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Commercial (two lanes + parking)	R4-XS1
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9.01 SCOPE

- .1 In general, streets shall be designed in accordance with the "Manual of Geometric Design Standards for Canadian Roads and Streets", distributed by the Transportation Association of Canada (TAC).

9.02 MINIMUM WIDTH OF RIGHT-OF-WAY

<u>Road Class</u>	<u>Min R/W Width (m)</u>	<u>STD. DWG No.</u>
Urban Arterial	26.0 to 28.7	R1-XS1, R1-XS2
Major Collector	25.0 to 27.5	R2-XS1, R2-XS2
Minor Collector	25.0	R3-XS1
Commercial/Cul-de-sac	22.0	R4-XS1, R4-CU1, R4-CU2
Industrial/Cul-de-sac	22.0	R5-XS1, R5-CU1, R5-CU2
Neighbourhood Collector	20.0	R6-XS1
Urban/Rural Local/Cul-de-sac	16.5 to 20.0	R7-XS1 to R7-XS5, R7-CU1 to R7-CU4
Lane	7.0	R8-XS1
Half Road Section	>12.5	R9-XS1

(REVISED NOVEMBER 2009)

- .2 Where urban local roads are constructed in a half road right-of-way, the right-of-way shall be not less than 12.5 m wide. **(REVISED NOVEMBER 2009)**
- .3 In hillside locations where the land slope exceeds ten percent (10%) the minimum width of right-of-way shall be 20 metres. Refer to the City of Nanaimo Development Services Steep Slope Guidelines. **(REVISED NOVEMBER 2009)**
- .4 For all other Road Classes, the minimum rights-of-way shall be as per the respective Standard Drawing.

9.03 MINIMUM WIDTH OF PAVEMENT

<u>Road Class</u>	<u>Min R/W Width (m)</u>	<u>STD. DWG No.</u>
Urban Arterial	17.4 to 20.1	R1-XS1, R1-XS2
Major Collector	15.6 to 18.9	R2-XS1, R2-XS2
Minor Collector	14.2	R3-XS1
Commercial/Cul-de-sac	14.2	R4-XS1, R4-CU1, R4-CU2
Industrial/Cul-de-sac	14.2	R5-XS1, R5-CU1, R5-CU2
Neighbourhood Collector	12.2	R6-XS1
Urban Local/Rural Local/ Cul-de-sac	7.2 to 10.0	R7-XS1 to R7-XS5, R7-CU1 to R7-CU4
Lane	5.7	R8-XS1
Half Road Section	Depends on specific cross section	R9-XS1

(REVISED NOVEMBER 2009)

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- .2 Where urban local roads are constructed in a reduced road right-of-way, in no case shall the pavement width be less than 7.5 m with concrete curb along at least one side of the right-of-way. On pavement edges where concrete curb is not required, a temporary 100 mm asphalt curb shall be provided for drainage and traffic control. Reduced right-of-way road construction shall be subject to approval of the City Engineer. **(REVISED NOVEMBER 2009)**
- .3 For all Road Classes, the minimum width of Pavement shall be as per the standard drawings.

9.04 DESIGN CROSS SECTIONS

- .1 All road cross sections shall conform to the Standard Drawings unless otherwise approved by the City Engineer.
- .2 Centre medians for divided roads shall conform to Standard Drawing No. R12-ME1. **(REVISED NOVEMBER 2009)**
- .3 Alternate sidewalk location to provide a boulevard shall conform to Standard Drawing No. R10-XS1. **(REVISED NOVEMBER 2009)**

9.05 DESCRIPTION OF ROAD CLASSES

.1 Rural Local:

The rural local roads classification applies to roads serving rural parcels of land (0.8 ha or larger) and not designated as an arterial or collector road.

.2 Urban Local:

Urban local streets are not intended to move large volumes of traffic. A local street primarily carries traffic with an origin and/or destination along its length. It is not intended to carry through traffic other than to immediately adjoining streets. Normally urban local streets serve only residential areas.

.3 Urban Local (Low Volume):

The Urban Local (Low Volume) street classification has similar requirements to Urban Local Streets but is to be applied to short cul-de-sacs and crescents serving residential areas.

.4 Neighbourhood Collector: **(REVISED NOVEMBER 2009)**

The neighbourhood collector provides traffic and land service to connect local roads to urban collectors. This classification provides the same service as local roads but provides for higher volumes of traffic by providing more width to reduce conflict with on-street parking. **(REVISED NOVEMBER 2009)**

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.5 Minor Collector: **(REVISED NOVEMBER 2009)**

Minor collector streets provide traffic and land service. The function of this type of street is to carry traffic from local roads to major roads. Urban minor collector roads include two vehicle through lanes and may include turning lanes. Full access to adjacent properties is generally allowed on minor collectors with some restrictions at intersections. **(REVISED NOVEMBER 2009)**

.6 Major Collector: **(REVISED NOVEMBER 2009)**

Major collector streets provide traffic and land service. The function of this type of street is to carry traffic from local roads to arterial roads. Urban major collector roads include up to four vehicle through lanes, and may include turning lanes. Direct access to adjacent properties is minimized with adequate separation from intersections. **(REVISED NOVEMBER 2009)**

.7 Urban Arterial

Urban arterial streets carry traffic between the principle areas of traffic generation. They are intended to carry large volumes of all types of traffic. Urban arterial streets shall be designed to minimize direct access to development. Access will be provided by adjoining streets, lanes, and rights-of-way.

.8 Commercial and Industrial: **(REVISED NOVEMBER 2009)**

This classification applies to roads serving commercial or industrial lands. The road is intended to carry a higher percentage of truck traffic and provide for on-street parking. **(REVISED NOVEMBER 2009)**

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9.06 MINIMUM BASE AND PAVEMENT STRENGTHS

- .1 The minimum standards shall be as shown. Pavement and road structure design shall be based on Benkelman Beam rebound values as outlined in the most current edition of the "Pavement Design and Management Guide", distributed by the Transportation Association of Canada. The maximum Benkelman Beam deflection tested shall be corrected for seasonal variation. If required, the minimum standards shall be increased to meet the maximum Benkelman Beam deflection. Proof of minimum strengths shall be required.

	<u>Local</u>	<u>Collector</u>	<u>Arterial, Industrial & Commercial</u>
Coarse Gravel Sub-base, compacted 75 mm minus	250 mm	250 mm	250 mm
Crushed Gravel Base, compacted 20 mm minus	100 mm	100 mm	100 mm
Hot plant-mix asphalt pavement, compacted	50 mm	75 mm	75 mm
Asphalt prime coat	As directed		
Maximum Benkelman Beam deflection	1.5 mm	1.25 mm	0.75 mm
Minimum compaction of subgrade and gravel	95% modified proctor	95% modified proctor	95% modified proctor

- .2 Where works are to be constructed in and/or adjacent to existing streets and existing pavements do not meet the maximum Benkelman Beam deflection, the City of Nanaimo may require its removal and replacement with new road and pavement structure to meet the current standard.

9.07 STANDARD LONGITUDINAL GRADE

.1	Minimum desirable for concrete gutter	0.50%
	Minimum absolute for concrete gutter	0.40%
	Maximum desirable local streets	8%
	Maximum absolute local streets	12%
	Maximum collector or arterial streets	8%
	Maximum cul-de-sac bulb	6%
	Minimum lanes	0.5%
	Maximum lanes	12%
	*Maximum desirable approach to intersection	5%
	*Maximum desirable approach to T-intersection	3%

*Unless otherwise approved by the City Engineer.

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.2 Vertical Curvature at Intersections (K Values):

Providing the minor intersecting street is marked as a STOP, the following K Values may be used for the minor street:

<u>Classification</u>	<u>Crest Curves</u>		<u>Sag Curves</u>	
	<u>Min</u>	<u>Pref</u>	<u>Min</u>	<u>Pref</u>
Collector	4	6	4	6
Local	2	4	1.5	4

Minimum K Values for sag curves may be used where street lighting is provided.

9.08 STANDARD CROWN AND CROSSFALL GRADES

- .1 Street pavements minimum 2%
Street pavements maximum 6%
- .2 All roads shall normally be a crown section. Crossfalls shall require prior approval from the City Engineer.

9.09 GEOMETRICS

- .1 Vertical curves, super elevation, spirals and intersection geometrics shall be designed in accordance with the most current standards in the Geometric Design Guide for Canadian Roads, distributed by the Transportation Association of Canada (TAC).
- .2 Reverse curves shall have a minimum tangent length of 30 metres between curves where one of the curves has a centerline radius less than 100 metres. This shall apply to all classifications of roads.
- .3 The minimum centerline radius allowed on local and neighbourhood collector street classifications shall be 30 metres. Radii less than 30 metres may only be used on local roads where: **(REVISED NOVEMBER 2009)**
 - (a) a single access point is provided to the existing road network and the maximum number of trips generated from the ultimate development does not exceed 150 vehicles per day.
 - (b) two access points are provided to the existing road network and the maximum number of trips generated from the ultimate development does not exceed 300 vehicles per day.
- .4 For radii less than 55m, consideration should be given to the following criteria:
 - parking and access restrictions on the curve portions
 - use of reverse crown cross section (2%)
 - sufficient lane width to accommodate emergency vehicle wheel tracking.
- .5 Vertical curves shall have a minimum length in metres not less than the design speed value in metres.

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- .6 The maximum centerline gradient allowed on minimum radius curves shall be as shown in Table 9.09.

Table 9.09
Maximum Grades for Minimum Radius Curves

Radius (m)	15	30	40	50	60	70	80	90	100	>100
Max. Grade (%)	3.5	4.0	4.3	4.7	5.0	5.3	5.7	6.0	6.3	As per 9.07.1

9.10 EARTHWORK

- .1 Gravel and earthwork slope in cut and fill:
- | | | |
|-----------|-------|--|
| Desirable | 2H:1V | Maximum 1.5H:1V - to be used only with approval from the City Engineer on a site specific basis. |
|-----------|-------|--|
- .2 Rock slope in cut:
- Maximum 1H:4V

9.11 STANDARD CROSS SECTIONS AND UTILITIES

- .1 The arrangements of utilities in relation to surface works and pavements and in relation to the right-of-way width shall be as shown in Section - 9 Street Section Standard Drawings.

9.12 ACCESS DRIVEWAYS

- .1 Driveway approaches shall be a minimum 4.25 metres wide. Gravel and earthwork slopes in cut and fill shall be a maximum 1.5H:1V on private property.
- .2 Rock slopes in cut shall be a maximum 1H:4V.
- .3 The grade of a residential driveway shall not exceed 20%.
- .4 For Access Driveways Fronting Arterial and Collector Roads
- (a) The vertical transition curves shall not exceed a grade change of 6% for each horizontal 3.5m distance, with proper vision clearance being provided at the street. The vertical transition curve shall begin two (2) metres behind the curb or future curb location towards the property. Refer to Standard Drawings No. R11-DW1 and Standard Drawing No. R11-DW2 for driveway profiles fronting arterial and collector roads. **(REVISED NOVEMBER 2009)**

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.5 For Access Driveways Fronting Urban Local and Rural Local Roads

- (a) The vertical transition curves, shall not exceed 12% for each horizontal 3.0m distance, with proper vision clearance being provided at the street. The vertical transition curve shall begin two (2) metres behind the curb or future curb location towards the property. Refer to Standard Drawings No. R11-DW3 and Standard Drawing No. R11-DW4 for driveway profiles fronting urban local and rural local roads. **(REVISED NOVEMBER 2009)**

.6 Access driveways shall conform to the City's Crossing Control Bylaw.

9.13 - NOT USED -

9.14 STREET NAME AND TRAFFIC SIGNS

- .1 The design and construction of all roads shall include the design and installation of traffic signs (regulatory and informational).
- .2 Street name signs shall be provided at all intersections, where possible, the street name sign shall be located above a traffic sign at one corner of the intersection.
- .3 Sign installation shall provide a minimum of 2.0 m vertical clearance from the ground to the bottom of the sign.
- .4 Signs shall not be located in sidewalks unless approved by City Engineer.

9.15 STREET MARKINGS

- .1 The design and construction of all roads shall include the design and application of pavement markings and hazard and delineation markings in accordance with the most current standards contained in the Manual of Uniform Traffic Control Devices in Canada distributed by the Transportation Association of Canada (TAC).
- .2 Curb markings delineating "Bus Stops" shall be red, "No Parking" yellow, and "Loading Zones" white.
- .3 Crosswalk locations shall be determined in accordance with the City of Nanaimo Pedestrian Crosswalk Guidelines, or as may be required by the City Engineer.

9.16 TEMPORARY CUL-DE-SACS

- .1 Temporary cul-de-sacs shall be required for all temporary dead end streets. Extent of works to be determined on a site specific basis and approved by the City Engineer.

SECTION 9 - STREETS SPECIFICATIONS

9.20 SCOPE

- .1 This specification refers to preparation and construction of the road subgrade, subbase, and base course. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.

9.21 TESTING

- .1 The Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications, additional testing shall be required at the Contractors expense.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 The types of tests listed below may be required.
 - (a) Regular sieve analysis of aggregate gradation during the crushing operation and during the delivery of aggregate to the project site in accordance with ASTM C136.
 - (b) Determination of optimum moisture content and Modified Proctor Density (ASTM D1557) on all materials to be used for subgrade, subbase and base course construction.
 - (c) Determination of moisture content and Modified Proctor Density on the remolded subgrade, subbase and base course materials in place during construction shall be as per ASTM D1557 or ASTM D2922 Standard Test Methods. A minimum of one field density test of subgrade or granular base per 1000 square metres for roads and per 50 lineal metres for sidewalks, will be performed.
 - (d) Benkelman beam tests on the prepared subgrade, subbase, base and pavement.
 - (e) Other testing as required by the Engineer.

9.22 DESIGN SUBGRADE CROSS SECTION

- .1 The design subgrade cross section shall mean the surface of the finished subgrade upon which select granular subbase material is to be placed.

9.23 OVERBURDEN

- .1 Shall mean the surface material which, in the opinion of the Engineer, is not suitable for classifying as topsoil or earth fill.

9.24 TOPSOIL

- .1 Topsoil is surface material containing organic components and which, in the opinion of the Engineer, is suitable for landscaping.

9.24A STRIPPING

- .1 Stripping is the excavation of topsoil and overburden including the stockpiling of topsoil at a location approved by the Engineer and disposal of overburden as specified in Section 4.11 - Disposal of Waste Excavated Material.

SECTION 9 - STREETS SPECIFICATIONS

9.25 COMMON EXCAVATION

- .1 Common excavation is the excavation and removal of all material encountered which is not classified as rock.

9.25A ROCK EXCAVATION

- .1 Rock excavation is the removal of solid rock which requires drilling and blasting or breaking with a power-operated tool for its removal, or is detached masses of rock having individual volumes in excess of 1 cubic metre. Detached masses of rock include boulders and pieces of concrete or masonry.
- .2 Removal of soft or disintegrated rock which can be removed with a hand pick or power-operated excavator or shovel, or previously blasted or broken stone in rock fills or elsewhere with individual volumes less than one cubic metre, or boulders or pieces of fractured rock which do not occur naturally within the excavated volume but fall into the excavation from the adjacent area, will not be classified as rock excavation. Hard pan (glacial till) will not be classified as rock excavation.
- .3 Overbreak, is that portion of solid rock which is excavated, displaced or loosened outside the limits used to calculate the volume of rock excavation and will be classified as unauthorized overexcavation.

9.26 AUTHORIZED OVEREXCAVATION

- .1 Authorized overexcavation is that excavation required by the Engineer as a result of unsuitable foundation conditions not resulting from the contractor's operation.

9.26A UNAUTHORIZED OVEREXCAVATION

- .1 Unauthorized overexcavation is that excavation required as a result of the contractors operation as determined by the Engineer.

9.27 EARTH FILL

- .1 Earth fill shall include all fills comprised of common excavation containing less than 15% by volume of rock larger than 150 mm in size, free of organic and deleterious matter and frozen earth lumps and shall be approved by the Engineer prior to placement.

9.27A IMPORTED EARTH FILL

- .1 Imported earth fill is defined as material imported from outside the project site to meet the specifications for earth fill.

9.28 ROCK FILL

Rock fill shall include all fills comprised of material containing more than 85% by volume of rock larger than 150 mm in size, free of organic and deleterious matter. Rock fill shall not contain rocks greater than 600 mm in diameter and be approved by the Engineer prior to placement.

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9.28A IMPORTED GRANULAR FILL

- .1 Imported granular fill shall consist of well graded granular material, with not more than 8% passing the 0.075mm sieve, which contains no stones larger than 150mm in diameter and contains no stumps, roots, organic or other deleterious material.
- .2 All imported granular fill shall require approval by the Engineer prior to placement.
 - (a) A wet sieve analysis (ASTM C117) may be required by the Engineer to confirm the fines content of the imported granular fill material.
- .3 The use of quarried or blast rock as import granular fill requires specific approval by the City Engineer unless listed in the City of Nanaimo Approved Product List. Quarried or blast rock shall be hard and durable, well graded, with not more than 8% passing the 0.075 mm sieve, which contains; no stones larger than 150 mm in diameter and no stumps, roots, organic or other deleterious material.

9.29 SUBBASE

- .1 Subbase shall be a pit run gravel, screened if necessary, composed of inert, durable aggregate, uniform in quality and free from soft or disintegrated particles, clay and silt balls and other deleterious material, and shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard <u>Sieve Size</u>	Gradation Limits (<u>Percent by Weight Passing</u>)
75 mm	100
25 mm	50 – 85
0.15 mm	0 – 16
0.075 mm	0 - 5

9.30 BASE COURSE

- .1 The base course shall be composed of inert, clean, tough, durable, crushed aggregate, uniform in quality and free from soft or disintegrated pieces. The aggregate particles shall be uniform in quality and free from an excess of flat or elongated particles. In the absence of satisfactory performance records over a 5-year period of the particular source of aggregate, its soundness shall be tested in accordance with ASTM C88 using magnesium sulfate. Maximum weighted average losses for coarse aggregate shall be 20%, and for fine aggregate, 25%. The sand equivalent value when tested in accordance with ASTM D2419 shall not be less than 40. The Los Angeles abrasion value when tested in accordance ASTM C131 shall have a maximum loss by mass of 25%.

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The aggregate gradation shall fall within the following limits when tested in accordance with ASTM C136:

<u>US Standard Sieve Size</u>	<u>Gradation Limits (Percent by Weight Passing)</u>
25 mm	100
19 mm	80 - 100
9.5 mm	50 - 100
4.75 mm	35 - 70
2.36 mm	25 - 50
1.18 mm	15 - 35
0.3 mm	5 - 20
0.075 mm	0 - 5

- .2 The Contractor shall submit to the Engineer for approval his proposed base course gradation for the project. Upon approval, this gradation curve shall become the project gradation. All samples of base course aggregate used on the project shall conform to the following requirements:

- (a) Deviation between samples and the project gradation shall not exceed the following limits:

<u>US Standard Sieve Size</u>	<u>Gradation Limits (Percent by Weight Passing)</u>
Larger than 2.36 mm	±3.5%
1.18 mm - 2.36 mm	±3.5%
0.3 mm - 0.6 mm	±2%
0.075 mm - 0.15 mm	±1%

- (b) All sample gradations shall fall within the gradation limits.
 (c) A minimum of 50% of all material retained on the 4.75 mm sieve shall have at least one fractured face. The percentage shall be determined by particle count.

9.31 RECLAIMED ASPHALT PRODUCT

- .1 Reclaimed Asphalt Product (RAP) may be used in conjunction with crushed aggregate to produce a blended product conforming to Section 9.30 - Road Base. RAP shall be uniformly crushed, screened and blended. Maximum RAP content shall be 10% by volume of the finished product.

9.32 - NOT USED -

9.33 - NOT USED -

SECTION 9 - STREETS SPECIFICATIONS

9.34 STREET NAME SIGNS

- .1 Street name signs shall be double sided and constructed of 3 mm x 150 mm flat sign grade aluminum with rounded corners.
- .2 The sign shall consist of diamond grade reflective sheeting reverse screened transparent blue. Letters shall be 100 mm universe 67 upper and lower case.
- .3 The abbreviations St., Dr., Pl., Rd., etc., are to be the same height as the street name.

9.35 TRAFFIC SIGNS

- .1 Traffic sign shapes, colours, dimensions, symbols and wording shall be in accordance with the standards detailed in the Motor Vehicle Act Regulations.
- .2 Illumination or reflectorization of signs shall also be in accordance with the standards detailed in the Motor Vehicle Act.
 - (a) Signs shall be made on 12 gauge (3 mm) sign grade aluminum.
 - (b) Reflective sheeting shall be engineering grade.

9.36 FASTENERS - STREET NAME AND TRAFFIC SIGNS (*REVISED NOVEMBER 2009*)

- .1 Non-corrosive metal fasteners shall be used for attaching all signs to their supports to avoid discolouration.

9.37 STREET NAME AND TRAFFIC SIGN POSTS

- .1 Street name and traffic sign posts and anchors shall be roll formed from strip steel (structural quality) in accordance with ASTM A446, Grade A.
- .2 Sign posts shall be 50mm x 50mm 12 gauge (3mm) galvanized with perforations. (12mm diameter holes at 50 mm O.C. on four sides)
- .3 Anchor bases shall be double sleeve consisting of a 0.90m base and a 0.45m sleeve. Anchor bases shall be 57mm x 57mm 12 gauge (3mm) galvanized square tubing with perforations. (12mm diameter holes at 50mm O.C. on four sides)

9.38 STREET MARKINGS

- .1 The "Manual of Uniform Traffic Control Devices for Canada" shall apply for all standards pertaining to markings including colours, materials and patterns, unless otherwise noted on the drawings or approved by the City Engineer.
- .2 Paint for curb markings delineating "Bus Stops" shall be red, "No Parking" yellow, and "Loading Zones" white.

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- .3 All marking paint shall be pre-qualified according to the Province of British Columbia Ministry of Transportation and Infrastructure (MOTI) qualification procedures and test methods. Marking paint shall be suitable for spray application at a temperature of $50^{\circ}\text{C} \pm 5^{\circ}$ to asphalt or concrete pavements and shall meet the MOTI General Specifications for Highway Construction Section 321 - Traffic Paint. **(REVISED NOVEMBER 2009)**
- .4 The paint shall be used with overlay glass reflectorizing beads. Paint shall not have any "Premix" beads.
- .5 Reflectorizing glass beads shall conform to the MOTI Specifications for Glass Beads. **(REVISED NOVEMBER 2009)**
- .6 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 3 mm. **(REVISED NOVEMBER 2009)**

SECTION 9 - STREETS INSTALLATION

9.40 BORROW PIT DEVELOPMENT

- .1 Prior to removal of any material from a borrow pit, the entire site to be excavated shall be cleared and grubbed and stripped of all unsuitable overburden. Combustible material shall be disposed of as directed by the Engineer. Overburden shall be removed to suitable locations approved by the Engineer.
- .2 Borrow pits shall be excavated such that they will be free draining to the lowest corner or to such other location as determined by the Engineer. Reject material from the pit operation shall be removed from the pit area and disposed of as specified for overburden.

9.41 STOCKPILING

- .1 All aggregate materials shall be stockpiled prior to use at either the crushing site or such other location on the jobsite subject to the approval of the Engineer. Stockpile sites shall be cleared of all vegetation, trees, brush, rocks and other debris and covered with a uniform layer of pit run gravel prior to deposition of the base course material.
- .2 Stockpiles shall be built up in layers not exceeding 1 metre in thickness to a minimum height of 3 metres in such a manner as to prevent any appreciable segregation. End dumping over the edge of the stockpile will not be permitted.
- .3 Planks or protected runways for vehicles shall be provided as necessary to prevent contamination of the stockpile.

9.42 ROAD ALIGNMENT AND GRADE

- .1 The streets shall be constructed to the alignment and grade specified on the drawings. The Contractor's methods to maintain alignment and grade shall be approved by the Engineer.

9.43 CONSTRUCTION CONDITIONS

- .1 Construction shall not be undertaken during snow, heavy rain, freezing, or other unsuitable conditions. Aggregate shall not be placed upon a frozen, wet, muddy or rutted subgrade or subbase surface, unless otherwise directed by the Engineer.

9.44 STRIPPING

- .1 Prior to commencing excavation operations, those areas designated by the Engineer shall be stripped of all overburden and topsoil. Overburden shall be disposed of as specified in Section 4.11 - Disposal of Excavated Material. Topsoil shall be stockpiled at locations approved by the Engineer. Stumps, boulders and other deleterious matter shall be removed from the topsoil and disposed of as specified in Section 4.11 - Disposal of Excavated Material.

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9.45 COMMON EXCAVATION

- .1 All material classified as common excavation shall be removed, to the design subgrade cross section, or as otherwise established by the Engineer.
- .2 Material which, in the opinion of the Engineer, is not suitable for use as earth fill or rock fill or not required for the works as shown on the construction drawings shall be disposed of as specified in Section 4.11 - Disposal of Excavated Material.
- .3 Material which is suitable for earth fill or rock fill shall be placed and compacted in those areas requiring filling to the design subgrade cross section.
- .4 The Contractor may strip and salvage existing surface gravel from roadways to be regraded. This material may be reused as subbase if in the opinion of the Engineer it conforms to this specification. However, in no case shall it be reused as base course.

9.46 ROCK EXCAVATION

- .1 Rock excavation shall be carried out to the design subgrade cross-section. No points or pinnacles of rock shall be left protruding above the rock cut cross section. Subgrade rock shall be shattered at least 300 mm below the subgrade.
- .2 In rock cuts, care shall be exercised to ensure no damage is caused to the supporting rock below the roadway. Damage so caused shall be repaired to a condition acceptable to the Engineer at no additional cost to the Owner.
- .3 Overbreak shall be removed as directed by the Engineer and replaced with subbase material placed and compacted as specified herein at no additional cost to the owner.

9.47 AUTHORIZED OVEREXCAVATION

- .1 Authorized overexcavation shall be replaced with earth fill, rock fill, imported granular fill, subbase material or base course as directed by the Engineer. Replacement fill shall be placed as specified elsewhere herein.

9.48 UNAUTHORIZED OVEREXCAVATION

- .1 Replacement of unauthorized excavation shall be as specified in Section 9.47 - Authorized Excavation and shall be at no additional cost to the Owner.

9.49 - NOT USED -

9.50 SUBGRADE PREPARATION

- .1 In areas where, after stripping, a fill in excess of 150 mm is required to bring the finished subgrade to the design subgrade elevation, earth fill or rock fill shall be placed as specified elsewhere herein.

SECTION 9 - STREETS INSTALLATION

- .2 In areas where after stripping, a cut or a fill of 150 mm or less is required to bring the finished subgrade to the design subgrade elevation, the subgrade shall be scarified to a minimum depth of 150 mm below the design subgrade elevation and all material windrowed to one side. The exposed surface shall then be compacted to 90% of Modified Proctor Density (ASTM D1557), the windrowed material moved, and the compaction repeated on the other side. Windrowed material shall then be brought to its optimum moisture content, shaped to line and grade, and compacted to 95% of Modified Proctor Density (ASTM D1557).
- .3 At transitions between cut and fill areas, the subgrade in the cut area shall be scarified and recompacted as specified above to a depth of 150 mm for a distance of 20 metres beyond the transition from a fill.
- .4 The subgrade in cut areas shall be prepared 600 mm wider on each side than the required width of the finished base course. In fill areas embankments shall be constructed to the required width of the finished base course as shown on the drawings with the specified side slopes. The finished subgrade shall be crowned and sloped as required to prevent ponding of water on the roadway.
- .5 Soft or unstable subgrade material shall be excavated and replaced as specified in Section 9.47 - Authorized Overexcavation. If, in the opinion of the Engineer, the overexcavation is necessitated as a result of the Contractor's operations it will be classified as unauthorized overexcavation.

9.51 WATERING FOR COMPACTION AND DUST CONTROL

- .1 If weather conditions and construction materials are such that watering may be required, upon direction from the Engineer, the Contractor shall maintain suitable watering equipment on the site. Watering shall be performed as directed by the Engineer to control dust and to ensure optimum moisture conditions for earth fill compaction, subgrade preparation and placing subbase and base course materials.
- .2 Water in excess of that required for optimum moisture conditions may be used only with the Engineer's approval, to obtain the specified density.
- .3 Water shall be supplied uniformly from a pressure type distributor equipped with suitable control apparatus and a spray bar and nozzles similar to those used on asphalt distributors. Splash plate type distributors or distributors with spray bars which discharge jets of water require approval by the Engineer.

9.52 EARTH FILLS

- .1 Earth fills shall be constructed in such a manner that they will be completely stable at all times during construction. Silts and clays shall not be used without proper aeration and drying. Placing of frozen material in fill areas will not be permitted.
- .2 Earth fills not exceeding 600mm (compacted thickness) shall be constructed in layers not exceeding 150mm (uncompacted thickness). Each layer shall be compacted to 95% Modified Proctor Density (ASTM D1557).

SECTION 9 - STREETS INSTALLATION

- .3 Earth fills exceeding 600mm (compacted thickness) shall be constructed in layers not exceeding 200mm (uncompacted thickness). Each layer shall be compacted to 95% Modified Proctor Density, except the top 600mm (compacted thickness) which shall be constructed as per Section 9.52.2.
- .4 Where shown on the construction drawings, or as directed by the Engineer, the existing side slopes shall be scarified or terraced to ensure a proper bond between existing and fill materials. Methods shall be approved by the Engineer prior to commencing work.
- .5 Should any soft spots develop during the process of compaction, such areas shall be excavated and replaced as specified in Section 9.47 - Authorized Overexcavation. If in the opinion of the Engineer, the excavation is necessitated as a result of the Contractor's operations, it will be classified as unauthorized overexcavation.

9.53 ROCK FILLS

- .1 Rock fills shall be constructed in layers equal in thickness to the largest average size of the material, but not exceeding 600 mm. Material shall be placed and spread in such a manner that the larger rocks are well distributed and the intervening void spaces are filled with sufficient amounts of smaller rocks and fines to create a stable structure. Fill surface voids at the subgrade level to prevent migration of sub-base gravels into the rock fill.

9.54 PLACING AND COMPACTING SUBBASE AND BASE COURSE

- .1 The subgrade shall be approved prior to placement of the subbase course.
- .2 Sub-base and base course materials shall be approved by the Engineer prior to being delivered to the project site. Approval shall require testing as per Section 9.21 - Testing.
- .3 Sub-base and base course shall be placed on the approved subgrade in those locations and to the compacted thicknesses and dimensions shown on the drawings or as otherwise directed by the Engineer. Testing shall be in accordance with Section 9.21 - Testing, Section 9.56 – Proof Rolling and Section 9.57 – Benkelman Beam Testing.
- .4 Sub-base and base courses shall be placed in maximum 150 mm lifts, and shall be spread in an approved manner such that the aggregate is neither segregated nor contaminated with foreign material. Segregated materials shall be remixed until uniform. The subbase course shall be approved prior to placement of the base course.
- .5 Immediately following spreading, the sub-base and base courses shall be graded and compacted at optimum moisture content to 95% of Modified Proctor Density (ASTM D1557).

9.55 FINISHED GRADE

- .1 The finished grade surface of the compacted subgrade shall be within 15mm of the design grade and cross-section, but not uniformly high or low, when measured with a 3.0m straight edge parallel or perpendicular to the road centre line.

SECTION 9 - STREETS INSTALLATION

- .2 The finished grade surface of the compacted sub-base course shall be within 15mm of the design grade and cross-section, but not uniformly high or low, when measured with a 3.0m straight edge parallel or perpendicular to the road centre line.
- .3 The finished grade surface of the compacted base course shall be within 10mm of the design grade and cross-section, but not uniformly high or low, when measured with a 3.0m straight edge parallel or perpendicular to the road centre line.

9.56 PROOF ROLLING

- .1 Before proceeding further with the work, each finished layer of subgrade, and subbase and base course shall be proof rolled by receiving complete coverage using a single axle truck having an 8000 kg rear axle load and a tire pressure of 550 kPa. Benkelman Beam testing may be required in conjunction with proof rolling. Should any areas of rutting or displacement result, they shall be excavated and refilled as specified in Section 9.47 Authorized Overexcavation. If, in the opinion of the Engineer, the excavation is necessitated as a result of the Contractor's operations it will be classified as unauthorized excavation. Excavated and refilled areas shall be retested to confirm rutting and/or displacement has been eliminated.
- .2 Intermediate tests will be conducted on the subbase prior to placement of road base material, and on the road base immediately prior to paving. Results of the intermediate tests will be supplied to the Contractor as a quality control guide, but will not constitute acceptance or rejection of the work.
- .3 It shall be the Contractor's responsibility to provide a single axle, dual wheel truck and driver for the tests. The truck shall be equipped with 250 x 500 mm, 12-ply tires inflated to a pressure of 550 kPa. The truck shall have an 8000 kg rear axle load distribution on both wheels.
- .4 Where proof rolling is likely to damage works or access is limited, determination of moisture content and Modified Proctor Density on the re-molded sub-grade, sub-base and base materials shall be performed as per Section 9.21 – Testing, clause 9.21.3c.

9.57 BENKELMAN BEAM TESTING

- .1 Prior to paving, the finished base course shall be checked by the Engineer for deflections utilizing a Benkelman Beam or other approved testing device.
- .2 Results of the test will be used to determine the final pavement strength resulting from the placement of the specified thickness of asphaltic concrete.
- .3 If the calculated deflections are in excess of the maximum Benkelman Beam deflections as outlined in Section 9.06 – Minimum Base and Pavement Strengths, clause 9.06.1 measures shall be taken to strengthen the road base and pavement structure prior to paving. Paving shall not proceed until the test results meet the minimum requirements.
- .4 Benkelman Beam test procedures, and the estimation of pavement strength shall be as outlined by "A Guide to the Structural Design of Flexible and Rigid Pavement in Canada" and the "Pavement Design and Management Guide", distributed by the Transportation Association of Canada.

SECTION 9 - STREETS INSTALLATION

9.58 - NOT USED -

9.59 CLEANUP

- .1 Prior to completion of construction, all existing and newly constructed drainage ditches, waterways, and culverts shall be cleaned to restore their full effectiveness. Boulevards and all other areas affected by the construction operation shall be cleaned of all loose rock, boulders and their debris and in all respects prepared suitable for placement of topsoil or as otherwise directed by the Engineer.

9.60 BOULEVARD GRADING

- .1 Boulevard areas and other areas within the road allowance or right-of-way shall be sloped, graded with 75 mm of topsoil and seeded with grass as shown on the drawings. The requirement for placement of topsoil and grass seeding shall be determined by the Engineer. As a general statement, top soil placement and grass seeding is not required in boulevards fronting undeveloped lots.

9.61 STREET NAME AND TRAFFIC SIGNS

- .1 Street name and traffic signs shall be located as shown on the drawings and as directed by the Engineer. 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 and No Stopping signs.
- .2 Reflectorized signs shall be placed at a slight angle away from approaching traffic.
- .3 Sign post bases shall be installed in accordance with the City of Nanaimo Manual of Engineering Standards and Specifications. (**REVISED NOVEMBER 2009**)
- .4 Anchor posts shall be provided for sign base installations where native soils are unable to hold the sign rigidly in its proper and permanent position and to prevent it from swaying in the wind, from being turned or otherwise displaced.

9.62 STREET MARKINGS

- .1 Layout works as shown on the construction drawings.
- .2 Pavement surface shall be free from surface water, frost, ice, dust, oil, grease and other foreign materials. In areas designated by the engineer, clean pavement surface by method approved by the Engineer.
- .3 Apply paint only when air temperature is above 10°C and no rain is forecast.
- .4 Apply paint evenly at 3m²/ litre.
- .5 Do not thin paint unless approved by the Engineer.
- .6 Paint lines to be of uniform colour and density. No overspray will be allowed.
- .7 Thoroughly clean distributor tank before refilling with a different colour paint.

SECTION 9 - STREETS INSTALLATION

- .8 Apply glass beads at a specified rate.
- .9 Paint markings shall be within ± 10 mm of specified dimensions.
- .10 Protect pavement markings until they are dry.
- .11 Thermoplastic shall be applied in accordance with the manufacturers recommendations.