6	166.5
450	208.5	203.5	209.5	204.5
525	245.8	239.9	246.3	240.4
600	276.6	269.9	279	272.3
675	311.7	304.2	314.9	307.4
750	357.1	348.5	350.6	342.1
900	427.3	417	421.9	411.7
1,050	496.4	484.5	493.2	481.3
1,200	566.7	553	564.5	550.9

f) An acceptable mandrel will pass through the oversize ring, but not through the undersize ring.

g) The allowed vertical deflection shall be as follows:

i) For testing done after 30 days, short term deflection, maximum allowable deflection is 5% of the CSA Base Inside Diameter (BID).

ii) For testing done after one year, long term deflection, maximum allowable deflection is 7.5% of the CSA BID.

.12 <u>Easements and Restrictive Covenants</u>

a) All easement, restrictive covenant and right-of-way documents indicated on the engineering drawings, shall be registered against the properties and on file at the Land Titles Office before construction completion certificates for the development will be issued.

4.5.2.2.10 Sewer Service Inspection and Testing

.1 All services must be verified by survey. Record of survey must identify sufficient grades, elevations and locations of all key points including, but not limited to: stubs, tees, property line crossing point, risers, water main CC, etc.

.2 Any sewer services that fail to pass inspection and testing, or having obstructions, breaks, or any other defects, shall be repaired, re-inspected, and re-tested to the satisfaction of the City, at the Developer's sole expense.

.3 The Consultant must provide a service report confirming satisfactory inspection and testing of each sewer service. The report shall be provided with the application for the Construction Completion Certificate.

4.5.2.2.11 Final Inspection

.1 Three (3) months prior to the expiry of the Warranty Period, the Developer shall be responsible for arranging for an additional CCTV inspection of the installed sewer mains, in accordance with the applicable requirements of Article 4.5.2.2.8. The CCTV inspection and reporting must be in accordance with NASSCO standards and applicable video/report issuance as best practice occurring today.

.2 Any sewer mains having obstructions, breaks, sags, or any other defects, shall be repaired, re-inspected, and re-tested to the satisfaction of the City, at the Developer's sole expense, prior to application for the Final Acceptance Certificate.

.3 One copy of the written CCTV inspection report, including still photographs and video footage of inspection must be provided to the City with the application for the Final Acceptance Certificate.

.4 The Final Acceptance Certificate shall not be issued by the City until the CCTV reports and footage has been reviewed and accepted by the City.

4.5.3 Stormwater Management System (33 40 00)

4.5.3.1 Materials

4.5.3.1.1 Storm Sewer Mains, Catch Basin Leads, and Foundation Drain Discharge Collection Sewers (33 40 00)

Storm sewer mains, catch basin leads, and foundation drain discharge collection sewers shall be polyvinyl chloride (PVC) or concrete pipe conforming to the following:

.1 PVC Pipe and Fittings

a) PVC pipe shall be installed for sewer mains up to 1200mm. PVC installed must be within two (2) years of manufacture with maintained proper storage and limited UV exposure.

b) PVC pipe and fittings shall meet CAN/CSA-B182.2 with locked-in elastomeric ring gasket and integral bell system joint type.

c) Minimum pipe dimension ratio shall be DR35. Strength design, considering trench and road loading, shall be integral to pipe design process.

d) Pipe shall be installed within two years from the production date indicated on the certification.

e) Joint lubricants shall be compatible with gasket material.

.2 Concrete Pipe and Fittings

a) Reinforced Circular Concrete Pipe and Fittings

i) Reinforced concrete pipe, and or other pipe materials may, on a case-by-case basis, be considered for installation and is subject to City approval prior to installation for sewer mains with a diameter of 600 mm or greater, upon consideration of geotechnical considerations, depth, upstream conditions, etc.

ii) Pipe and fittings shall meet CAN/CSA-257.2, concentric reinforcing, designed for flexible rubber gasket joints to CAN/CSA-257.3, and constructed with Type HS sulphate resistant Portland cement to CAN/CSA-A3000.

iii) Strength design, considering all Dead and Live load as well as soil structures, shall be integral to pipe design process to ensure that all critical failures modes are reviewed. D-load shall be as determined by load analysis and are subject to review and acceptance by the City prior to installation.

iv) Reinforced concrete pipe and fittings shall be protected from damage or defects including, but not limited to chipping, cracking, spalling or other fractures; All pipe and fittings shall conform to manufacturer specifications and must be installed without any damage or defects. The City may inspect or reject the installation of any concrete pipe or fittings deemed by the City to be defective.

4.5.3.1.2 Culverts (33 42 00)

.1 Polyvinyl Chloride pipe (PVC) shall be acceptable for culverts and temporary inlets and outlets for stormwater management facilities.

.2 Culverts shall be Ultra-Rib or approved equivalent. CMP will not be accepted.

4.5.3.1.3 Manholes (33 42 00)

.1 Manholes shall be minimum 1,200 mm in diameter and in accordance with the Engineering Standard Drawings in Appendix A.

.2 Catch basin manholes shall be minimum 1,200 mm in diameter and in accordance with the Engineering Standard Drawings in Appendix A.

.3 Manhole materials shall be reinforced concrete, constructed of Type HS sulphate resistant cement.

.4 Precast manhole sections, adjusting neck rings, and manhole steps shall conform to CAN/CSA-A257.4 and ASTM-C478.

.5 New installation stormwater manholes shall be supplied with pre-benched manhole bases and pre-cored service connections complete with watertight joints, Duraseal or accepted alternate. The only exceptions to the requirement for pre-benched or pre-cored stormwater manholes are perched manholes, pipe diameters that are greater than 525 mm and manhole diameters greater than 1800 mm.

.6 Manhole joints shall meet the requirements of CAN/CSA-257.3 and ASTM-C443. Furthermore, all joints shall be sealed with a suitable non-shrink grout on the inside and outside for the circumference of the manhole including grade rings. Alternative applications such as Boa-Tape and Riser-Wrap are considered acceptable joint sealing measures for the exterior joints on manhole barrel sections.

.7 Manhole steps shall be standard safety type, constructed of aluminum, forged of 6061-76 aluminum alloy, with a minimum tensile strength of 200 MPa. Manhole steps shall conform to CAN/CSA-A257.4.

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

.9 Frames and Covers

a) Type F-80 and type F-39S manhole frame and covers shall be made from ductile iron, conform to ASTM A536, be Class 60-40-18 and conform to the Engineering Standard Drawings in Appendix A. (Class 80-55-06 is an acceptable alternative).

b) Type F-39 manhole frame and covers shall be made from grey cast iron, conform to ASTM A48, be Class 20B and conform to the Engineering Standard Drawings in Appendix A. (Class 35B is an acceptable alternative).

c) Frames for manholes on concrete paved surfaces shall be Type F-80 floating type with solid cover. Manholes on Asphalt paved surfaces not in sag locations shall utilize Type F-39.

d) Frames for manholes not on paved surfaces shall be Type F-39S with solid cover.

e) All Type F-39, F-39S and F-80 covers shall be imprinted with the City of St. Albert's name and coat-of-arms.

f) All frame and covers shall be supplied by Trojan Foundry Ltd., Norwood Foundry Ltd., or accepted alternate.

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

i) Section 2.3 – Referenced Documents - Federal Specifications, is deleted

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

iii) Section 6 – Proof-Load Testing - Section 6.1 - First article inspection and proof-load testing is defined as a single representative test of a design being required in any of the following cases: a) any product that the City specifies that is subject to loads, (b) any revision to an original design including any those where material changes are proposed, (c) any new manufacturer who has not supplied to the City previously and (d) any manufacturer who has had their products rejected due to failures and wish to reenter the supply market.

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

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

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

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

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

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

x) Section 10 - Markings - Section 10.1.1 – The AASHTO standard shall be superseded by Section 1.9 of this standard. “Made in …” is not required.

xi) Section 10 – Markings – Section 10.1.6 shall be deleted.

h) Perched manholes, or accepted alternate, are required for sewer mains from 600 mm to 1,050 mm in diameter and in accordance with the Engineering Standard Drawings in Appendix A.

i) Tee-riser manholes, or accepted alternate, are required for sewer mains greater than 1,050 mm in diameter and in accordance with the Engineering Standard Drawings in Appendix A.

j) For manholes exceeding 7 m in depth, the City may stipulate requirements for additional manholes. This is to accommodate the use of drop manholes.

k) The City may require lockable covers be provided where safety or security risks may be a concern. Where required, such shall be subject to the review and acceptance of the City.

4.5.3.1.4 Catch Basins (33 42 00)

.1 Catch basins shall be minimum 900 mm in diameter with a minimum sump depth of 600 mm in accordance with the Engineering Standard Drawings in Appendix A.

a) Catch basin materials shall be reinforced concrete, constructed of Type HS sulphate resistant cement.

b) Catch Basin steps are required for barrels in excess of 900mm diameter at a depth of 1.5m or deeper. Catch basin steps shall be standard safety type, constructed of hot-dipped iron in accordance with ASTM-A615 and ASTM-A123 or aluminum, forged of 6061-76 aluminum alloy, with a minimum tensile strength of 200 MPa.

c) Frames and Covers

.2 Frames and covers shall be made of iron conforming to ASTM-A48 and in accordance with the Engineering Standard Drawings in Appendix A.

.3 Top inlet, round top frames and covers shall be Type F-38 or Type F-39 open grate type, or accepted alternate.

.4 Side inlet frames and covers for straight-faced curb shall be two-piece Type F-51, or accepted alternate.

.5 Side inlet frames and covers for rolled-faced curb shall be Type K-7, or Type DK-7, or accepted alternate.

4.5.3.1.5 Stormwater Service Connections (33 42 00)

.1 Single-family residential sewer services shall be PVC pipe conforming to Article 4.5.3.1.1.

.2 Tee-type fittings shall be used to connect service connections to sewer mains for all new construction. The tee-type fittings will be positioned such that the service connection discharges into the upper half of the sewer main. Stainless steel strap-on type service saddles shall only be permitted for service connections to existing mains, or where otherwise this may be the only option (i.e. connections to large diameter sewer mains).

.3 Sewer services for all other developments, in accordance with Article 3.2.3.7, shall comply with Article 4.5.3.1.1.

.4 Stormwater service stubs must be painted green for identification.

.5 For infill projects and/or lot splitting, new services and any existing lines that are tied into must be reviewed with CCTV to the specifications outlined under Article 4.5. The CCTV report will then be reviewed by the Utilities group for any deficiencies and/or damage to existing infrastructure. Any required repairs to existing infrastructure and any new services both on public and private lands will be at the cost of the property owner.

4.5.3.1.6 Oil and Grit Interceptors (33 44 00)

.1 Oil and grit interceptors shall be as manufactured by Stormceptor or CDS Technologies. Any alternative must be pre-approved by the City.

.2 Detailed analysis to be provided with engineering drawings along with design.

4.5.3.1.7 Bedding and Backfill (31 23 00)

4.5.3.2 Construction

4.5.3.2.1 General

.1 The following articles represent the minimum requirements for some typical, key construction procedures for stormwater management system construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

.2 Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Article 2.3.1.

4.5.3.2.2 Quality Assurance (33 40 00)

.1 Refer to *article 2.7.3.3.2.*

4.5.3.2.3 Quality Control Testing (33 40 00)

.1 Refer to *article 2.7.3.3.2.*

4.5.3.2.4 Alignment and Grade (33 40 00)

.1 Lay pipe to the required alignment and grade, with manholes and all other appurtenances at the locations identified on the construction drawings.

.2 Provide minimum 1.80 m depth of cover on sewer mains, unless otherwise authorized by the City in writing. Where depth of cover is less than 1.80 m, provide insulation.

.3 Acceptable tolerances are as follows:

a) Alignment – the centreline of the pipe shall not be more than 100 mm off the specified alignment.

b) Elevation – the pipe invert shall not be more than 20 mm plus 0.01 mm per mm diameter of the pipe off the specified elevation. It is the responsibility of the design Engineer to ensure proper design capacities and flow velocities are met.

c) Joints – for concrete pipe, deflections at joints shall not exceed that specified by CAN/CSA-A257. For PVC pipe, deflections at joints shall not exceed those recommended by the manufacturer.

.4 All pipe shall be laid sloping in the desired direction with no reversed grades on any pipe lengths.

.5 Maintain, and provide to the City upon request, grade sheets for the installation of the pipe.

.6 No deviation shall be made from the required alignment or grade without the written consent of the City.

4.5.3.2.5 Pipe Bedding and Pipe Zone Backfill

.1 Refer to Article 4.5.1.2.6 of these Standards.

4.5.3.2.6 Pipe Installation (33 42 00)

.1 Refer to Article 4.5.2.2.6 of these Standards.

4.5.3.2.7 Setting Manholes (33 42 00)

.1 Refer to Article 4.5.2.2.7 of these Standards.

4.5.3.2.8 Setting Catch Basins (33 42 00)

.1 General

a) Bases shall be placed on solid, unfrozen ground.

b) Construct catch basin unit plumb and true to alignment and grade.

.2 Catch Basin Completion

a) Backfill around the catch basin with sand, as specified in Article 4.5.1.1.7 or fillcrete. Sand backfill shall be placed and compacted to minimum 98% Standard Proctor Density in uniform lifts not exceeding 150 mm in depth.

b) If vertical adjustment is required for final grade, use concrete grade rings to a maximum depth of 450 mm with a maximum of 3 grade rings in total.

c) Grade rings must not be staggered horizontally more than 100mm beyond plumb with the edge of the top barrel section.

d) Place frame and cover to the elevation indicated, and adjust tops flush finished grades.

4.5.3.2.9 Stormwater Service Connections (33 42 00)

.1 Refer to Article 4.5.2.2.8 of these Standards.

.2 Storm service connections shall be:

a) Minimum 150 mm diameter.

b) Installed at a minimum of 2 % grade continuously from the service connection at the main to the service termination at the end of the lot easement. Sags in gravity service connection pipes that hold standing water will be rejected by the City and require re-installation at the Developers expense.

4.5.3.2.10 Sewer Main Inspection and Testing

.1 CCTV inspection to be completed for all sewer mains and catch basin leads.

.2 Refer to Article 4.5.2.2.9 of these Standards.

4.5.3.2.11 Sewer Service Inspection and Testing

.1 Refer to *Article 4.5.2.2.10* of these Standards.

4.5.3.2.12 Final Inspection of Sewer Mains

.1 Refer to *Article 4.5.2.2.11* of these Standards.

4.5.4 Liftstation

.1 Please refer to Appendix I for all construction and material standards / specifications regarding lift stations and SCADA development.

4.5.5 Cast Iron Products

The following outlines the cast iron product specifications as outlined by Trojan Foundry Ltd.

4.5.5.1 General Requirements

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

.2 Gray iron shall conform to ASTM A48 latest edition: Class is shown on individual drawings and castings.

.3 Ductile iron shall conform to ASTM A536 latest edition: class is shown on individual drawings and product.

.4 Requirements for manufacturing testing shall conform to AASHTO M306, ASTM A48 and ASTM A536

.5 Any reference to United States in the AASHTO or ASTM specifications shall mean Canada for our purposes.

.6 All tests and sampling of samples shall be witnessed by a Canadian professional engineer.

4.5.5.2 Testing and Frequency

.1 Gray iron test bars. Samples (3) of gray iron test bars shall be poured twice annually from the metal supplied to the individual casting. Preparation of sample and testing shall be in accordance with ASTM A48 – latest samples made be tested, identified and be witnessed by a Canadian engineer. Test results shall be submitted and stamped by a professional engineer.

Tensile Strength	
Class 20	20 ksi
Class 25	25 ksi
Class 30	30 ksi
Class 35	35 ksi

.2 Ductile iron test bars. Samples of ductile iron test bars (3) poured twice annually from the metal supplied to an individual casting. Preparation of sample and testing shall be In accordance with ASTM A536 latest edition. Samples made shall be witnessed by a Canadian engineer identified and tested. Test results shall be submitted and stamped by same engineer

	Grade	Grade	Grade	Grade	Grade
	60-40-18	65-45-12	80-55-06	100-70-03	120-90-02
Tensile strength, min, psi	60 000	65 000	80 000	100 000	120 000
Tensile strength, min, MPa	414	448	552	689	827
Yield strength, min, psi	40 000	45 000	55 000	70 000	90 000
Yield strength, min, MPa	276	310	379	483	621
Elongation in 2 in, or 50 mm, min	18	12	6.0	3.0	2.0

.3 Proof Load Testing

.4 Proof load testing shall be performed on the grate and cover using a 9”x 9” block. Test is according to AASHTO M306. Load is taken to 178 kn and recorded. Test shall be witnessed and recorded by a profession engineer from Canada.(Typically, the load is 10% higher than 178 and hold for 1 minute.)

.5 FAR Reports

a) First article reports are done on first casting coming out of the pattern mold. Dimensions are taken comparing these to actual drawing dimensions and recorded.The report shall be taken at initial casting of new pattern and twice thereafter per year.

4.5.5.3 Drawing Submission

.1 Drawing stamped by a professional engineer shall be submitted to the owner of the castings. These drawings will display all necessary dimensions along with tolerances. All specifications regarding the castings shall be displayed on drawings. Required Marking shall be on drawings. The casting is built to this drawing.

.2 Tolerances as follows:

a) Casting Pattern Dimension Allowable Tolerance

b) Mating Parts: Less than 50 mm +/- 0.8 mm

c) Mating Parts: 300 mm to 50 mm +/-1.5 mm

d) Mating Parts: Greater than 300 mm +/-3.0 mm

e) Other Dimensions to 900 mm +/-3.0 mm

4.5.5.4 Certification by Engineer

.1 Certificate of compliance shall be given to the owner by the professional engineer. This certifies that the engineer is comfortable that the foundry is meeting the specifications as well as the testing requirements.

4.5.5.5 Workmanship and Finish

.1 Castings shall be free from cracks, porosity, claws and excessive shrinkage.

.2 Castings shall be true to pattern.

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

.4 Coated or painted castings will not be accepted.

.5 Manhole cover castings shall not rock when mated with corresponding frame.

.6 Surfaces shall be machined or ground as noted on the drawing.

4.5.5.6 Markings

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

a) City specifications.

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

c) Markings shall be located in such a manner that they are easily identifiable. The markings shall be located on the “non wear” location of the product. State country of origin visibly on castings.

4.5.5.7 Reference Documents Required

.1 ASTM-A48 – Latest Edition

.2 ASTM A536 – Latest Edition

.3 AASHTO M306 – Latest Edition

4.6 Commercial, Institutional, Industrial and Multi-Family

4.6.1 General

.1 All private site development shall conform to all relevant zoning bylaws.

4.6.2 Grading

.1 All private site construction shall conform to grading standards outlined in *Article: 4.2.*

4.6.3 Underground

.1 All private site construction shall conform to underground standards outlined in *Article: 4.5.*

4.6.4 Surface

.1 All private site construction shall conform to surface standards outlined in *Article: 4.3.*

4.6.5 Landscaping

.1 All private site construction shall conform to landscaping standards outlined in *Article: 4.4.*

5 Appendices