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Roads, Curbs, Walkways and Sidewalk Standard Drawings

RC1	Standard Road Cross Section Urban Local Roadway 18.0 m Road Dedication
RC2	Standard Road Cross Section Urban Collector Roadway 20.0 m Road Dedication
RC3	Standard Road Cross Section Resort/Rural Collector Roadway 20.0 m Road Dedication
RC4	Standard Road Cross Section Urban Arterial Roadway 25.0 m (min) Road Dedication
RC5	Standard Road Cross Section Rural Arterial Roadway 25.0 m (min) Road Dedication
RC6	Standard Road Cross Section Downtown Roadway 20.0 m Road Dedication
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RC8	Standard Road Cross Section Urban Lane 7.0 m Road Dedication
R9	Cul-de-sac
R10	Cul-de-sac Offset Type
R11	Temporary Turn Arounds
R12	Mountable Curb & Gutter
R13	Non-Mountable Curb & Gutter
R14	Typical Sidewalk Finishing Details
R15	Sidewalk Treatments for the Downtown Core
R16	Pedestrian Sidewalk Ramp for Barrier Curb
R17	Pedestrian Sidewalk Ramp for Non-Mountable Curb
R18	Driveway Crossing for Barrier Curb
R19	Typical Driveway Grades
R20	Emergency Access 4.0 m ROW
R21	Walkway
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R23	Handrail
R24	Sign Details
R25	Signs on Perforated Steel Tubing
R26	Perforated Steel Base for Signs
R27	Park Fence Details

7.01 Introduction

All roads in the City shall be designed in accordance with recommended practices in "Geometric Design Guide for Canadian Roads and Streets" (Current Edition), as published by the Transportation Association of Canada (TAC), and as specified in this manual.

The design of curbs, sidewalks and walkways within the City shall provide access for persons who are physically challenged by mobility and / or sight impairments.

The design of new roads shall be based on the contents of these standards and specifications and on the results of a geotechnical assessment of the proposed road site. Test holes and samples shall be undertaken by a qualified geotechnical company, and all reports shall be signed and sealed by a qualified geotechnical engineer. The geotechnical engineer shall be retained throughout the design and construction phases of the project.

Road construction and asphalt overlay design for upgrading existing roads shall be based on design standards for new roads contained in these standards and specifications and on the results of test holes carried out by a qualified geotechnical company and Benkelman Beam testing. Crack sealing and pavement patching may be required as part of the road upgrade.

The pavement structure shall be appropriate for a road under the expected traffic conditions for the class of road.

7.02 Classifications

The City will advise the Applicant of the classification of each road. The design of these roads shall be in accordance with the standard cross-section for each road type.

Generally, the following criteria will apply. However, factors such as traffic volume and predominant type of development may result in adjustments to the criteria.

	<u>Posted Speed km/h</u>	<u>Road Width (m)</u>	<u>Minimum Road Dedication (m)</u>
RC1 - Urban Local	50	8.5	18
RC2 - Urban Collector	50	12.8	20
RC3 – Resort/Rural Collector	50	8.6	20

	<u>Posted Speed km/h</u>	<u>Road Width (m)</u>	<u>Minimum Road Dedication (m)</u>
RC4 – Urban Arterial	50	16.5	25
RC5 – Rural Arterial	60	17.4	25
RC6 – Downtown Road	50	11.0	20
RC7 – Industrial Road	50	8.6	20
RC8 - Urban Lane	20	6.0	7

For local roads north of the Island Highway and for local roads north of Resort Drive a 20 meter right-of-way shall be provided if required to provide access to water in accordance with Provincial regulation.

Roads shall be designed in accordance with the dimensions and requirements shown on Municipal Standard Drawings RC1 to RC8 inclusive. Roads contained within the downtown core will require special design considerations to accommodate pedestrian crossings both mid-block and at intersections.

Typical cross-sections, including dimensions and requirements, must be shown on the design drawings.

7.03 Grades

The maximum longitudinal grades shall be as follows.

Vertical Control

Maximum grade - Local Road	12 Percent
Maximum grade – Collector & Arterial	8.0 Percent
Minimum grade	0.5 Percent
Minimum grade at curb returns	0.5 Percent
Maximum grade on turn-around at cul-de-sac	8.0 Percent
Normal crown	2.0 Percent

Where topographical constraints restrict attaining the grades noted above, consideration to vary the grades may be given by the City Engineer.

For longitudinal grades at intersections see Section 7.11

7.04 Cross-Slopes

Standard cross-slopes on streets shall be 2.0 percent, with the crown located at the centreline of the pavement.

Where extreme topography is involved, limited local roads may be designed with cross-slopes from 1 percent to 3 percent, or with one-way cross fall where approved by the City Engineer.

Local and collector roads are not to be super-elevated.

The length of a transition from a normal crowned road to a section of road with super-elevation shall be greater than 45 metres.

7.05 Vertical Curves

Vertical curves shall be governed by the design speed of the road. Generally, the following criteria apply.

Minimum length of crest vertical curves:

Design Speed	Length
50 km/h	9 metres / 1 percent change in slope
60 km/h	15 metres / 1 percent change in slope

Minimum length of sag vertical curves:

Design Speed	Length
50 km/h	11 metres / 1 percent change in slope
60 km/h	15 metres / 1 percent change in slope

7.06 Horizontal Curves

Horizontal curves shall be governed by the design speed of the road.

Minimum radius of curve and maximum super elevation are as follows.

Design Speed (km/h)	Minimum Centreline Radius	Maximum Super Elevation
Local 50	50 metres	Normal Crown
Collector 50	100 metres	Normal Crown
Arterial Road 50 / 60	Refer to TAC	Special Design

Subject to the approval of the City Engineer, curves on crescent-shaped local roads may be reduced to a minimum centerline radius equal to 30 metres.

Horizontal curves shall be fully described on the drawings, specifying internal angle, radius, tangent length and arc.

7.07 Curb Returns

The minimum curb return radii shall be as follows.

Industrial	13.7 metres
Commercial	12.0 metres
Arterial and Collector	12.0 metres
Local	7.0 metres

7.08 Cul-de-sacs and P-Loops

Design of cul-de-sacs shall follow the applicable Standard Drawings R9 and R10. A walkway shall be provided from the end of the cul-de-sac to the adjacent road, where feasible.

The maximum length of any road dead ending in a cul-de-sac or P-loop shall be 150 metres as measured from the intersecting highway having more than one access to the beginning of the turn-around.

7.09 Temporary Turnarounds

In cases where the proposed road exceeds 50 metres in length and is to be extended in the future, temporary paved turnarounds are required to accommodate a fire truck.

7.10 Half Roads

In a subdivision where the road layout is such that a highway will service the adjoining properties outside the subdivision, the City Engineer may allow construction of a new half road along the perimeter of the subdivision, provided, however, there is sufficient road width to provide for two way traffic, sidewalk, streetlights, a drainage collection system, and other required utilities.

7.11 Intersections

Particular attention shall be given to the design of intersections. The Consultant shall employ good engineering practice in assessing the following concerns.

- approach grades and grade transitions

- crossing sight distance
- design speed(s)
- intersection cross-slopes
- curb returns
- intersection alignment
- turning movements
- vehicle storage (left-turn bays)
- drainage

Grades of major and minor roads at intersections shall be adjusted where topographic or other conditions dictate the use of maximum or near maximum permissible grades. Such adjustments are essential to provide reasonable stopping opportunities during extreme roadway icing conditions. The following table specifies the standards for road grades at intersections.

Vertical Alignment at Intersections

Road Type	Maximum Grade & Minimum Flattened Distance* for Intersection with:		
	Arterial	Collector	Local
Arterial	2 percent/60 metres	---	---
Collector	2 percent/30 metres	2 percent/25 metres	---
Local	2 percent/25 metres	2 percent/20 metres	2 percent/10 metres

*Distances are measured along the minor road from the nearest curb line of the major road to the beginning of the vertical curve (BVC).

7.12 Cross Section Considerations

The road width and pavement structure shall be determined by:

- the minimum specified on the applicable standard drawing; or
- per Section 7.25 for reconstruction of existing roads; and
- per Section 7.01.

Typical cross-sections complete with dimensions and requirements must be shown on the design drawing set for each road.

The maximum side slope of earth fills or cuts shall be 3H:1V (2H:1V where absolutely necessary). Flatter slopes shall be used where unstable soil conditions are encountered.

Beginning at a point 600 millimetres from the back of the sidewalk, if a 3H:1V side slope creates a vertical cut or fill at the property line in excess of 600 millimetres, a concrete retaining wall shall be constructed. Retaining walls shall be adequately drained, not preclude a vehicle and pedestrian access to each property and be equipped with railings.

The design shall ensure that the road cross-sections accommodate the Major Flood Path Route.

7.13 Driveways

Each lot created by a development must have sufficient road frontage to accommodate the construction of a standard driveway per the applicable standard drawing and the following specifications.

Residential driveways shall be no wider than 6 metres with a minimum width of 4 metres at any point on public property.

Commercial, industrial, institutional and high density residential driveways shall be no wider than 9 metres at any point on public property.

The number of driveways to a parcel that is used for residential use only shall be not more than one for each 24 metres or remaining fraction thereof of the total highway frontage of the parcel.

The number of driveways to a non-residential parcel shall be not more than one for each 30 metres or remaining fraction thereof, of the total highway frontage of the parcel.

No two driveways to one parcel shall be closer to each other than 9 metres at any point.

Where a non-residential parcel adjoins another parcel, no driveway to the non-residential parcel shall be less than 1.5 metres from the adjoining parcel boundary.

Driveways shall be located adjacent to the interior side lot line of a property and no closer than 7.5 metres at any point to the point of intersection of two highway right-of-way boundaries, or if one or more of the highways is a lane, within 4.5 metres of the intersection.

Angled driveways to parcels are permitted, provided that the included angle between the driveway and the edge of pavement on the road right-of-way is no less than 45 degrees.

Loop driveways are permitted, provided that the driveways at each end of the loop meet the requirements of this section and that no part of the connecting loop is on public property.

Except in areas where curbs have been installed or where all City services have been completed, no concrete driveways are permitted on public property.

For driveway crossings of ditches/swales or where piped storm systems do not exist, the driveway crossings shall be designed in accordance with Section 4.02, and the culvert shall be

no less than 300 millimetres in diameter. The minimum length of any culvert shall be 7 metres.

All driveways shall be designed to permit the appropriate vehicular access for the zone without 'bottoming-out' or 'hanging-up'.

The maximum grade on a driveway shall conform to Standard Drawing R19. The maximum grade for driveways to collector and arterial roads, and in all commercial and industrial zones, shall be 10 percent.

Where a proposed lot abuts roads of different classifications, the driveway shall be located to access the road of the lower classification, except for service stations where access may be provided from both adjoining roads.

7.14 Emergency Accesses

The requirement for emergency access is governed by consultation with the Fire Department and by the BC Building Code.

Where required, any emergency access must be able to support a wheel axle bearing load of 9.1 tonnes.

Urban, permanent emergency accesses shall conform to Standard Drawing R20. The full width of the right-of-way shall be broom swept concrete and shall have wheelchair accessible bicycle baffles or bollards at each end.

Rural emergency accesses or temporary emergency accesses in urban developments will require a special design. The travel surface may be asphalt, and fencing may not be a requirement. However, vehicular restriction devices must be designed for each end.

Where there is a reasonable expectation that a rural development will be urbanized in the future, an urban standard emergency access will be required.

7.15 Boulevards

All existing boulevards that have been disturbed during the course of construction work are to be restored to original or better condition. Restoration will include placement and light compaction of 150 millimetres of topsoil free of clay, gravel, couch grass or perennial weeds, followed by uniformly distributed hydroseed. All new boulevards created as a result of subdivision may remain unfinished until 80 percent of the houses have been finished and landscaped, but must be completed with grass established prior to final acceptance of the works. Drainage issues must be addressed. The boulevards shall be finished with

150 millimetres of topsoil and either seeded or sodded and maintained for the rest of the one year maintenance period.

The City Engineer may under some circumstances request the placement of topsoil and sod for commercial or industrial boulevards. When the placement of sod is specified as a requirement, it shall be nursery grown, true to type, and conforming to standards of the nursery and their respective specifications.

In order to qualify for final acceptance, the developer shall ensure that:

- a) grassed areas are mowed and watered at regular intervals,
- b) all areas are rolled out to remove depressions or irregularities,
- c) weed control is carried out as required, and
- d) seeded areas are adequately protected with warning signs, twine fences or other means.

7.16 Signs and Street Markings

Street name signs and traffic advisory signs will be supplied and installed by the City at the Applicant's expense, unless otherwise approved. Street name signs shall be provided at all intersections.

Signs shall not be located in sidewalks. All signs shall be retro-reflective to show the same colour, shape and message at night as they do in daytime. Reflective signs shall be "Diamond Grade".

Traffic signs shall be supplied and located to conform to the specifications of the latest edition of the "Manual of Uniform Traffic Control Devices for Canada" distributed by the Transportation Association of Canada (TAC).

Design and construction of roads shall include the design and application of pavement markings and hazard delineation markings in accordance with the most current standards contained in the Manual of Uniform Traffic Control Devices for Canada distributed by the Transportation Association of Canada (TAC).

Line painting shall be provided by the City at the developer's expense, unless otherwise approved.

7.17 Sidewalks, Curbs, Gutters and Walkways

.1 Curbs and Gutters

Urban roads shall be constructed with concrete curb and gutter on both sides of the road, unless otherwise noted on the applicable standard drawing cross-section. Local roads in single family/duplex developments shall have mountable curbs.

Where Major Flood Path routing dictates, the Consultant may propose non-mountable curbs on local roads, provided that pre-determined driveway accesses are incorporated into the design.

Medians shall be constructed with non-mountable concrete curb with an optional gutter.

The transition between mountable and non-mountable curbs shall be done through a minimum distance of 2.0 metres beginning at the end of the curb return on the road of lower classification.

The sub-base for the road shall be constructed a minimum 0.3 metres wider than the curb in order to provide support for the curb.

.2 Sidewalks and Walkways

Sidewalks shall be provided on highways within the lands being subdivided in accordance with the standards set out herein.

Without limiting the generality of the above sentence, the City Engineer may require:

- Sidewalks along a highway within the subdivision on which substantial pedestrian traffic is expected to be generated,
- Sidewalks along the side of a highway within the subdivision which fronts or abuts a school, park, recreation facility, public building or commercial development,
- Sidewalks on each side of an arterial, collector or local road within the subdivision, and
- Walkways within the subdivision to facilitate pedestrian movement such as connecting dead end roads, long roads (mid-block) or cul-de-sacs to other roads.

Sidewalks and walkways shall be designed using the following minimum design criteria.

- Sidewalks shall be continuous around curb returns and for a minimum of 3.0 metres after the curb return into roads not requiring sidewalks, ending with an asphalt letdown.
- The longitudinal grade of the sidewalk(s) shall be consistent with the grade of the road.
- All sidewalks adjacent to mountable style curbs shall be a minimum 150 millimetres thick. All sidewalks adjacent to barrier style curbs shall be a minimum 100 millimetres thick.
- All walkways shall be in accordance with the cross-sections shown on Standard Drawing R22. The type of walkway that is to be constructed will be specified by the City Engineer.
- Urban walkways shall be per Standard Drawing R21
- The maximum grade shall not exceed 12.0 percent, unless steps and handrails are provided.
- Walkways for pedestrian connectivity within a subdivision and walkways within a park shall be concrete.

7.18 Wheelchair Ramps

Wheelchair ramps are required at all intersections where sidewalks are constructed. The design for wheelchair ramps shall be in accordance with the Standard Drawing R16 and R17.

Where mountable curb is constructed, the back of the curb shall be sloped flush with the gutter (over an arc of 3 metres minimum) at all street corners to allow wheelchairs and scooters access to the walkway. The presence of mountable curb alone does not allow access to be achieved at these locations.

Special designs for assistance of the physically handicapped are encouraged.

A catch basin must be located so as to intercept road drainage in advance of the wheelchair ramp.

7.19 Handrails

All handrails shall be constructed and installed in accordance with Standard Drawing R23. Handrails are required for walkways and sidewalks where grades warrant such installations, or where steps are required.

Handrails may also be required along the top of major storm sewer headwalls, along walkways or sidewalks where there are steep or excessive side-slopes, or in any location as deemed necessary by the City Engineer, where the safety of pedestrians or the protection of the public so requires. If the slope of the ground adjacent to the walkway is greater than 3:1 and closer than 1.0 metre from the walkway or sidewalk, handrails shall be provided. Handrails shall be used on retaining walls with greater than 0.45 metre drop.

7.20 Appurtenances

The Consultant shall detail all appurtenances such as retaining walls, guardrails, handrails and fences on the design drawings. These structures shall be designed according to good engineering practice. Supporting material shall be submitted.

Utility Poles: The Consultant shall specify utility poles that require relocation prior to construction. The Consultant shall confirm the new pole location with the appropriate utility.

Underground Wiring and Gas Mains: The Consultant shall specify on the civil design drawing (Key Plan) the issued for construction designs supplied by BC Hydro, Telus, Shaw Cable, and Fortis BC for all underground wiring and gas mains that require relocation or are proposed, including connections to properties.

7.21 Scope

This specification governs the construction of roads, curbs, sidewalks, and appurtenances within the City.

7.22 Clearing

The full width of the roadway and shoulders shall be cleared of trees and brush. All topsoil and turf shall be removed for at least 2.5 metres clear of the curbs. Sufficient topsoil must be retained onsite for topsoil replacement on the boulevard.

The remaining portion of road allowance shall be cleared of stumps, rubble and loose rock, and rough graded. Finished grading, rolling and seeding of grass on established boulevards adjacent to new road construction shall be done upon completion of all construction.

7.23 Setting of Grades

Grade hubs will be set at 10 metre intervals or less on tangents and 5 metre intervals on curves, on both sides of the road and at the same chainage points. Hubs will be located so that they are not disturbed by construction equipment.

On horizontal curves the increased or decreased arc shall be calculated to compensate for the radius so that the hubs on both sides of the road will bear the same centre line chainage.

If the road will be super elevated it may be necessary to calculate the difference in elevation due to the offset of the hub to enable the sub-base to be graded. Care should be taken to ensure that this compensated elevation is not used when the concrete curbs are being formed.

Sturdy hubs of sufficient length to provide a firm footing shall be used, with nails driven in the top for fine alignment, and the hubs shall be suitably identified with chainage, cut or fill and offset to curb face. Cut or fill information will face the hub and will be related to the elevation of the design gutter line.

Crossheads may be erected at a suitable height at every station, clearly marked with the amount of cut or fill to finished grade. Cuts or fills should be adjusted to even vertical intervals above the required grade. Grades should be checked with a boning rod by sighting across the cross heads.

Alternate methods of layout and construction may be used provided that the curbs or centreline are within 15 millimetres of the design elevation and 30 millimetres of the design horizontal alignment.

7.24 Sub-grade Preparation

In cuts, the top 300 millimetres of the subgrade will be compacted to 95 percent Modified Proctor Density obtained by following ASTM Specification D1557, or the latest revision thereof.

The toe of the fill slope or the top of a cut slope shall not extend outside the right-of-way. The containment of these slopes may require the construction of retaining walls or the use of rip-rap, or the right-of-way could be widened.

Where the Consultant deems that the sub-grade is unsatisfactory, excavation will be required to an acceptable depth.

No topsoil, trees, stumps or organic matter will be buried in the sub-grade.

7.25 Sub-Base and Base Course Testing Procedure

For reconstruction of existing roads, the maximum seasonally adjusted design deflections (mean plus two standard deviations) of the Benkelman Beam tests shall be as follows.

	Classification	Minimum Granular Sub-Base Thickness (75 mm minus Pit Run) (mm)	Minimum Granular Base Thickness (20 mm minus Crushed Gravel) (mm)	Minimum Asphalt Thickness (mm)		Maximum Seasonally Adjusted Benkelman Beam Rebound Reading (mm)	
				Base	Surface	Granular Base	Finished Pavement
RC1	Local	200	100	50	--	3.40	1.50
RC2	Collector	300	100	50	35	2.20	1.20
RC3	Resort Collector	300	100	50	35	2.20	1.20
RC4	Urban Arterial	450	300	50	50	1.9	0.75
RC5	Rural Arterial	450	300	50	50	1.9	0.75
RC6	Downtown	300	100	50	35	2.20	1.20
RC7	Industrial	300	100	50	35	2.20	1.20
RC8	Lane	300	100	50	--		
RC9							

Recommended granular sub-base and base thickness are minimum requirements only. Site conditions may dictate greater thicknesses of granular material.

Where rebound readings are greater than values in the table above, the subgrade should be investigated for potential weak areas.

For construction of new roads and reconstruction of existing roads each finished course of sub-grade, sub-base and base shall be proof rolled, receiving complete coverage, using a single axle truck having an 8,000 kilograms (kg) rear axle load and a tire pressure of 550 kilopascals (kPa). Should any areas of rutting or displacement result, they shall be excavated and backfilled with approved material and re-compacted to the densities set out in this standard. Each refilled area shall be re-tested to confirm that the rutting and/or displacement have been eliminated.

Intermediate tests will be conducted on the sub-base immediately prior to the placement of road base material and on the road base immediately prior to paving. Results of the field density tests will be supplied to the Works Inspector as a quality control guide, but will not constitute acceptance or rejection of the work. All field densities shall be obtained by use of a nuclear densometer in accordance with ASTM Specification D2922, or latest revision thereof.

No base course gravel shall be placed until all underground services have been installed unless otherwise approved by the Works Inspector.

7.26 Construction Methodology

.1 Weather and Job Conditions

No construction shall be undertaken during heavy rain, snow or freezing conditions, unless approved by the City Works Inspector.

Granular aggregate shall not be placed upon a frozen, wet, muddy or rutted sub-grade, sub-base, or surface.

When the sub-grade or sub-base is soft due to excessive moisture, granular material for the base shall be hauled and placed in such a manner that no rutting or displacement of any lower layer occurs.

.2 Construction Thickness of Granular Courses

The crushed granular or pit-run base course and sub-base course shall be constructed to the thickness and dimensions specified on the Standard Drawings or as otherwise approved by the City Engineer.

Aggregates shall be delivered to the road bed as uniform mixtures and shall be spread in layers or windrows without segregation. Granular aggregate shall not be end-dumped from trucks and piled on the road bed.

If the sub-grade consists of cohesionless material, the geotechnical engineer may approve in writing that granular sub-base or base is dumped in piles and spread in sufficient quantity to stabilize the sub-grade.

Fly spreading from the tailgate of trucks may be permitted by the Consultant, provided that the work is well controlled and that no segregation occurs. If segregation occurs, the material shall be removed and remixed until it is uniform.

Material shall only be placed on a dry base and when weather conditions are suitable, except as directed by the Consultant.

.3 Construction of Crushed Granular Base or Granular Sub-Base

Where the required thickness is 150 millimetres or less, the aggregate base or sub-base may be spread and compacted in one layer. Where the required thickness is more than 150 millimetres, the aggregate shall be spread and compacted in two or more layers of equal thickness. The maximum compacted thickness of any one layer shall not exceed 150 millimetres. Each layer shall be spread and compacted in a similar manner.

Following spreading, the material shall be compacted to 95 percent Modified Proctor Density obtained by following ASTM Specification D1557, or the latest revision thereof.

The sub-base or base shall be constructed so that the final surface conforms to the design drawings for alignment, grade and cross section, to an accuracy of plus or minus 10 millimetres.

.4 Construction of 20 Millimetre Minus Crushed Granular Surfacing

Crushed granular surfacing shall not be spread until the base has been approved by the Consultant. If the finished surface of the base does not meet the requirements of these Standards and Specifications, but has been thoroughly compacted and should not be disturbed, the Consultant may order the surface of the base corrected to true cross section, alignment and grade within the specified tolerances by use of a leveling course of 20 millimetres minus granular surfacing aggregate.

The surfacing aggregate shall be spread in such a manner that the aggregate does not segregate. The thickness of the surfacing aggregate shall be uniform.

Following spreading, the material shall be compacted to 95 percent Modified Proctor Density in accordance with ASTM Specification D1557, or latest revision thereof.

The sub-base or base shall be constructed so that the final surface conforms to the design drawings and to the Standard Drawings for alignment, grade and cross-section, to an accuracy of plus or minus 10 millimetres.

.5 Compaction Method and Equipment

The compaction equipment used to obtain the specified density may be selected by the Contractor, but will be subject to review or change by the Consultant if the Contractor is unable to obtain the required density.

Compaction equipment shall meet the following minimum requirements.

- Three wheeled steel rollers shall have a loaded mass of not less than 10.9 tonnes, with a compression at the rear wheels of not less than 60.0 Newton millimetres (N/mm) of width.
- Segmented steel shell rollers shall have two rolls side by side each of a minimum width of 750 millimetres and minimum diameter of 1500 millimetres. The minimum loaded rolling mass shall be 13.6 tonnes.
- Vibratory rollers shall have a minimum steel drum diameter of 1150 millimetres, and a minimum drum width of 1500 millimetres, and shall be capable of bearing a load of 17.5 Newtons per millimetres (N/mm) of drum width.
- Pneumatic tired rollers shall be equipped with wheels that carry 13 x 24 pneumatic tires capable of being inflated to a minimum pressure of 825 kilopascals (kPa), and shall have a loaded mass such that all wheels carry a minimum proportional load of 31.14 kilonewtons (kN).

Notwithstanding the above requirements, the Consultant may give approval for the use of new or alternative compaction equipment, if such equipment can provide equal or superior compaction performance.

Base, sub-base and surfacing aggregates may be watered by the Contractor, as required, in order to obtain the specified density. The use of City water to assist compaction may or may not be permitted, depending on water restrictions in effect at the time. The Contractor must have a Hydrant Use Permit to use any City hydrant as a water source.

7.27 Import Fill Materials

In fill areas, the subgrade will be constructed of granular material placed in layers not exceeding 150 millimetres and compacted to 95 percent of the Modified Proctor Density obtained by following ASTM Specification D1557, or the latest revision thereof. Imported granular fill shall consist of well graded granular material, with not more than 8 percent passing the 0.075 millimetre sieve, no stones larger than 300 millimetres in diameter and no stumps, roots, organic or other deleterious material.

7.28 Base Course and Sub-Base Materials

.1 General

The aggregates for bases and subbases shall be from an approved source and shall be free from clay lumps, silt, rock, organics or other deleterious matter. Material that is stockpiled prior to use shall be handled in a manner to avoid segregation. Care shall be used subsequently in hauling the material to the placement area. The material shall be placed, constructed accurately to the designated line and grade, and thoroughly compacted.

.2 Sub-Base Materials

The sub-base will be constructed of granular material placed in layers not exceeding 150 millimetres and compacted to 95 percent of the Modified Proctor Density obtained by following ASTM Specification D1557, or latest revision thereof.

Sub-base materials when tested in accordance with ASTM Specification C136 shall have a gradation falling within the following limits:

U.S. Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
75 millimetres	100
25 millimetres	50 - 85
0.150 millimetre	0 - 15
0.075 millimetre	0 - 8

.3 Base Course Materials

Aggregates shall be composed of inert, durable fragments, free from an excess of flat or elongated particles and uniform in quality. Soundness testing may be requested by the Consultant in the absence of satisfactory performance records for the aggregates' particular source. Such testing shall be in accordance with ASTM Specification C88. Aggregates so tested shall be considered satisfactory if the loss of five (5) cycles does not exceed 20 percent for coarse aggregate or 25 percent

for fine aggregate. Base course materials when tested in accordance with ASTM Specification C136 shall have a gradation falling within the following limits:

U.S. Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
19 millimetres	100
12.5 millimetres	75 - 100
9.5 millimetres	60 - 90
4.75 millimetres	40 - 70
2.36 millimetres	27 - 55
0.850 millimetre	10 - 35
0.300 millimetre	5 - 20
0.075 millimetre	2 - 8

In the crushed material, at least 50 percent by numerical count of all coarse particles retained on the 4.75 millimetre sieve shall have at least one fractured face or shall be naturally angular with sharp edges. Reclaimed Asphalt Product (RAP) may be used for all roads except arterials, in conjunction with crushed aggregate to produce a blended product conforming to the gradation specified above. RAP shall be uniformly crushed, screened and blended. Maximum RAP content shall be 15 percent by mass of the finished product.

7.29 Asphalt Concrete Materials

.1 Scope

This specification governs the production, placing and compaction of hot mix, and hot laid asphalt concrete.

.2 Special Mixes

For special purposes such as patching, padding, leveling; paving of shoulders, boulevards, sidewalks and small parking lots; and the construction of curb or curb and gutter, the requirements of this specification, particularly with respect to the composition of the mixture, gradation of coarse aggregate and thickness of courses, may be subject to amendment by the Works Inspector.

.3 Aggregate Materials for Asphalt

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

Testing shall be to ASTM C136 and ASTM C117. Gradation shall be within the following limits:

U.S. Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
25 millimetres	100
19 millimetres	100
12.5 millimetres	84 - 95
9.5 millimetres	73 - 90
4.75 millimetres	50 - 75
2.36 millimetres	35 - 57
1.18 millimetres	26 - 45
0.600 millimetre	18 - 34
0.300 millimetre	10 - 26
0.150 millimetre	6 - 17
0.075 millimetre	3 - 7

All sample gradations shall fall within the gradation limits and any deviations between the samples and the project gradation curve, based on the mix design, shall not exceed the following limits:

U.S. Standard Sieve Size	Maximum Permissible Tolerance (Percent by Weight Passing)
4.75 millimetre sieve and larger	+/- 4.5
2.36 millimetre sieve	+/- 4.0
0.600 millimetre sieve	+/- 3.5
0.300 millimetre sieve	+/- 2.5
0.150 millimetre sieve	+/- 1.5
0.075 millimetre sieve	+/- 1.0

A minimum 70 percent of the material retained on the 4.75 millimetre sieve shall have at least two fractured faces. Material shall be divided into ranges using methods specified in ASTM C136. Percentages shall be determined by particle count.

Shale content by weight shall not exceed three percent in the lower course, or 1.5 percent in the surface course.

Aggregate short of material passing the 0.075 millimetre sieve shall have approved mineral filler added. Mineral filler shall be only material passing the 0.075 millimetre sieve and shall be finely ground particles of limestone, hydrated lime, Portland cement or other approved non-plastic materials when tested in accordance with ASTM D4318.

The following tests may be required to confirm that the gravel source is suitable for use in the production of aggregate for asphaltic concrete.

- Magnesium Sulphate soundness to ASTM C88
Maximum loss by mass after 5 cycles is:
Coarse aggregate = 15 Percent
Fine aggregate = 18 Percent
- Los Angeles Abrasion to ASTM C131
Maximum loss by mass = 25 Percent
- Absorption of aggregate to ASTM C127
Maximum water absorption by mass = 2 Percent
- Sand Equivalent to ASTM D2419
Minimum = 40
- Petrographic Examination to ASTM C295

.4 Asphalt Cement

Asphalt cement shall be in accordance with CAN/CGSB - 16.3, be prepared from the refining of petroleum oils, be homogenous and free of water, and not foam when heated to 175°Celsius. Asphalt shall conform to the following specifications.

Test Designation	Minimum	Maximum	Units
ASTM D5 - Penetration at 25°Celsius (100 grams for 5 seconds)	80	100	0.1 millimetre
ASTM D2171 - Absolute Viscosity at 60°Celsius	550	750	
ASTM D113 - Ductility at 25°Celsius	100	-	centimetre
ASTM D2042 - Solubility in trichloroethylene, min.	99.0	-	Percentage
ASTM D92 - Flash point by Cleveland Open Cup	230	-	°Celsius
ASTM D1754 - Loss on heating	-	0.85	Percent
ASTM D5 - Penetration at 25 degrees Celsius after loss on heating 100 grams for 5 seconds	47	-	Percent of original

.5 Asphalt Concrete Mix Design Criteria

Asphalt concrete mix design shall conform to the following specifications as based on the Marshall method of design (ASTM D1559).

Parameters	Local	Collector /Downtown Core	Arterial	Parking Lots
Number of blows on each face:	75	75	75	50
Minimum percent voids in mineral VMA aggregate, based on bulk specific gravity				
19 millimetre aggregate	14	14	14	14
12 millimetre aggregate	-	-	-	15
Percent Air Voids in Compacted Mixture (surface and lower course)	3 - 5	3 - 5	3 - 5	3 - 5
Minimum modified Marshall load, for 80 - 100 at 60°Celsius	4500	7000	7000	4500
Flow Index (units of 0.25 mm)	8 - 16	8 - 16	8 - 16	8 - 16
Minimum index of retained stability after immersion in water at 60°Celsius for 24 hours	75 Percent	75 Percent	75 Percent	75 Percent

Asphalt content in mix shall be within +/- 0.25 percent of that specified in the mix design.

7.30 Asphalt Concrete Paving

.1 Installation of Asphalt

Responsibility for Base

The Contractor shall conduct a proof roll test on the base course prior to commencing paving operations to ensure that it is properly prepared to receive the pavement. If pavement fails due to failure of the base, the base shall be replaced. Prior to delivery of the asphalt mixture, the prepared base shall be cleaned of all loose or foreign material. Prior to placement of the mixture the base shall be approved by the Works Inspector.

Traffic Control

The Contractor shall be responsible for traffic control during all operations, and shall not unduly disrupt normal traffic movement. All traffic control methods shall satisfy the requirements of the *Motor Vehicle Act* and *MOTI Traffic Control Manual for Work on Roadways*.

Under no circumstances shall the Contractor fully close any road without the written consent of the City Engineer. Failure to comply with this requirement will result in the issuance of a stop work order.

Traffic shall not be permitted on the finished pavement until it has cooled to atmospheric temperature.

Cutting and Removal of Existing Asphalt

Existing pavement that, in the opinion of the Works Inspector, must be removed shall be removed by the Contractor. Removal shall consist of saw cutting the pavement on the perimeter of the area that is to be removed to produce a neat vertical cut face and then disposal of the unwanted pavement.

Adjustment of Grade of Appurtenances

The Contractor shall adjust manholes, catch basins, valves, etc. to the proper finished grade at the time of paving.

Primer

Primer shall only be applied when directed by the Works Inspector. Primer shall be applied on the granular base when the surface is dry or slightly damp and the air temperature above 10° Celsius. The primer shall be uniformly applied with an approved pressure distributor at a rate of 1.15 to 1.52 litres per square metre. The temperature of the material shall be such that the kinematic viscosity is between 50 and 150 centistokes. Traffic shall be kept off primed areas until the primer has been absorbed. Additional primer shall be applied to areas requiring priming to fill voids, and to coat and bond particles, or as directed by the Works Inspector. If the primed surface is loose, the Works Inspector may require rolling of the surface with a pneumatic-tired roller.

The primer should be entirely absorbed by the base course. If it is not absorbed within 24 hours after application, sand shall be spread over the surface to blot the excess asphalt. Care shall be exercised to prevent over-priming. The prime shall be fully set before placing the surface treatment.

Tack Coat

Bituminous tack coat shall be grade SS-1 or SS-1h asphalt emulsion, in accordance with CGSB 16.2-M89, or as approved.

The tack coat shall be applied to all existing asphaltic concrete that is to be overlain, to the edge of the existing asphaltic concrete, and to the edge of curbs and structures

where these items will be in contact with the new asphaltic concrete pavement. The tack coat shall be applied only when the surface is dry and clean, and the air temperature is over 10° Celsius.

The existing asphaltic concrete surface shall be thoroughly cleaned by a power-driven sweeper immediately prior to applying the tack coat.

The tack coat shall be uniformly applied with an approved pressure distributor at a rate of 0.25 litres per square metre. The temperature of the material shall be maintained between 32° Celsius and 38° Celsius.

Traffic shall, where possible, be kept off tack coat areas. If traffic has been allowed on the tack coat, these areas shall be thoroughly cleaned by a power driven sweeper immediately prior to laying asphaltic concrete.

No hot mix shall be placed on the tack coat until it has dried to a proper condition of tackiness, as determined by the Consultant.

Work shall be planned so that no more tack coat than is necessary for the day's operation is placed on the surface.

Transportation of Hot Mix

The mixture shall be transported from the paving plant to the work in vehicles with tight metal boxes, previously cleaned of foreign material.

Vehicles shall be suitably insulated, and each load covered with canvas or other suitable material of sufficient size to protect the load from adverse weather conditions. Inside surfaces of truck boxes shall be lubricated with a suitable thin layer of oil or soap. Excessive use of lubricant will not be permitted. Trucks used to transport hot mix shall be equipped with tarpaulins.

Placing and Compacting Pavement

Placing:

Surfaces onto which bituminous concrete pavement is placed shall be dry, above five degrees Celsius, and cleaned of all loose and foreign material. Mixtures shall normally not be laid when the atmospheric temperature is less than five degrees Celsius and falling. The mixture at time of placing shall not be less than 120 degrees Celsius, or greater than 140 degrees Celsius.

An approved, self-propelled mechanical paver shall be used to spread the mixture to the specified thickness. The rate of delivery shall be such that

stoppage of the paver is minimized. The Contractor may use such methods as approved by the Works Inspector in narrow areas, irregular sections, intersections, turnouts or driveways, where it is impractical to spread with a paver. Minor inequalities in spreading and shaping the paved surface adjacent to structures such as manholes, catch basins or valves shall be performed by skilled workers to a condition satisfactory to the Works Inspector.

Joints made from new to existing pavement are to be done at 45 - 75 degrees to the road rather than 90 degrees. This will help to reduce awareness of the joint by vehicles.

Compacting:

Compaction shall commence immediately after bearing capacity of the course is adequate to support compaction equipment without undesirable displacement or cracking.

In general, compaction shall be performed in the following manner.

Transverse Joints - Transverse joints shall have a vertical face, and shall be carefully constructed and thoroughly compacted to provide a smooth riding surface over the joint. Horizontal alignment of joints shall be straight-edged to ensure smoothness. Rolling of transverse joints shall be performed immediately after raking is completed.

Longitudinal Joints - Longitudinal joints shall have a vertical face and shall be rolled directly behind the paving operation. Joints shall be rolled by passing the roller on the previously compacted lane letting one wheel project 100 - 150 millimetres on the new lane. A minimum of two passes are required to thoroughly compact this narrow strip down to, and even with the existing lane.

Edges - Pavement edges shall be rolled concurrently with the longitudinal joints and shall not be exposed more than 15 minutes before rolling. After longitudinal joints and edges have been compacted, longitudinal rolling shall start at the edge and progress to the centre of the pavement, overlapping at least one-half the width of the roller with each successive pass. On super-elevated curves, rolling shall begin on the low side and progress to the high side.

Initial Rolling - Initial rolling shall immediately follow the rolling of longitudinal joints and edges. The roller shall be operated as close to the paver as necessary to obtain adequate density without causing undue displacement. Initial rolling shall be performed by steel wheel rollers.

Secondary Rolling - Secondary rolling shall be performed by pneumatic tire rollers, follow the initial rolling as closely as possible, and be continuous until the mix has been thoroughly compacted.

Finish Rolling - Finish rolling shall be by steel wheel roller to remove all marks left by pneumatic rolling. Finish rolling shall be accomplished with the minimum number of passes required to produce a satisfactory surface. Finish rolling shall start longitudinally at the higher edge and proceed toward the lower edge.

Rollers:

Unless otherwise directed by the Works Inspector, the Contractor shall furnish a minimum of two self-propelled rollers to roll and compact the asphaltic concrete mixture. One roller shall be an approved self-propelled smooth steel wheeled type, capable of exerting a compression on the main roll of at least 4000 kilograms per metre of width. The other roller shall be an approved self-propelled pneumatic tired type weighing not less than 10 tonnes.

The wheels of the pneumatic tired roller shall be so constructed that the contact pressure can be uniform for all wheels. The tire pressure of the several tires shall not vary by more than 3.5 grams per square metre.

All rollers shall be in good condition and capable of reversing without backlash.

Maximum speed for initial rolling shall not exceed 5 kilometres per hour, and for subsequent rolling, 8 kilometres per hour. Speeds shall be maintained at all times such that displacement of asphaltic concrete does not occur. During the rolling operation, roller wheels shall be kept moist with only enough water to avoid picking up material. Fuel oil, lubricating oil, or kerosene shall not be permitted as lubricants for the surface of the roller wheels.

The line of rolling shall not suddenly change, and the direction of rolling shall not suddenly reverse. Pronounced changes in direction shall be made on stable material.

Irregularities shall be removed to a depth of one pavement layer and replaced with fresh hot mix compacted to conform to the surrounding area.

The finished surface shall be smooth and true to grade. The finished surface shall show no irregularities exceeding 6.5 millimetres when measured with a five metre straight edge at right angles and parallel to the centreline.

Finish Against Structures

The finished elevation of compacted asphalt adjacent to structures shall be at least flush with and not more than 6.5 millimetres above the finished elevation of the structures. Structures include, but are not limited to curbs, gutters, manhole lids, valve boxes and survey monuments.

Cleaning

The Contractor shall thoroughly remove any asphalt or other materials contaminating culverts, catch basins, curbs, gutters and other structures that may have resulted from the performance of the work.

.2 Asphalt Inspection and Testing

Testing Laboratory

The City Engineer may appoint an independent testing laboratory to provide inspection services, or to conduct materials testing to ensure compliance with the specifications.

Weather

Asphalt concrete pavement shall not be placed during wet conditions or when the atmospheric temperature is less than 5° C and falling.

Inspection

Plant and Equipment

The Contractor shall at all times provide access to, and allow for inspection of the plant and all equipment during the work. Any deficiencies in plant or equipment, during either preparation of materials or subsequent construction, shall be reported to the Contractor immediately and corrective measures shall be taken by the Contractor.

Should the Contractor not take remedial action to any request arising from the above paragraph, the City Engineer may order a stoppage of the work until the necessary remedial action has been taken by the Contractor.

Construction

During construction, the Contractor shall at all times comply with the methods of construction outlined in these specifications.

Should the Contractor not take remedial action to any request of the Consultant, the Consultant may order a stoppage of the work until the necessary remedial action has been taken by the Contractor.

The requirements of the previous paragraph shall in no way relieve the Contractor of the responsibility for obtaining the required degree of compaction and finish without direction from the Consultant.

Deficiencies in the finished pavement shall be corrected by the Contractor, if such deficiencies are at variance with these specifications.

Testing

Aggregates

One aggregate gradation test shall be carried out either for each 300 tonnes of production or a minimum of once per day. (ASTM C 136)

Additional testing shall be performed upon the request of the City Engineer.

Asphaltic Concrete

One Marshall test consisting of three briquettes for every three hundred tonnes of production, or a minimum of two tests per day, shall be performed to determine the following per ASTM D1559.

- Marshall stability
- Specific gravity
- Air voids and voids in mineral aggregate (VMA)
- Flow index
- Asphalt content extraction

Compaction

Upon completion of the asphalt paving operation, one core from each 750 square metres of finished pavement shall be obtained at locations determined by the geotechnical engineer for the purpose of determining the asphalt concrete density in accordance with ASTM D1559 and the asphaltic thickness. A minimum of four cores shall be obtained to determine asphalt compaction.

Final compaction results shall be expressed as a percentage, defined as follows.

$$\frac{\text{Density of sample}}{\text{Marshall Density}} \times 100$$

For compaction testing purposes, the materials testing representative shall remove samples carefully from the completed pavement. Holes made by removal of such samples shall be carefully filled by the Contractor with the appropriate mixtures and thoroughly compacted to conform in every way with the adjoining undisturbed pavement.

Test result data will be subject to statistical analysis. The final compaction will not be satisfactory unless the mean of the test result data is above an acceptable minimum, and the standard deviation of the test result data is less than an acceptable maximum. The acceptable limits are as follows.

For All Classes of Pavement

Minimum Mean Compacted Density (Percentage)	Maximum Acceptable Standard Deviation of Test Data
97	1.25

If test results fail to satisfy the above compaction requirements, the sections with inadequate compaction shall be re-compacted, or rejected and removed, as may be directed by the City Engineer.

Full testing may be required during the first few days of paving to determine, and thus control the asphalt quality and the construction procedure. As paving progresses, sufficient tests are required to confirm that uniformity of results is maintained.

If test results indicate non-compliance with these specifications, the pavement may be rejected by the City Engineer. Pavement thus rejected shall be removed and replaced at the Contractor's expense.

Failure to Meet Test Requirements

If tests required by the Consultant fail to meet the requirements of these specifications, the City Engineer may direct re-testing, as deemed necessary.

Inspection and Testing Costs

If an independent certified materials testing company is appointed by the City Engineer for the purpose of quality control, the costs of inspection and testing services provided by the company shall be paid by the Applicant.

7.31 Sidewalks, Curbs and Gutters

.1 General

Concrete for sidewalks, curbs, gutters and walkways shall conform to the requirements outlined in these Standards and Specifications. This Section must be referenced and interpreted simultaneously with all other sections pertinent to the works described herein. This specification is not to be used for any structural facilities such as buildings, bridges, retaining walls or any similar structure requiring site specific structural engineering design.

Except where specifically stated otherwise, all materials and methods in this Section shall conform to the requirements of the latest version of CAN/CSA-A23.1.

.2 Materials

Mix Elements

- Cement: Portland cement shall conform to the requirements of CAN/CSA-A5.

- Water: Mixing water for concrete shall be clear and free from injurious amounts of oil, acid, alkali, organic matter, sediment or any other deleterious substance. (reference standard CAN/CSA-A23.1)
- Aggregates: Fine and coarse aggregates shall conform to CAN/CSA-A23.1.
- Admixtures:

Air Entraining Admixtures shall conform to the requirements of CSA Standard A266.1.

Water Reducing Agents shall conform to the requirements of ASTM Specifications C494 (Type A). Accelerating or retarding admixtures of Types B, C, D and E shall only be used if approved by the Works Inspector.

Fly Ash shall conform to the requirements of ASTM Specification C618 - Class F. Fly ash shall only be used if approved by the Works Inspector.

Concrete Mix Design

All concrete shall be controlled concrete in accordance with CSA Standard A23.1, as defined by the National Building Code. Concrete mixes shall be proportioned in accordance with CSA Standard A23.1.9.2.1, Alternative No. 1, and the requirements of paragraph 1.0.4. Batching of materials for concrete shall be in accordance with CSA Standard A23.1.11.2.

The mix design for concrete shall conform to one of the following.

- Hand formed and hand placed concrete
Cement: Type 10 or 30
Slump: 80 +/- 20 millimetres
Air Entrainment: 5 to 8 percent
Maximum Aggregate Size: 19 millimetres
Minimum Cement Content: 335 kilogram/cubic metre (m³)
Minimum 28 day compressive strength: 30 megapascals (MPa)
- Extruded concrete
Cement: Type 10 or 30
Slump: 0 - 25 millimetres
Air Entrainment: 6 to 9 percent

Maximum Aggregate Size: 19 millimetres

Fineness modulus: 2.2 to 3.1

Minimum Cement Content: 335 kilograms/cubic metre (m³)

Minimum 28 day compressive strength: 30 megapascals (MPa)

Curing Compound

The curing compound shall be spray-applied, liquid type conforming to ASTM C309, containing a fugitive dye.

Expansion Joints

Expansion joints shall be pre-formed 13 millimetre thick bituminous fiber board conforming to ASTM Specification D-1751, with the same shape as the concrete cross sections.

Isolation Joints

Longitudinal isolation joints shall be pre-formed 6 mm thick bituminous fiber board conforming to ASTM Specification D-1751 pre-cut for the required cross sections.

Reinforcing Steel

Reinforcing steel shall be intermediate grade steel conforming to CSA G30.18, Grade 400. Steel shall be free of rust, scale or other deleterious substances that may affect the bond with the concrete.

.3 Sub-grade, Sub-Base and Base Preparation

The base structure for all concrete curb and sidewalk shall be roll-tested in the presence of the Works Inspector prior to the placement of the concrete.

.4 Formwork

Steel forms shall be of approved design, and are to be free from twists and defects. Wood forms shall be select dressed lumber, straight and free from defects, and thoroughly cleaned.

Flexible forms are to be used for all curves with a radius less than 60 metres.

After obtaining the Works Inspector's approval of the compacted base, forms shall be set to the required alignment and grade, free of waves and irregularities. Special forms shall be set around catch basins, manholes, poles and other obstructions.

All forms shall be lightly treated with an approved form release agent prior to the placement of concrete.

Face of curb forms shall be removed after the initial set. Adequate care shall be taken in removing forms to avoid spoiling or marring the concrete. Any required patching shall be started immediately after form removal.

Immediately after form removal and/or patching, the exposed surfaces shall be sprayed with membrane curing material.

.5 Placing of Concrete

All concrete shall be mixed and delivered in accordance with CSA Standard A23.1.

After mixing, the concrete shall be transported rapidly to the job site and shall be delivered as close as possible to the point of deposit. Rehandling concrete will not be permitted. All concrete must be placed within 1.5 hours of the batching time.

The granular base shall be pre-wetted prior to the placement of concrete.

Concrete operations shall be continuous until the section, panel, or scheduled pour is completed.

The concrete shall be placed in such a manner as to prevent separation of the components. Special care shall be taken to place the concrete against the forms, particularly in corners, in order to prevent voids, rough areas and honey combing.

The concrete shall be placed to the full specified depth. After spreading, the concrete shall be struck-off and compacted by means of an approved screed. The technique and use of vibrators or vibrating screeds shall be at the discretion of the Consultant.

Freshly placed concrete shall be protected in an approved manner against damage from the weather and construction operations.

Concrete shall not be placed during wet or cold weather unless special precautions are taken. Concrete shall be kept at a temperature of not less than 13° Celsius for at least 72 hours following placement.

.6 Finishing

All sidewalks, curbs and gutters shall be constructed to conform to the standard drawings and the design drawings, and shall satisfy the following.

Sidewalks

After placing, the concrete shall be adequately worked with magnesium or wood float trowels to a smooth finish, and then brushed with a broom to provide a uniform non-skid surface in accordance with the pattern shown on the standard drawings.

Under no circumstance shall the concrete be overworked by troweling, dusted with dry cement, or finished with a mortar coat. If there is evidence of concrete bleeding, finishing shall cease until the excess water has evaporated, to the satisfaction of the Consultant. Failure to comply with the above will result in complete replacement of the sections involved.

Driveway and lane crossings and pedestrian ramps shall be finished in accordance with the applicable standard drawing.

The finished grade of concrete sidewalks shall be flush with the finished elevation of all valves, manholes and service boxes.

After troweling, the surface grade along the lip of the gutter shall be checked by the Contractor with straight edges, and shall achieve an accuracy of plus or minus 10 millimetres in 3 metres.

Concrete Curb and Gutter

Concrete curb and gutter shall have a steel trowel finish. The completed surface shall have a dense uniform finish, free of blemishes.

The finish on curbs shall be within 5 millimetres of the design grade and cross-section when measured with a 3 metre straight edge.

.7 Joints

For sawed joints, saw cuts are to be made with a special concrete saw capable of producing a true straight joint of constant depth.

The work shall end at a control or expansion joint. The joint is to be sawn to a depth of 22 millimetres minimum and neatly hand chiseled.

Control Joints

For sidewalks, soft troweled "Ped-friendly" control joints shall be extended across the full width of the sidewalk at a maximum of 3 metre intervals.

In curb or curb and gutter, control joints shall be constructed at a maximum spacing of 3 metres. They shall match the control joints of the abutting sidewalk.

Control joints shall be cut to the depth shown on the applicable standard drawing and shall not exceed 7 millimetres in width.

The edges of the joint shall be rounded off with an edger having the arc of a circle with a 7 millimetre radius while the concrete is still pliable.

Expansion Joints

Transverse expansion joints shall be formed at both ends of curb returns at a maximum spacing of 9 metres for both sidewalks and curb and gutter at each end of driveway crossings and at tangent points on circular work. Expansion joints shall be extended through the full depth of the concrete.

Isolation Joints

Form isolation joints around poles, hydrants, manholes and all structures or fixed objects located within the concrete section by using approved joint filling material.

Form longitudinal isolation joints between sidewalk and abutting curb and gutter, and abutting utility structures using 13 mm approved joint filler material.

Dummy Joints

Scoring lines or dummy joints 13 mm in depth and 7 mm in width will be cut in sidewalk sections only every 1.5 metres in between the control joints. The edge of the joint shall be rounded off with an edger having an arc of a circle of 7 mm radius.

.8 Protection of Work

All concrete shall be protected during cold and hot weather in accordance with CSA A23.1.

If required, the surface of the concrete shall be protected by an approved membrane curing material applied to the entire exposed surface of the concrete immediately after the concrete has received its finish treatment. The curing compound shall meet the requirements of ASTM C309.

The membrane material shall be applied uniformly per the manufacturer's recommendations. The compound when applied to a new concrete surface at the specified rate of application shall present a uniform appearance and shall effectively obscure the original colour of the concrete.

The Contractor shall ensure that the quality of the product remains intact and the works are protected until substantial completion.

.9 Inspection and Testing

All required sampling, preparation of specimens and testing shall be performed by an independent certified materials testing agency. If initial testing indicates inadequacies, additional testing shall be required.

The certified testing company shall perform the following tasks.

- Approve all mix designs
- Supply cylinder moulds (150 x 300 millimetres), sample the concrete, make and cure test cylinders and perform compressive strength tests in accordance with CSA Standards A23.2.13 and A23.2.14.
- Conduct slump tests and air content tests in accordance with CSA Standards A23.2.18 or A23.2.19 and A23.2.20.
- Take one test cylinder for each 150 lineal metres of concrete work or a minimum of three cylinders for concrete placed on any given day, per the CSA approved standard, ensuring separate tests for each mix, and separate tests for each day of production.
- The City Engineer may reduce the number of test cylinders taken for minor pours or pours not of structural significance.
- A compression strength test of one cylinder of each set shall be performed at the test specimen age of seven days. Copies of these test reports shall be forwarded to the Works Inspector and concrete supplier within fourteen days of concrete placement.
- Compression strength tests of the remaining two cylinders of each set shall be performed at the test specimen age of twenty-eight (28) days.
- The 28-day strength test shall be defined as the average compressive strength of the two test specimens. Copies of these test reports shall be

forwarded to the Works Inspector and concrete supplier within thirty-five (35) days of concrete placement.

- The strength of the concrete shall be considered satisfactory if the averages of all sets of three compressive strength tests equal or exceed the specified strength and no individual test is more than 3.45 megapascals (MPa) below the specified strength.

.10 Failure to Meet Test Requirements

If the results of tests indicate that the concrete is not of the specified quality, the City Engineer can enforce the provisions of CSA Standard A23.1.10.6. Should additional testing indicate that the concrete is not of the specified quality, the concrete in question shall be removed at the City Engineer's request.

.11 Clean -Up

All surplus material, tools, temporary structures, debris, dirt and rubbish shall be promptly removed immediately following completion of the construction work.

The site shall be left clean and tidy to the satisfaction of the Works Inspector.

7.32 Signs, Posts and Line Painting

Signs will be supplied and installed by the City at the developer's expense, unless otherwise directed by the Works Inspector.

Street name and regulatory signs shall be located as shown on the design drawings and as directed by the Consultant. All signs shall be mounted approximately at right angles to the direction of, and facing the traffic they are intended to serve, except in the case of 'No Parking' signs.

Sign posts shall be installed in accordance with the applicable standard drawing. Anchor posts shall be provided for sign base installation. Drive rivets shall be aluminum and used for attaching signs to their supports to avoid discoloration.

Street name and regulatory sign posts and anchors shall be roll formed from strip steel (structural quality) in accordance with ASTM A446 Grade A. The posts shall be 12 gauge (3 millimetres) galvanized square tubing with perforations (12 millimetre diameter holes at 50 millimetre O.C. on four sides).

Anchor bases shall be double sleeved consisting of a 0.90 metre base and a 0.45 metre sleeve.

Line painting will be by the City at the developer's expense unless otherwise approved.

All marking paint shall be pre-qualified according to the Ministry of Transportation and Infrastructure (MOTI) qualification procedures and test methods. Marking paint shall be suitable for spray application at a temperature of 50° Celsius +/- 5° to asphalt or concrete pavements and shall meet the MOTI General Specifications for Highway Construction Section 321 – Traffic Paint.

The paint shall be used with overlay glass reflectorizing beads. Paint shall not have any 'Premix' beads. Reflectorizing glass beads shall conform to the MOTI Specifications for Glass Beads. All crosswalks, stop bars, dashed lane lines, white solid storage bay lane lines, continuity lines, guiding lines and traffic arrows shall be thermoplastic with a minimum thickness of three millimetres.