MUNICIPALITY OF NORTH Cowichan

CONSOLIDATION

SUBDIVISION CONTROL BYLAW

Bylaw No. 1851

Current to April 29, 2025

Last amended on March 19, 2025

This consolidation is a copy of a bylaw consolidated under the authority of section 139 of the *Community Charter* and in accordance with section 1 of Consolidation and Revision Authority Bylaw 3514, 2013.

Amendments

Number	Amendment Bylaw Number	Effective Date yyyy-mmm-dd
1991	Amending Section 3; Adding Schedule A;	1981-Jun-17
2001 [REPEALED]	Adding subsection 15 a) 'Service Level 4'	1981-Oct-07
2007	Adding subsection (c), under Section 11	1981-Nov-18
2164 (Schedule A)	Amending Schedule A	1984-Sep-26
2266	Amending subsections a), i), k), n), under Section 1 (Definitions); Amending subsection e), under Section 5; Adding subsections d), and e), under Section 11; Amending subsection a), under Section 15; Amending Sections 24, and 27; Amending Sections 28, and 43	1986-Oct-01
2712	Amending Section 14; Adding Schedule B;	1993-Aug-11
2714 [REPEALED]	Fees updated in Schedule A	1994-Jul-27
2837	Amending subsections a), j), under Section 1; Amending Section 3; Adding subsection e), under Section 5; Amending Section 12; Adding subsections (vi), (vii), (viii), under Section 16 b) (v); Amending subsection f), under Section 16; Amending Section 27; Amending 'Table of Contents' in Schedule B; Adding 'Section 0' to Schedule B	1995-Sep-13
2925 [REPEALED]	Amending subsection (b) (iii), under Section 16	1997-Mar-05
2943 [REPEALED]	Amending Section 42	1994-Dec-17
3011	Amending Section 11	1999-Apr-07
3044	Amending Section 40	2000-Feb-02
3224	Amending Section 21	2005-Mar-02
3470	Municipal Engineering and Administration charge	2012-May-16
3548 [REPEALED]	Amending subsection (a)(h), under Section 1; Amending (a), (d), under Section 15; Amending (a)(i), (d), (e), (f)(ii), (g), under Section 16; Amending Sections 20, 24, 26 and 35	2014-Jul-16
3700	Amending bylaw title; Amending Section 1; Repealing Sections 3, 50 and 51; Repealing paragraph (5), under Section 11	2018-Jul-18

3986	Amending the Water Demand Calculations and the Sewer Flow Calculations in Schedule B [Engineering Standards]	2025-Mar-19

The Corporation of the District of North Cowichan

Subdivision Control Bylaw [BL3700]

Bylaw 1851

WHEREAS it is desirable to prescribe the requirements to be met as a condition precedent to granting of approval to a subdivision;

NOW THEREFORE the Municipal Council of the Corporation of the District of North Cowichan ENACTS as follows:

1. In this bylaw, unless the context otherwise requires, the following words shall have the meanings hereinafter assigned to them:

   (a) "Approving Officer" means the person duly authorized by Council to administer this bylaw [BL2837]

   (b) "Building Area" on a parcel means a specified portion (or portions) which is topographically and otherwise suited for the construction of a building in accordance with this bylaw, the building, zoning, and other relevant bylaws

   (c) "Cul-de-sac" means a dead end local street which terminates in a turning area for motor vehicles

   (d) "Lane" means a public way not less than 6.0m (19.68') or more than 10.0m (32.8') in width

   (e) "Major Street" means a street which, in addition to serving local needs, is, or is designed to form part of the major or arterial street system of the Municipality, wherein a significant proportion of the traffic has both its origin and destination outside the subdivision area

   (f) "Minor Street" means a street used primarily for travel and access to and from the parcels contiguous thereto created in the subdivision

   (g) "Municipality" means The Corporation of the District of North Cowichan

   (h) "Director of Engineering and Operations" means the person so appointed by the Chief Administrative Officer [BL3548]

   (i) [BL2266, Repealed; BL3700]

   (j) "Panhandle Lot" means any parcel, the building area of which is serviced and gains road frontage through the use of a strip of land at least 6 metres (19.68') in width, which is an integral part of the parcel [BL2837]

(k) "Parcel" means any lot, block, bare land strata lot, strata lot, or other area in which land is held or subdivided [BL2266]

(l) "Professional Engineer" means a person currently certified under the provisions of the *Engineers and Geoscientists Act* [BL3700]

(m) "Streets" include all highways, roads, squares, thoroughfares and any other public way, but not lanes, trails and bridges

(n) "Subdivision" means the division of land into two or more parcels, whether by subdivision plan, strata plan, bare land strata plan. [BL2266]

2. Unless otherwise defined herein, any word or expression in this Bylaw shall have the same meaning as any word or expression contained in the "Land Title Act" and any Amendments and Regulations thereto.

3. [BL1991, BL2837, Repealed; BL3700]

4. The Approving Officer shall maintain a permanent record of all subdivision applications submitted under this bylaw.

5. The Approving Officer shall not grant approval of any subdivision plan if the proposed subdivision:

(a) is not suited to the configuration of the land being subdivided;

(b) is not suited to the use for which it is intended;

(c) will make impracticable the future subdivision of the land proposed for subdivision or of any adjacent land;

(d) would create excessive costs to the Municipality of providing public utilities or other Municipal works or services;

(e) does not abut on a public street, except as provided for in Section 12 herein, and the "Land Title Act" and any Amendments and Regulations thereto; [BL2266]

(f) would create a panhandle lot in new subdivisions of more than three lots, where it is otherwise possible to create a design with a conventional road system and conventional frontages. [BL2837]

6. The application for subdivision approval shall be made by the owner or his duly authorized agent. The Approving Officer, before dealing with an application for subdivision approval made by a person other than the owner, shall require such other person to produce satisfactory evidence that he is duly authorized by the owner to make such application.

7. A preliminary sketch plan of the proposed subdivision shall be submitted for tentative approval, outlining:

(a) the boundaries of all adjacent properties and shall where feasible show the relationship of the proposed subdivision to at least one street intersection;

(b) the layout, dimensions and alignment of all lots, and streets;

(c) a legal description of the proposed subdivision;

(d) the location, dimension and size of all buildings existing on the property or any encroachment;

(e) the location of any watercourses within the boundary of the land proposed for subdivision;

(f) location of existing easement and right-of-ways.

8. In order that any proposed subdivision can be properly considered by the Approving Officer, the owner of the land being subdivided may be further required to provide any of the following:

(a) topographic survey

(b) spot elevations

(c) where unusual soil conditions exist or may develop on part or all of the subdivision area, a soils report from a Professional Engineer actively engaged in the field of soils investigation

(d) the location of any existing services, if applicable.

9. All subdivisions shall comply with the relevant provisions of all applicable bylaws then in effect.

10. Where a portion of a parcel is to be added to an existing adjoining parcel, and the balance of such first-mentioned parcel is thereby so reduced in size as to be less than permissible under Section 11 hereof, such balance must be added to another adjoining parcel.

11. The approving officer may approve subdivisions with lots smaller than the minimum lot sizes permitted by "Zoning Bylaw 1997", in the following situations: [BL2007, BL3011]

(1) Where part of a parcel is or has been required for road widening purposes, provided that the parcel size is reduced by no more that 10% in agricultural zones and 5% in all other zones;

(2) Where the parcel is physically divided by:

(a) a parcel of land held under separate title and ownership,

(b) a dedicated public road, or

(c) or a Crown owned water course,

provided that parcel is not rendered incapable of being used in the manner anticipated in "Zoning Bylaw 1997";

(3) Where the parcel being created is to be used solely for the unattended equipment necessary for the operation of:

(a) a bus shelter, railway station, public transit station, excluding airport;

(b) a Municipal water system;

(c) a Municipal sewer system;

(d) a community gas distribution system;

(e) a public radio or television receiving antenna;

(f) a radio or television broadcasting antenna;

(g) a telecommunication relay station;

(h) an automatic telephone exchange;

(i) an air or marine navigational aid; or

(j) other public utilities not specifically listed by considered to be similar in nature to those uses listed above;

(4) Where the parcel being created is to be used as a park, nature reserve, or wildlife sanctuary; and

(5) [Repealed; BL3700]

12. Frontage requirements may be waived where cul-de-sacs comply with Section 21. [BL2837]

13. Parcels that abut a street at both the front and rear shall not be permitted unless in the opinion of the Approving Officer, such an arrangement is essential.

14. All works and services must conform to standards prescribed in Schedule "B" (Engineering Standards, dated April 1993) attached to and forming part of this bylaw. [BL2712]

15. (a) For the purpose of determining those services required of a developer as a condition of subdivision, the Municipality is hereby classified and divided into the following Service Level Areas, as shown on Schedule A, titled "Subdivision Service Level Map" attached hereto and made part of this Bylaw:

AREA	REQUIRED SERVICES BY OWNER	NUMBER OF MAP
Service Level 1	Including paved roads, storm drains, sanitary sewers, concrete sidewalks, concrete curbs and gutters, watermains and hydrants, lot connections	1
Service Level 2	Including paved roads, storm drains, drains, sanitary sewers, concrete sidewalks (on one side of the road), concrete curbs, and gutters, watermains and hydrants, lot connections [BL2266]	2
Service Level 3	Including paved roads, watermains and hydrants, storm drains, and concrete curbs and gutters, lot connections, private percolation private percolation sites for sewage disposal [BL2266]	3
Service Level 4	Including paved roads, ditching and driveway culverts, additional drainage where required by Director of Engineering and Operations, private wells, private percolation sites for sewage disposal [BL3548]	4

Notwithstanding the above, the requirements of Service Levels 2, 3, and 4, are not applicable to a subdivision of three new lots or less, all of which front only on an existing road, but in every case sewage, storm drainage, and water services must be provided to each lot and where the land to be subdivided is adjacent to property meeting applicable service level requirements, continuation of those services is required as a condition of subdivision approval. [BL2001, BL2266]

(b) The boundary lines of said areas shall be parcel lines, Municipal boundaries, centreline roads, or shown otherwise on the attached "Subdivision Service Level Map - Schedule "A" of The Corporation of the District of North Cowichan.

(c) All costs of development, including the provision of services, connections, hydrants, drainage, roads, any necessary easement, engineering and supervision shall be at the expense of the developer, and not limiting the foregoing, the owner must provide those services listed under Service Levels 1 to 4 in Section 15(a) for subdivisions in the corresponding areas as shown on the "Subdivision Service Level Map - Schedule "A".

(d) All storm drains, ditching, culverting or combinations thereof shall be capable of accepting all tributary lot and building drainage, roadwater run-off, upstream and overland flow and shall extend to outlets acceptable to the Director of Engineering and Operations. [BL3548]

16. The owner shall comply with the following general conditions of subdivision:

(a) Engineering

i. The design and as-built drawings for all services for subdivision shall be prepared by a Professional Engineer and approved by the Director of Engineering and Operations. [BL3548]

ii. The installation of all works and services shall be supervised by a Professional Engineer.

(b) Installation of Services

i. The developer shall provide for the installation of required services including all house connections to existing mains.

ii. All installations shall be made to Municipal Engineering standards.

iii. The developer must pay a Municipal Engineering and Administration charge to the Municipality as set out in the Fees Bylaw. [BL 2714, BL 2925, BL2943, BL3470]

iv. Required services shall be installed by persons qualified in the particular type of work being carried out.

v. Required works and services must be completed and the maintenance period begun within one year of registration of the subdivision plan unless the term is otherwise extended by the Municipal Council.

vi. The developer shall install, or have installed, natural gas service in new subdivisions where natural gas service is in the vicinity of such subdivisions. [BL2837]

vii. The developer shall install, or have installed, underground hydro services in new subdivisions with lots less than 1,675 m2 in area. [BL2837]

viii. The developer shall pay the Municipality $300.00 for each street light installed in new subdivisions with overhead hydro service. [BL2837]

(c) Should work be required on existing roads, sanitary sewers, water lines, storm drains, curbs and gutters, and paving, the said work shall be carried out at the expense of the developer.

(d) Maintenance Bond [BL3548]

The developer shall deposit a maintenance bond in favour of the Municipality in a form acceptable to the Approving Officer amounting to 10% of the installation cost of all required services which will be held and used for the maintenance and/or repair of the said required services, if necessary, by the Municipality for a period of one year, or a term acceptable to the Director of Engineering and Operations, from the date of final approval and acceptance of the services.

(e) Hydrants [BL3548]

In areas served by a Municipal water system, the subdivider shall install fire hydrants of a type and in such quantity and at such locations as specified by the Director of Engineering and Operations and the Fire Chief.

(f) Other Services [BL2837]

Prior to final approval of the subdivision the developer must:

i. In the case of overhead services (including street lighting) provide written confirmation from B.C. Hydro and Power Authority and B.C. Telephone, that installation is authorized;

ii. In the case of underground services, have installation at a stage acceptable to the Director of Engineering and Operations. [BL3548]

(g) Final Approval [BL3548]

The Approving Officer shall not approve the legal subdivision plan until required Municipal services are installed to the satisfaction of the Director of Engineering and Operations or the value of the said required services deposited with the Municipality in acceptable form.

17. In examining any proposed plan of subdivision the Approving Officer shall require that:

(a) The arrangement of streets in a subdivision provide for the continuation of appropriate projection of existing streets in surrounding areas, and access to adjacent lands.

(b) The number of street intersections within a subdivision be kept to a minimum and where practical:

i. Y-shaped intersection shall not be used

ii. T-shaped intersections are preferred in the low density single family residential areas

iii. Intersections with more than four (4) legs shall not be used

iv. No intersection shall be less than 76.0m (249.34') from any other intersection or likely future intersection, measured between centre lines

v. Intersecting streets shall meet at an angle of 90 degrees

vi. The dimensions, location and standards of all streets in a proposed subdivision shall conform substantially to any applicable community or regional plan of streets or of proposed streets.

18. Major street right-of-ways shall be a minimum width of 20.0m (65.62') and minor street right-of-ways shall be a minimum of 15.3m (50.20').

19. (a) At right angles in a lane, triangular corner cut-offs not less than 3.0m (9.84') each way from the corner may be required by the Approving Officer.

(b) At street intersections, triangular corner cut-offs not less than 6.0m (19.68') each way from the corner may be required by the Approving Officer.

20. Cul-de-sac streets shall have ample turnaround area at their closed end, with proper facilities for street drainage. Such turnaround shall have a minimum diameter of 30.0m (98.42'). Temporary turnarounds on roads capable of future extension may be reduced to 20.0m (65.62') where approved by the Director of Engineering and Operations. [BL3548]

    Except in special circumstances, the length of any such cul-de-sac shall not exceed 160.0m (524.98') to the end of the turnaround, and shall permit a direct line of vision from the point of entry to the closed end.

21. In the subdivision of a parcel of land smaller than 1 675.0 square metres (18 029.5 square feet), the following apply to each lot fronting on a cul-de-sac: [BL3224]

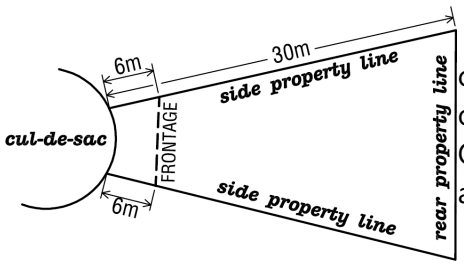
    (a) Frontage is deemed to be the length of a straight line parallel to the arc of the cul-de-sac between the two side property lines, measured from a point 6 metres (19.68 feet) towards the rear of the lot;

    (b) Frontage as defined in paragraph (a) must not be less than 60 per cent of the minimum frontage requirement for that zone;

    (c) The length of each side property line must not be less than 30 metres (98.42 feet);

    (d) Side property lines must be radial to the centre of the cul-de-sac's turnaround area.

22. Where extra road width for cuts or fills is necessary in order to bring any new street or lane to the required gradient, the Approving Officer may require the owner to dedicate such additional width as public road allowance.



23. Pedestrian walkways shall be dedicated and constructed where they are deemed by the Approving Officer to be essential to provide circulation or access to schools, playgrounds, shopping centre, transportation, beaches, and other community facilities or for property circulation of pedestrian traffic.

24. Where sanitary sewer accommodation is not available to serve the parcels in a subdivision under application for approval, arrangements satisfactory to the Medical Health Officer shall have been made for the proper disposal of such sewage or industrial waste as may result from the anticipated use of the parcels. For proposed subdivision of land in areas of known sewage disposal problems, as determined by the Director of Engineering and Operations, the Public Health Inspector's written approval for septic percolation sites may be required prior to further processing of the subdivision application. [BL2266, 3548]

25. Where any sewage collection system or water system is required to service parcels to be created by subdivision, the owner shall be required to connect the system(s) to Municipal trunk lines at his own expense.

26. No subdivision requiring Municipal sanitary sewer service or Municipal water service shall be approved until the Director of Engineering and Operations has confirmed to the Approving Officer that sewers and/or water will be available and of adequate capacity to

serve the parcels to be created by the subdivision within 90 days after the tentative approval of the subdivision. [BL3548]

27. Where lots are not required to connect to a Municipal water system, individual wells must be installed on each lot less than four (4.0) hectares in size to supply water, and the following conditions apply: [BL2837]

    (a) Well locations must be plotted by a British Columbia Land Surveyor on a print of the subdivision plan and submitted for review prior to final approval.

    (b) Water quantity shall be determined from accredited well log construction records or by a well pump test performed by a recognized well testing company or witnessed by a Professional Engineer. The pump test shall be a minimum length of four (4) hours or longer, if necessary, to determine the sustained yield of the well.

    (c) The minimum well quantity requirements are as follows:

<table>
<tr><th colspan="3">Minimum Well Quantity Requirements</th></tr>
<tr><th>Well Depth</th><th>Minimum Sustained Yield</th><th>Useable Storage</th></tr>
<tr><td rowspan="3">Wells 25 or more metres deep
&
Wells less than 25 metres deep tested between June 1st and November 1st</td><td>9.0 litre/min
(2.0 lgal/min)</td><td></td></tr>
<tr><td colspan="2">or</td></tr>
<tr><td>7.0 litre/min
(1.5 lgal/min)</td><td>1140 l
(250 lgal)</td></tr>
<tr><td rowspan="3">Wells less than 25 metres deep tested between November 2nd and May 31st</td><td>18.0 litre/min
(4.0 lgal/min)</td><td></td></tr>
<tr><td colspan="2">or</td></tr>
<tr><td>13.5 litre/min
(3.0 lgal/min)</td><td>1140 l
(250 lgal)</td></tr>
</table>

    (d) Well water shall be tested for the presence of total and fecal coliform bacteria by a recognized testing laboratory. Testing and acceptable standards shall be as specified in the latest edition of the Guidelines for Canadian Drinking Water Quality. A copy of the test result, including an assessment of the result with respect to acceptable standards, shall be submitted for review.

28. Where land within a plan of subdivision is subject, or could reasonably be expected to the subject to flooding, the Approving Officer shall not approve the subdivision without prior consent of the Deputy Minister of Environment who may require, as a condition of his consent, that the subdivider enter into such covenants registerable under Section 215 of the Land Title Act as the Deputy Minister considers advisable. [BL2266]

29. The owner of the land being subdivided shall provide, without compensation land for public open space in the locations and to the extent required by the Approving Officer for the purpose of providing sufficient open space for park and public use.

30. Where land being subdivided adjoins a lake, river, stream, or other body of water, the Approving Officer may, as a condition of approving the subdivision, require the dedication, without compensation of a strip of land not exceeding 7.0m (22.97') in width along the bank or shore of the purpose of providing public access if, in his opinion, it is in the public interest to do so.

31. Land to be dedicated under Section 30 shall be measured from

    (a) the high water mark, or

    (b) the controlled high water mark, or

    (c) the natural boundary of the lake, river, stream, or other body of water as defined by the Land Act.

    whichever is applicable.

32. The amount of land required to the provided or dedicated under Sections 29 and 30 shall not exceed 5% of the land being developed.

33. Sections 29 and 32 do not apply

    (a) to subdivision of one or two lots, or

    (b) to subdivision where the smallest lot being created is larger than 2 hectares (4.94 acres), or

    (c) to consolidations of existing subdivided parcels.

34. All structures encroaching upon and obstructions of any kind to the free and uninterrupted use by the public of full width and extent of all new streets and lanes shall be removed therefrom before approval of any subdivision plan is granted, unless by prior arrangement with the Municipality, such are allowed to remain for a limited period of time.

35. All new streets and lanes within the subdivision, including widening strips of existing streets and lanes, if any, shall be cleared, graded, drained, and surfaced to the standard prescribed by the Director of Engineering and Operations. [BL3548]

36. The Approving Officer may require an overall development plan from the person tendering the subdivision approval, showing the ultimate method of subdivision when, in the opinion of the Approving Officer, the application for subdivision approval indicates that there is reason to anticipate a further resubdivision of the relevant lands.

37. The approving Officer is empowered to approve minor realignment of lot lines of existing parcels where such realignment does not affect the substances of either parcel affected.

38. The Approving Officer may require the applicant applying for tentative approval to produce a plan or sketch verified by a British Columbia Land Surveyor, showing the proposed new boundary or boundaries in relation to the affected parcels and to the buildings thereon.

39. The Approving Officer shall examine the preliminary application and advise the applicant in writing within sixty (60) days from receipt by him of such application, either that the subdivision proposal could be approved, or that it could not be approved. In the latter case, the reasons for so deciding shall be stated.

40. (1) Tentative approval of any proposed subdivision shall be granted for a one year period, and shall not be construed as final approval of such subdivision for land registration purposes. [BL3044]

    (2) Despite the foregoing, the Approving Officer may grant an extension of the tentative approval, provided there have been no changes to applicable subdivision construction standards, or fees.

41. Within sixty (60) days from the date on which an application is tendered for examination and final approval, or within sixty (60) days from the furnishing by the applicant of such further information as the Approving Officer may rightfully require, including satisfactory evidence that all of the relevant provisions of this Bylaw have been duly complied with, the Approving Officer shall either approve or reject the proposed subdivision in the manner provided by this Bylaw.

42. The final subdivision shall conform substantially to the approved preliminary plan, but the application for final approval need not necessarily cover the whole project in one application. If the subdivision project is submitted in sections a separate application may be made covering each section, and such applications may occur at different times.

43. When any subdivision plan is approved, the Approving Officer shall sign and date the plan thereof, tendered for approval in the form provided on such plan under the provisions of the "Land Title Act" and any Amendments and Regulations thereto. [BL2266]

44. A certificate of final approval shall be valid sixty (60) days from the date thereof, after which time approval shall be deemed to have been revoked, unless registered.

45. Notwithstanding the provisions of Section 43 hereof, a certificate of Final Approval which has not been used for registration purposes, and which is deemed to be revoked as aforesaid, may be renewed on application in writing to the Approving Officer, for a further period not exceeding sixty (60) days, provided the time elapsed since the issue of the original certificate does not exceed twelve (12) months. Thereafter, a new application for approval of the subdivision shall be required and shall be dealt with as an original application.

46. All work required to be done hereunder, in connection with the subdivision of any lands, shall be carried out at the sole expense of the owner of such lands, and to the satisfaction of the Approving Officer before approval of such subdivision hereunder; provided, however, that upon the due execution of any agreement in writing between the owner and the Municipality providing for the payment of such amount of cash or such other forms of acceptable security required by the Approving Officer, approval may be given before completion of the work.

47. The imperial measurements in this Bylaw, shown in brackets immediately following each metric measurement have been included for information and convenience only and do not form part of the Bylaw.

48. Nothing contained in this Bylaw shall relieve the owner of a subdivision from the responsibility to seek out and comply with the legislation applicable to his undertaking.

49. If any section, subsection, clause or phrase of this Bylaw is for any reason held to be invalid by the decision of any Court of competent jurisdiction, such decision shall not affect the validity of the remaining portion of this Bylaw.

50. [Repealed; BL3700]

51. [Repealed; BL3700]

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Read a first time on the 21st day of June, 1979
Read and second and third time on the 28th day of May, 1980
Adopted on the 4th day of July, 1980

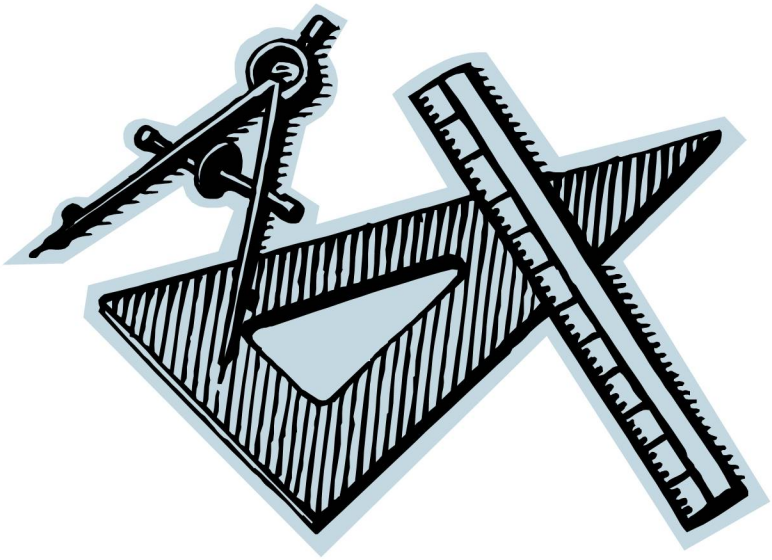
Attachment A

Please contact Engineering to access Attachment A:

Engineering
Phone: 250-746-3103
Email: engineering@northcowichan.ca

Municipality of North Cowichan

ENGINEERING STANDARDS



1993

Schedule “B”

By-Law No. 1851

Section	Reference		Revision
1	Maintenance	Sec.1.27	Add "On September 15, 1993, Council set policy authorizing the Operations Department to make emergency repairs, when required, in new subdivisions which are still under the one-year maintenance period and invoice the developer for this work.
2	Service Cards	Sec.2.10	See additional notes on sample service card in **Appendix "G"** (attached).
3	Native Backfill	Sec.3.7.3.	"... Backfill in these cases shall be free of stones over **200mm** size...."
4	Air Valve	Sec.4A.7.6-...	"...Air valves for watermains greater than 200mm diameter shall be as approved by the Engineer..."
4	50mm Water Meter	Sec.4A.7.10(c) (i)	See new **Standard Drawing W8.**
4	Meter Box	Sec.4A.7.10(e)	"...In travelled areas... service boxes for water services 40mm in diameter and smaller shall be "A.E. Concrete Precast Products", **#66, 430mm x 760mm** concrete meter boxes...".
4	Reaction Blocking	Std. Dwg. W1	Add note: "For HxH line valves, tie valve with 10mm rebar to concrete thrust block. Thrust block same size as for reducer".
4	Reaction Blocking	Std. Dwg. W3	Recess trench dimension "W" for 150 reducer to be **150 not 350.**
5 & 6	Manholes	Std. Dwgs. S2 & D2	Add note: "Install approved platform at midpoint when depth exceeds 4.2m". Add note: "Where pipe diameter exceeds 300mm, larger manhole barrels may be required".
6	Catch Basin	Std. Dwg. D8	Height dimension to be **760mm, not 7760mm.**
7	Hazard Barricade	Sec.7A.7.8	"New dead end road not ending in a full cul-de-sac shall be marked with a Hazard Barricade as shown on **Std. Dwg. R-22**".
7	Intersection	Sec.7A.8.1	Sight distances shown are **minimum. Desirable sight distances** are 130m for 50km/hr. and 165m for 60km/hr.

Section	Reference		Revision
8	Conduit Depth	Sec.8.1.5	Minimum Depth of Bury: 0.6 m in boulevard, 0.9m in travelled roadway.
8	Splices	New Sec.8.1.8	Splices shall be made weather-proof.
8	Conductors	Sec.8.2.1	...shall be **stranded** copper.... Add "Anticipated future extension of circuit loads to be confirmed by contractor by contacting Engineer prior to construction".
8	Permits	Sec.8.2.1.	Add "The contractor shall submit a copy of the permit and outline the scope of work covered by the permit prior to commencing work".
8	Conduit Installation	Sec.8.3.4	Add "Service conduit shall be complete and continuous to the service entrance switch".
8	Poles	Sec.8.2.7	Add "Grounding stud (or bolt) shall be galvanized $\frac{1}{4}$ inch min. and each pole shall be bonded at this stud.
8	Service Base	Sec.8.2.9	Add "The backing plate, if required, shall be galvanized steel".
8	Service Panel	Sec.8.2.10	Add "Service conduit shall be continuous to the Hydro connection".

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	T2 Unshrinkable Fill, Concrete Capping and Encasement
	T3 Trench Dams
4	Water - Design and Installation
	W1 Gate Valve
	W2 Fire Hydrant Assembly
	W3 Thrust Block details
	W4 Air Valve
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	W6 19mm Metered Water Service
	W7 19mm Unmetered Water Service
	W8 50mm Metered Water Service
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A P P E N D I X E S

GENERAL CONDITIONS 1

GENERAL CONDITIONS 1

1.1_ Scope

This manual of Engineering Standards has been compiled to reflect the minimum requirements for the design and construction of municipal works and services within the District of North Cowichan. The manual is intended to provide information to Developers, Contractors and Consultants. These standards may be required to be exceeded based on site conditions. In all cases, good engineering judgement must prevail.

These standards are intended to provide information related to design and construction only; requirements related to development approval processes are not covered by this manual.

1.2 Definitions

In these specifications, unless the context otherwise requires, the following definitions shall apply:

"Developer" shall mean that person or company who has applied for approval of a proposed development or to service an existing parcel of land as an owner.

"Contractor" shall mean any person or company, including sub-contractors, which shall undertake the installation of municipal works and services on behalf of either the Developer or the Municipality.

"Developer/Contractor" shall mean either the Developer or Contractor as may apply, depending upon the particular project.

"Consulting Engineer" or "Consultant" shall mean that Professional Engineer, retained by the Developer to be responsible for design, preparation of drawings and specifications, contract administration, inspection, as-built records and any other engineering services required in connection with the provision of Municipal works and services. The Consulting Engineer shall be registered in the Province of British Columbia and possess the appropriate qualifications and experience to provide the required professional services.

"Engineer" shall mean the Municipal Engineer or his authorized representative.

"Municipal" or "Municipality" shall refer to The Corporation of the District of North Cowichan.

"Municipal right-of-way" shall refer to any road or easement right-of-way, statutory right-of-way, laneway or other right-of-way registered in the name of the Municipality.

"Other Utilities" shall mean those utilities located in Municipal rights-of-way that are owned and operated by other jurisdictions. These utilities shall include hydro, telephone, cable vision and gas.

1.3 Works and Services to be Provided

Works and services shall be provided as required by all applicable by-laws and Council policies.

1.4 Engineering

The Developer shall retain a Consulting Engineer who shall be responsible for design, preparation of drawings and specifications, contract administration, inspection, testing, as-built records and any other engineering services required in connection with the provision of Municipal works and services for a project. Where necessary, other Professional Engineers shall be retained to provide specialized engineering services.

1.5 Letter of Assurance

Prior to design approval, the Municipality shall be provided with a Letter of Assurance, signed by the Developer and the Consulting Engineer, confirming that sufficient engineering services will be provided to ensure that the required works and services can be installed in accordance with Municipal Engineering Standards. A sample copy of a Letter of Assurance is contained in Appendix "C".

1.6 Design Approval

Design approval must be obtained from the Engineer prior to any construction. Construction may not commence until design drawings stamped "Approved for Construction", signed by the Engineer, have been returned to the Consulting Engineer by the Municipality.

It is also the Developer's responsibility to obtain the approval of any other authority having jurisdiction over any aspect of a project prior to submitting for construction approval.

1.7 Design Changes

If the Consulting Engineer or Contractor wishes to make a change in the design either before or during the execution of the work, a written request, including prints of the proposed revisions, shall be submitted by the Consulting Engineer to the Engineer for review. Installation of the works shall not proceed unless approval has been granted.

1.8 Legal Boundaries

Before commencing the works, all existing legal boundaries shall be clearly staked. It is the Developer's/Contractor's responsibility to maintain legal stakes, monuments and pins and to replace those removed or damaged during construction.

1.9 Permits, Notices, Laws and Regulations

The Developer/Contractor shall obtain and pay for all necessary permits or licenses required for the execution of the work. The Developer/Contractor shall give all necessary notices and pay all fees required by law and comply with all laws, ordinance, rules and regulations relating to the work and to the preservation of public health and safety.

1.10 Business Licence

The Contractor shall hold a current Business Licence issued by the District of North Cowichan, and may be required to present the said licence to the municipality prior to the commencement of work.

1.11 Safety

The Developer/Contractor shall be responsible for the safety of all workmen and equipment on the project in accordance with all applicable safety legislation passed by federal, provincial and local authorities governing construction safety. The attention of the Developer, Contractor and Consulting Engineer is specifically directed to the safety regulations of the Workers Compensation Board. No approval will be given to installations which cannot be inspected because of unsafe working conditions. The Contractor shall be registered under the Worker's Compensation Act and the Contractor and the Contractor's employees shall be entitled to the benefits thereof. Before the start of a project, a Notice of Project shall be forwarded to the local Worker's Compensation Board office.

1.12 Municipal Utility Connections

Connections to existing Municipal utilities shall be by Municipal forces at the Developer's expense. Payment of the estimated charge is required prior to installation, with final charges based on actual cost. No work will be scheduled prior to receipt of payment. Work schedule will be subject to availability of labour, equipment, and materials.

1.13 Contractor's Qualifications

The required works and services must be installed by a contractor qualified to carry out the particular type of work required. The Engineer may request the contractor's previous experience on similar projects and reserves the right to disqualify a contractor should the contractor be unqualified.

1.14 Liability

The Contractor shall protect himself and indemnify and save the Municipality harmless from any and all claims which arise from the Contractor's operations where bodily injury, death or property damage is caused and for this purpose shall, without restricting the generality of the foregoing, maintain insurance acceptable to the Municipality to the limits set forth as follows:

(a) Contractor's Public Liability and Property Damage

1) Bodily Injury - Inclusive limits not less than $1,000,000.00.

2) Property Damage - Each Accident - $1,000,000.

(b) Vehicle Public Liability and Property Damage

1) Bodily Injury - Inclusive limits not less than $1,000,000.00.

2) Property Damage - Inclusive limits not less than $1,000,000.00.

The Municipality shall be named as an additional insured on the Contractor's public liability and property damage policy, and shall be provided with thirty (30) days notice in writing should a policy be cancelled or changed.

The Contractor shall maintain general liability insurance covering premises and operations liability, contractor's contingency liability with respect to the operations of subcontractors, completed operations liability, contractual liability and automobile liability insurance (owner, non-owned, or hired units).

The Contractor shall furnish acceptable evidence of compliance with all requirements of the applicable Workers' Compensation Act or Ordinance of the Province including payment due thereunder.

All liability insurance policies shall be written in such terms as will fully protect the Contractor notwithstanding his assumption of liability and his indemnification covenants.

Prior to commencement of any work hereunder, the Contractor may be required to file with the Municipality a copy of each insurance policy and certificate required. All such insurance shall be maintained until final completion of the work including the making good of faulty work or materials except that coverage of completed operations liability shall in any event be maintained for twelve (12) months from date of acceptance as approved by the Engineer.

1.15 Construction Site

Sites under development shall be signed or barricaded to identify them as private property until final approval and acceptance by the Municipality.

1.16 Construction Permit

Prior to undertaking any construction in an existing Municipal right-of-way, the Contractor shall obtain a **Highway Construction Permit** from the Municipality. Conditions of permit issuance include the posting of a performance bond in the amount of 150% of the estimated construction cost, indemnification and release of the Municipality from any claims, damages and costs, and proof of insurance as detailed under Section 1.14.

1.17 Traffic Control

Certified traffic control personnel and approved signage shall be provided for construction taking place in municipal rights-of-way in accordance with Municipal construction permit requirements (Section 1.16). The Municipality and all local emergency services (Police, Ambulances, Fire Departments, etc.) must be notified and advised of proposed construction, and any anticipated lane closures, detour routes, etc., 24 hours in advance.

1.18 Operation of New Works

Underground services shall not be permitted to operate as part of the existing Municipal system until the works have been approved and accepted by the Engineer in writing.

1.19 Operation of Municipal Works

Unless otherwise approved, municipal works shall be operated by Municipal personnel only. The Contractor shall not be permitted to operate or alter any portion of any existing Municipal system without the written consent of the Engineer.

1.20 Damage to Municipal Works

Any damage to Municipal works must be reported immediately, with all repairs to be performed by Municipal personnel at the Developer's/Contractor's expense. The Developer/Contractor shall also be responsible for maintaining all Municipal roads and utilities in a clean and acceptable condition as determined by the Engineer. Any costs incurred by the Municipality will be charges to the Developer/Contractor.

1.21 Stoppage of Work

The Engineer has authority to stop the progress of the work whenever in his opinion such stoppage may be necessary to ensure the protection of public safety, public utilities, or private property. This includes authority to make such changes and to order, assess and award the cost of such work extra to the Developer/Contractor or otherwise as may in his opinion be necessary.

1.22 Inspection

General and sufficient resident inspection shall be provided by the Consulting Engineer to ensure that the works and services are constructed in accordance with the approved design drawings. Sufficient inspection

shall range from a minimum of one site visit per day during construction to full time resident inspection for major developments. The Consulting Engineer shall submit copies of his inspection reports, when requested, to the Engineer. At least 24 hours advance notice shall be given to the Engineer prior to the start of construction and subsequent stages, ie. start of watermain installation, start of sewer installation, start of curb installation etc., and prior to the testing of roadworks, underground municipal utilities and street lighting. A series of Inspection Checklists have been included in Appendixes "A" and "B". These checklists shall serve as a general guide as to the extent and standard of inspection expected by the municipality.

1.23 Final Inspection

Prior to requesting a final inspection of the works and services by the Municipality, the Consulting Engineer and Contractor shall carry out a thorough review of the project to identify and remedy any deficiencies. The Inspection Checklists contained in Appendixes "A" and "B" shall be used as references. The Consulting Engineer shall also thoroughly review as-built record information and make any changes necessary.

Upon request for a final inspection, the Consulting Engineer shall submit the following:

(a) Two copies of the as-built drawings.

(b) A copy of the draft legal plan and confirmation that the legal pins have been installed.

(c) Copies of all test results.

(d) Video inspection reports.

(e) Completed copies of the Final Inspection Checklist.

Following receipt and review of the above noted information, a final inspection shall be carried out with the Consulting Engineer, Contractor and Engineer in attendance. The Consultant shall provide the Contractor and Engineer with a written summary of the final inspection, listing any deficiencies and the proposed course of action.

1.24 As-built Records

The Consulting Engineer shall be responsible for the preparation of as-built records as detailed in Section 2. Certified, reproducible as-built drawings and service cards shall be submitted to the Municipality within four weeks of completion of the project and prior to final approval of the works.

1.25 Letter of Certification

The Consulting Engineer shall provide a Letter of Certification at the time the as-built records are submitted, to confirm that the required works and services have been installed in accordance with Municipal Engineering Standards. A sample copy of a Letter of Certification is contained in Appendix "D".

1.26 Survey Monuments

Integrated survey monuments shall be installed in new developments at the time of construction. Proposed monument locations shall be submitted for approval and installation shall comply to the latest revision of the "Specifications and Guidelines for Control Surveys" as published by the Ministry of Crown Lands Surveys and Resource Mapping Branch.

1.27 Rectification, Repair and Maintenance

The Developer shall be responsible for and at his own expense execute all work, repair, alteration, reconstruction or replacement required to remedy any defect, fault or deficiency in or developing in the completed work during construction and also during a minimum period, herein referred to as the "maintenance period", of one year after the date of approval of all the works by the Engineer. The Developer shall also be responsible for the design and construction of additional works and services as may be required to remedy faults that arise during the maintenance period. Extension of the maintenance period may be required by the Engineer where maintenance items or concerns are still outstanding after the one year period.

All such works of rectification, repair and maintenance shall, during the maintenance period, be executed as the need for them becomes apparent or upon the written request of the Municipal Engineer. Should the Developer neglect or fail to commence the execution of such works within a space of seven (7) days from the date of written request for their performance, the Municipality shall be entitled to obtain the remedy using the maintenance security. Work which is deemed to be in need of urgent repair will be performed by the Municipality at a cost to the Developer.

All work shall be carried out by a qualified contractor and design and inspection services shall be provided by a Consulting Engineer.

1.28 Maintenance Security

During the maintenance period, the Developer shall provide maintenance security in the amount of ten percent (10%) of the project construction cost in accordance with bonding requirements noted below.

1.29 Bonding of Uncompleted Works

Any bonding of uncompleted works shall be at 150% of the estimated cost of completion. In general, bondable items only include asphalt paving and road base construction.

1.30 Fees and Bonds

The Developer shall be required to pay all fees and post all bonds as may be prescribed by the Municipality.

All bonding shall either be in the form of a cash deposit, certified cheque or letter of credit. All letters of credit shall include an automatic extension clause as specified by the Municipality.

Bonding amounts shall be based on estimates provided by the Consulting Engineer and approved by the Engineer.

1.31 Final Approval of Works

Prior to requesting final approval and acceptance of the works the Consulting Engineer shall ensure that the following has been submitted to the Municipality:

(a) Two sets of certified, as-built drawings and one reproducible set.

(b) Service cards.

(c) Letter of Certification (Appendix D).

(d) Copies of test results.

(e) Copies of any geotechnical or other engineering reports.

(f) Video inspection reports.

(g) Final inspection summary.

(h) Municipal Works Statistics Summary (Appendix E)

(i) List of any deficiencies that are proposed to be bonded.

(j) Any cost estimates that are required to determine bonding amounts.

(k) Proposed maintenance bond amount.

(l) Copies of any legal plans and documents including statutory rights-of-way, easements, covenants and other legal agreements.

(m) Confirmation of final approval from other agencies as may be required.

Final approval of the works will not be considered until all required information has been received and reviewed.

1.32 Engineer's Decision

The Engineer shall decide on questions relating to the interpretation of these standards, and the performance of the work, and his decision shall be final.

GENERAL CONDITIONS 1

ENGINEERING DRAWINGS 2

2.1 Scope

This section shall govern the preparation of engineering drawings associated with development approval and the installation Municipal works and services.

2.2 General

2.2.1 Standard Requirements

The following shall apply to **all** engineering drawings submitted to the municipality:

(a) Existing Information

Any information received from the Municipality on existing services should be used as a guide only. Verification of locations and elevations must be checked by actual survey. Contours as shown on Municipal orthophotos are approximate only and should be verified as required. The Municipality assumes no responsibility for the accuracy of service information obtained from Municipal records.

(b) Legal Information

All legal boundaries, including roads, statutory rights-of-way, private easements and covenants shall be shown complete with legal descriptions.

(c) Scales

Drawings shall be produced at standard metric scales as specified below. Bar scales must be shown on all drawings.

(d) Elevations

Elevations are to be shown in metric geodetic datum (G.S.C.), (mean sea level 0). Integrated survey monuments numbers, locations and elevations can be obtained from the Municipal Engineering Department.

(e) Drawing Standard

All drawings shall be produced in accordance with good drafting and engineering practice and the specific requirements detailed below. Drafting may be performed either manually or by computer. Symbols and line types shall be as shown in Appendix "F". In general, toning or screening shall not be used; if used it must be of a low density so as not to obscure details when printed, photocopied, or microfilmed.

2.2.2 Standard Engineering Drawings

Following is a list of standard engineering drawings related to developments and the construction of municipal works and services. Detailed requirements for each type of drawing are listed separately below.

(a) Development Approval

Drawings that may be required as a condition of the development approval process include the following:

- Preliminary Layout Plans
- Schematic Servicing Plans
- Drainage Area Plans
- Building Grade Plans

(b) Standard Servicing Design

Design of standard municipal services including roads, water, sewer, and storm drains shall be shown on Plan/Profile Drawings and Cross Sections.

(c) As-built Records

Municipal service installations records are kept in the form of as-built drawings and service cards.

2.3 Preliminary Layout Plan

2.3.1 General

A Preliminary Layout Plan shall be provide upon application for preliminary layout approval for a development.

2.3.2 Drawing Standard

(a) The scale shall may range between 1:250 to 1:2500, depending on the size of the project and detail of information required.

(b) Where ever possible, the drawing should be sized to allow for reproduction on 11"x 17" size paper.

(c) Drawings shall be drafted in ink using Leroy type lettering.

2.3.3 Information Required

(a) Standard information as noted in Section 2.2.

(b) The boundaries of all adjacent properties and, where feasible, the relationship of the proposed subdivision to at least one road intersection. Where the subdivision fronts on an existing road, both sides of the road and the road width shall be shown.

(c) The layout, dimension and size of all proposed lots and roads.

(d) The location, dimension and size of all buildings, driveways or other improvements existing on the property including any encroachments.

(e) The location of any water courses, drainage route or ditches.

(f) The location of any wells, septic tanks and sewage disposal fields.

(g) Topographic information with contours at 2.0 m intervals. On very steeply sloping ground, larger intervals will be accepted. Orthophotos showing topographic information may be purchased from the Municipality.

(h) The location of existing services including utility poles, sanitary sewer, storm sewer, watermains and non-municipal underground utilities. The size and type of existing municipal utilities shall be shown as applicable. If new services are required to service the development, the locations of these proposed services shall be indicated.

(i) Proposed phasing of development, if any.

2.4 Schematic Servicing/Key Plan

2.4.1 General

A Schematic Servicing Plan shall be provided for any project requiring more than one plan/profile drawing.

In the case of a subdivision, the Preliminary Layout Plan should form the basis for the Schematic Servicing Plan.

2.4.2 Drawing Standard

(a) The scale shall generally be 1:1000, however other standard scales may be used provided the required information can be shown clearly.

(b) Standard drawing sheets or CAD Template disk as supplied by the Municipality shall be used unless approval otherwise is given by the Engineer.

(c) Drawings shall be drafted in ink using Leroy type lettering.

2.4.3 Information Required

(a) Standard information as noted in Section 2.2.

(b) Contours at 1.0 m intervals except on very steeply sloping ground, where 3.0 m intervals will be accepted.

(c) Existing and proposed road alignment and lot layout.

(d) Schematic layout of existing and proposed water, sewer and storm drain systems, including the location of all valves, hydrants, manholes, catch basins and other appurtenances.

(e) Proposed sidewalk location where required.

(f) Location of street lighting, if any.

(g) Proposed phasing of development, if any.

(h) Index of plan/profile design drawings.

2.5 Drainage Area Plan

2.5.1 General

A drainage area plan must accompany storm drainage calculations for a subdivision or development.

2.5.2 Drawing Standard

(a) The scale shall be 1:2500 unless otherwise required by the Engineer.

(b) Drawings may be drafted in pencil using freehand lettering.

2.5.3 Information Required

(a) Onsite and offsite drainage areas.

(b) Existing and proposed drainage system.

(c) The 200 year storm flood routing paths.

(d) Contours as per Municipal orthophoto contour overlays. Contour accuracy to be verified as necessary.

(e) Existing and proposed road and lot layout.

2.6 Building Grade Plan

2.6.1 General

Building grade plans may be required by the Engineer in areas where driveway grades, drainage outlets, servicing elevations, etc. may have a critical impact on the development of the lot.

2.6.2 Drawing Standard

(a) The scale shall be 1:500 unless otherwise required by the Engineer. If possible, the Plan/Profile drawings should be used as a base for these plans.

(b) Drawings may be drafted in pencil using freehand lettering.

2.6.3 Information Required

(a) Existing ground elevations of lot corners and proposed building site. Include the location and depth of any fill areas.

(b) Location and invert elevations for storm and sanitary services.

(c) Location of water service.

(d) Minimum footing elevation (MFE), and critical finished landscape elevations.

(e) Direction of surface drainage and location of drainage swales, ditches and catch basins.

(f) Proposed driveway location and grade.

2.7 Plan/Profile Drawings

2.7.1 General

(a) Design drawings for standard municipal service installations shall show the plan and profile of all existing and proposed roads, sanitary sewers, storm drains and watermains, including all appurtenances and their relative position to property lines. The drawings shall also show in plan view the location of existing or proposed power, telephone, cablevision and gas lines. All services are generally to be shown on one drawing, with proposed works shown as bold lines and existing works shown as thinner lines.

(b) Reference bench marks and elevations shall be shown on the design drawings.

(c) In general, dimensioning should be given from an existing or proposed lot line or iron pin. Chainages must be tied to iron pins.

(d) The plan/profile design drawings shall form the basis for the as-built drawings required upon completion of construction.

2.7.2 Drawing Standard

(a) Horizontal scale shall be 1:500. Vertical scale shall generally be 1:50, however, 1:100 should be used for profiles with steep grades in order to avoid staggering the profile.

(b) Standard drawing sheets or CAD template disk as supplied by the Municipality shall be used unless approval otherwise is given by the Engineer.

(c) Plan view shall be on the lower half of the sheet and profile view on the upper. Construction notes should be confined to a separate note column on the right hand side of the sheet. A north arrow shall be located in the upper right hand corner of the plan portion of the sheet.

(d) Symbols and line types shall be as shown in Appendix "F".

(e) Drawings shall be drafted in ink using Leroy type lettering. Lettering shall have a minimum height of 2.0 mm. Line work must be of uniform width and density with a minimum pen size of 0.25 mm (3 x 0). Lettering may be may be either vertical or sloped.

2.7.3 Specific Information Required

(a) Roads and Parking Areas

i) Show all iron pins adjacent to the works and the existing ground elevation at each pin or proposed pin.

ii) Both plan and profile must be tied to an iron pin, preferably near or at 0 + 00 chainage. If the chainage exceeds 120 m, a second tie shall be shown.

iii) Show the road width, curb and sidewalk offsets measured from the property line to the face of curb as defined on Standard Drawing R12.

iv) Road profiles shall show centre line elevations.

v) Detail the road construction with a cross-sectional view of any non-standard construction.

vi) The profile shall be shown at true centre line length and projected to provide as close as possible relationship to the plan.

vii) Locate catch basins in accordance with specifications.

viii) Locate barricades.

ix) Locate ditches and centre of pavement in minimum road construction by offsetting to property line.

x) Existing driveways and proposed driveways in critical locations shall be shown as well as profile of these driveways from the road centre line to a point 6.0 m within the property.

xi) Chainage of the BC and EC or horizontal curves shall be shown together with the centre line radius. Curb radii are not required if the centre line radius and road width are shown, except on curb returns at intersections if other than 9.0 m, at the end of cul-de-sacs, and on any curbs where alignment is not directly related to the centre line radius.

xii) The percent grade to two decimal places shall be shown on the profile together with the following information on vertical curves:

- The chainage and elevations of BVC, EVC, and VPI;
- The length of vertical curve;
- The elevation and chainage of the low spot of sag curves;
- The value "k" calculated as the length of the vertical curve in meters divided by the algebraic difference percent grades.

xiii) On super-elevated curves and cul-de-sacs on vertical and horizontal curves, show the gutter profile of each curb (no centre line profile).

(b) Sewer and Drain

i) The following information shall be shown on the profile:

- Size, type, class of pipe.
- Percent grades to two decimal places.
- Invert elevations at both inlet and outlet of manholes;
- Information on vertical curves as detailed in Section 2.7.3(a)xii), except for the value "k";
- Any existing utilities.

ii) The following information shall be shown on the plan:

- Give information on horizontal curves as detailed in Section 2.7.3(a)xi);
- Indicate pipe offsets from property line;
- Indicate if connections to be installed at a grade other than two percent.
- Proposed invert elevations of sanitary sewer and storm drain lot services and the lowest existing ground elevation at building site.
- Show location of existing and proposed service connections.

iii) The following additional information shall also be shown on the appropriate part of the drawing:

- Sewer and drain manholes and cleanouts shall be labelled in accordance with the municipal labelling convention. Prior to submitting design drawings, the consultant shall contact the North Cowichan Engineering Department to confirm the labelling sequence.

- Structural detail of all manholes not covered by Municipal Standard Drawings.

- The location of existing and proposed sewage disposal fields and perc sites.

- The location of existing and proposed open ditches, drainage courses and culverts.

(c) Water

i) Drawings shall indicate whether the watermain passes over or under other underground services which it is crossing.

ii) Show the offset of the main centre line from the property line.

iii) Indicate the size, type and class of pipe.

iv) Indicate extent of work required of the Municipality in making the connection to the existing watermain.

v) Show all hydrants, valves air valves and other appurtenances.

(d) Structures

i) Show the location and dimensions of underground vaults or chambers. Also show the elevation of the top and floor of the structure, and the invert elevations of any pipes entering or leaving the structure.

ii) Show the location and dimensions of bridges or major culvert structures. Also show the elevation of the deck, the underside of the structure and the current water level.

iii) Show the elevation of all existing and proposed basement floors where critical.

(e) Lighting

i) Location of existing and proposed underground wiring for street lighting.

ii) Location, wattage and type of proposed luminaries.

(f) Non-Municipal Utilities

i) Dimension the offset from property line and/or iron pins of the existing underground conductors or mains and the location of all appurtenances related to the system including house connections. Refer to the appropriate utility for complete details of existing underground installations. Offsets to be verified through the appropriate utility.

ii) Dimension the location of all poles, both existing and proposed from the pole road face to property line and/or iron pin.

iii) Proposed underground utilities shall be shown schematically in a dashed line form.

iv) Show typical trench cross-section detailing location of conduit banks, conductors and gas mains.

2.7.4 Plan/Profile Submission and Approval

The Consulting Engineer shall submit three copies of each drawing, duly sealed and signed, to the Engineer for approval. The Engineer reserves the right to request copies of design notes at his discretion. Prior to approval of engineering drawings, the Engineer may require that pertinent features such road centre lines and utility locations be staked in the field. Cross sections may also be required and driveways proven in critical locations.

2.8 Cross-Sections

2.8.1 General

Cross-sections shall be provided as requested by the Engineer in order to aid in the review of proposed roads, driveways parking areas and various utility installations.

2.8.2 Drawing Standard

(a) Horizontal scale shall be 1:100. Vertical scale shall generally be 1:50. Vertical grid spacing shall not exceed 10 mm.

(b) Starting at the lower left hand corner of the drawing sheet, cross-sections shall be placed up the sheet in order of increasing chainages. Grid elevations shall be shown at the left hand side of each cross-section and chainages shall be shown below each cross-section. Adequate space shall be left between cross-sections so as to ensure clarity.

(c) Cross-sections may be drafted in pencil using freehand lettering.

2.8.3 Information Required

(a) Cross-sections shall be provided at minimum 15.0 m intervals, however additional sections shall be shown at all road intersections, driveways and other critical cuts or fills (ie. creek crossings)

(b) Information shown shall include but not be limited to the location and elevation of road centre line, edge of pavement, edge of shoulder, ditches, top of bank, bottom of bank, ground at property line, etc.

2.9 As-Built Drawings

2.9.1 Scope

This section pertains to the as-built drawings of all Municipal works and services.

2.9.2 General

(a) Within four weeks of completion of the municipal improvements and prior to the registration of a subdivision plan, the Consulting Engineer shall supply two sets of prints and one reproducible set of as-built drawings.

(b) The drawings shall accurately represent the services as they were installed and reflect all changes from the design.

(c) The drawings shall be signed, sealed and dated by the Consulting Engineer and include the following statement:
"I certify that the following services (name them)_____were inspected during construction and to the best of my knowledge, were installed in accordance with District of North Cowichan Engineering Standards and as shown on this drawing."

(d) All proposed street names shall be approved by the Municipality and placed on the Engineering Drawings and legal plan prior to the submission of As-builts/legal plan.

2.9.3 Tolerances

All horizontal locations shall be to the nearest 100 mm and all vertical locations to the nearest 5 mm except that road horizontal locations shall be to the nearest 30 mm and ground elevations and house connection inverts at property line may be to the nearest 30 mm .

2.9.4 Additional Information Required

As-built drawings shall generally be based on the plan/profile design drawings with additional information added as specified below.

(a) Roads

i) Location of end of curb, sidewalk and pavement.

ii) Location of any driveways and driveway access culverts.

(b) Sewer and Drain

i) Profile of rock cuts and hardpan requiring blasting.

ii) The invert elevation at both inlet and outlet of manholes.

iii) Elevation of manhole rims and catch basin grates.

iv) Tie locations of manholes, cleanouts and other appurtenances to iron pins in boulevards or easements.

v) Locate catch basin leads at the main by chainage from the centre of the downstream manhole and show in wye drainage table.

vi) Locate house connections at property line showing distance from the nearest I.P. Locate house connections at the main by chainage from the centre of the downstream manhole and show in wye chainage table.

vii) Show invert elevations of sewer and drain house connections at the property line or edge of right-of-way.

viii) Manhole and cleanout labelling to conform to municipal labelling convention.

(c) Water

i) Show domestic water services and tie to corner iron pin.

ii) Profile of rock cuts.

iii) Profile of main.

iv) Tie locations of fire hydrants to main valve.

v) Locate all valves and tie to iron pin in boulevards or easements.

(d) Lighting

i) Location of underground wiring and lamp standards;

ii) Location of relays, photo-electric controls and circuitry.

(e) Non-Municipal Utilities

i) As-built non-municipal utilities shall be shown schematically in a dashed line form.

ii) Show typical location and cross-section of conduit banks, conductors and gas mains.

iii) A note shall be included stating that appropriate utilities shall be contacted to confirm utility locations.

2.9.5 Schematic Servicing Plan

The schematic servicing plan shall be revised to conform to the as built drawings and where possible, submitted in CAD format as noted below. These drawings will be used as the basis for Municipal servicing overlays, and must clearly show the following information:

(a) Standard information as noted in Section 2.2.1.

(b) Road alignment and lot layout.

(c) Schematic layout of water, sewer and storm drain systems, including the location of all valves, hydrants, manholes, catch basins and other appurtenances.

(d) Size and material type of all watermains, sewers and storm drains.

(e) Labelling of manholes and cleanouts to conform with municipal labelling convention.

(f) Sidewalk location where required.

(g) Location of street lighting, if any.

(h) Index of plan/profile design drawings.

2.9.6 CAD Drawings

Where the drawings have been produced using a CAD system, a disk shall be submitted with the as-built drawings in an AutoCad compatible format.

2.10 Service Cards

2.10.1 The Consultant is required to fill out Municipal service cards for all service installations.

2.10.2 The information required and the format of the service cards shall be as per sample service card shown in Appendix "G". Blank service cards may be obtained from the Municipal Engineering Department.

2.10.3 Service cards shall be completed in conjunction with the as-built drawing revisions and the information contained thereon must be consistent.

2.10.4 Where required by the Engineer, Building Grade information shall be shown on the service card.

ENGINEERING DRAWINGS 2

TRENCHING, BACKFILLING AND RESTORATION 3

3.1 Scope

This section shall govern excavation, bedding, backfilling and restoration related to the installation of underground municipal utilities.

3.2 Excavation

3.2.1 General

The limits of the excavation shall be established and any asphalt or concrete shall be cut in neat straight lines by means of a saw or asphalt cutting wheel, in accordance with Standard Drawings T1 and T2. Care shall be exercised to minimize the undermining of any adjacent asphalt, curbs, sidewalks, etc. The trench shall only be excavated as far in advance of the pipe laying as permitted by the Engineer.

3.2.2 Grade/Alignment

The trench shall be excavated so that the pipe can be laid to the alignment, grade and depth required. All excavation shall be made exactly to lines and grades as shown on the drawings. No deviation from authorized lines and grades shall be made without the written authority of the Engineer.

3.2.3 Uniformity

The sub-grade shall provide a uniform and continuous support for the pipe bedding on solid undisturbed ground. Any over excavation shall be backfilled with sand or gravel and thoroughly compacted.

3.2.4 Trench Cross Section

The trench cross-section shall suit the utility being installed. Typical cross-sections are shown on Standard Drawings T1 and T2.

In general, the minimum width of trench below the crown of the pipe shall be not less than the outside diameter of the pipe plus 300 mm, or 600 mm whichever is the greater and the maximum width of the trench shall be not more than the outside diameter of the pipe plus 600 mm, plus allowance for trench support.

3.2.5 Rock

Where excavation is made in rock, or where excavation is made in a material which cannot provide an even, uniform, and smooth surface or where large stones are encountered in the trench, such material shall be removed to provide a clear distance between any part of projection of such material and the surface of all pipe and fittings to permit the minimum bedding depths noted below. The sub-grade shall then be formed by backfilling with an approved bedding material compacted to 100% Standard Proctor Density. The finished sub-grade surface shall be shaped to provide a uniform and continuous support for the pipe bedding. All rock blasting and excavation shall continue a minimum of 1.5 metres beyond all ends of line. Any loose blasted rock shall be removed from the trench walls.

3.2.6 Unstable Subgrade

Where the sub-grade of the trench is unstable and will not properly support the pipe, or where it contains material harmful to the pipe such as ashes, refuse, vegetable or organic matter, such material shall be excavated to the width, depth and length required and shall be disposed of in a manner approved by the Engineer.

The sub-grade shall then be made by backfilling with an approved sand or gravel compacted in maximum 150 mm layers to 100% Standard Proctor Density. The finished sub-grade surface shall be shaped to provide uniform and continuous support for the pipe bedding.

Where the sub-grade cannot be made to properly support the pipe by replacing unsound material with compacted sand or gravel, a foundation for the pipe shall be constructed of pilings, timber, concrete or other material. The design details of such a support structure must have prior approval of the Engineer before construction.

3.3 Safety

3.3.1 Shoring

Open cut trenches shall be shored and braced as required by the Accident Prevention Regulations of the Workers' Compensation Board and Municipal Ordinances and as may be necessary to protect life, property, and the work.

All Municipal employees have been instructed not to enter excavations which are not properly braced. No approval will be given to installations which cannot be inspected because of unsafe working conditions.

3.3.2 Barricades

Excavations shall be securely barricaded and fenced as required to protect construction personnel and the general public. Flashing barricades shall be provided at night in road and walkway areas. If additional barricades must be installed the Municipality the cost will be charged to the contractor.

3.3.3 Traffic Control

Traffic control shall be provided in accordance with Section 1.17.

3.4 Blasting

3.4.1 Blasting for excavation will be permitted only with the approval of the Engineer and only when proper precautions are taken for the protection of persons or property. The procedure used in blasting shall conform to applicable Federal, Provincial and Municipal Laws. A blasting permit must be obtained from the Municipality prior to blasting.

3.5 Shoring

3.5.1 When using movable trench support, care should be exercised not to disturb the pipe location, jointing or its bedding.

3.5.2 Removal of any trench protection below the top of the pipe and within 2½ pipe diameters of each side of the pipe should not take place after the pipe bedding has been compacted. For this reason, movable trench supports should only be used in either wide trench construction where supports extend below the top of the pipe or on a shelf above the pipe with the pipe installed in a narrow, vertical-wall subditch.

3.5.3 Any voids left in the bedding material by support removal should be carefully filled with granular material which is adequately compacted. Removal of bracing between sheeting should only be done where backfilling proceeds and bracing is removed in a manner that does not relax trench support.

3.5.4 When advancing trench boxes or shields, care must be taken to prevent longitudinal pipe movement or disjointing, and damage to existing municipal utilities.

3.6 Bedding

3.6.1 Materials

(a) Bedding shall be a granular, free draining material, evenly graded from coarse to fine with a maximum size of 20 mm and a maximum 10% passing a 0.075 mm sieve. It shall be free of any organic material, silt or clay, and shall compact readily under trench conditions.

(b) The bedding used must suit trench conditions and pipe type. Particular attention shall be paid in wet conditions to ensure that the bedding is capable of proper placement and compaction in a saturated state. Where necessary, a screened or washed bedding material shall be used.

(c) All bedding shall be imported from an approved supplier.

3.6.2 Depths

(a) All pipe shall be bedded to a depth of 300 mm above the top of the pipe.

(b) The minimum depth of bedding below any pipe or fittings shall be 100 mm in a uniform trench and 150 mm in rock.

3.6.3 Installation

(a) Bedding cross-sections shall be as shown on Standard Drawings T1 and T2.

(b) Installation of bedding shall be in accordance with these standards and the manufacturer's recommendation for the pipe being installed. Placement and compaction procedures may vary depending upon trench conditions and the type of pipe and bedding being used.

(c) Prior to placing bedding, the trench bottom shall be prepared to provide a uniform and continuous support for the pipe in accordance with Section 3.2.

(d) Bedding under the pipe shall be placed by hand and compacted to 100% of Standard Proctor Density to the depth specified in Section 3.6.2.

(e) Further bedding material shall be placed by hand around the pipe and thoroughly compacted with hand tampers in layers having a maximum depth of 150 mm to the same level as the top of the pipe. Bedding material at this point shall completely fill the void between the pipe and trench wall and shall be firmly compacted throughout. Compaction shall be 100% of Standard Proctor Density. Care shall be taken in compacting above pipe invert grades to ensure that the pipe is not shifted laterally or vertically. In particular, care must be taken when bedding pipe in wet conditions to ensure that the pipe does not float upwards.

(f) Care shall be taken when depositing the bedding in the trench with a machine. Initial bedding must be deposited in small quantities and placed by hand to ensure that the pipe is not displaced laterally or vertically.

(g) Where the pipe has already been covered, bedding may be dumped directly in the trench in volumes not exceeding one-half (½) of a cubic metre and shall be spread evenly by hand to a thickness not exceeding 150 mm per layer. Each layer shall be compacted to 100% of Standard Proctor Density against the trench wall while the material immediately over the pipe

shall be left loose. The pipe bedding shall be levelled off 300 mm above the top of the pipe and shall not be mounded over the pipe.

The trench shall then be backfilled.

3.7 Backfilling

3.7.1 Backfill cross-section shall be in accordance with Standard Drawings T1 and T2.

3.7.2 Granular Backfill

(a) Where a pipe is installed beneath an existing or foreseeable future road, curb, sidewalk, driveway or gravel shoulder, the backfill shall be pitrun gravel, compacted to a minimum 98% Standard Proctor Density. Compaction shall be in layers of 150 mm using a hand operated compactor or in 300 mm layers using a hoe-pac. In the latter case, the gravel shall extend at least 1 m beyond the curb, sidewalk or future edge of pavement. Care must be taken to ensure that the compaction method does not adversely affect pipe.

(b) In areas of rock excavation, ensure that any voids in the trench walls are carefully filled and compacted.

(c) If required to meet optimum moisture requirement, a controlled amount of water shall be added to the gravel to ensure optimum moisture content for compaction.

(d) Use of granular backfill other than import pitrun gravel will not be permitted unless specifically approved by the Engineer.

(e) Granular backfill shall have the following gradation when tested in accordance with ASTM C136:

US Standard Sieve Size	% Passing (by Weight)
75 mm	100 %
25 mm	50-85 %
0.15 mm	0-16 %
0.075 mm	0-5 %

3.7.3 Native Backfill

(a) Suitable native materials as approved by the Engineer may be used as backfill where the pipe is installed in untravelled areas. Backfill in these cases shall be free of stones over 150 mm size, frozen material, organic, or other perishable or objectionable material that would prevent proper consolidation or might cause subsequent settlement.

(b) Where it is required to replace topsoil it shall occupy the upper 200 mm of the trench and shall be heaped on top to allow for settlement.

3.7.4 Unshrinkable Fill

(a) Installation of unshrinkable fill may be required in areas where no trench settlement can be tolerated. Materials and installation shall be as specified below unless otherwise approved by the Engineer.

(b) Materials shall conform to the requirements of the latest revision of the applicable CSA Standard.

(c) Unshrinkable fill shall contain a maximum of 25 kg. of Type 10 Portland cement per m^3. For winter construction, Type 30 Portland cement may be used.

(d) The slump of unshrinkable fill, as measured in accordance with CAN3-A23.2-5C, shall be between 150 and 200 mm.

(e) When air entrainment is required, the total air content, as measured in accordance with CAN3-A23.2, shall be between 4 and 6%.

(f) The maximum 28-day compression strength, measured in accordance with CAN3-A23.2-9C, shall not exceed 0.40 Mpa.

(g) Once the utility has been bedded with sand in accordance with regular procedures, the trench shall be filled with the unshrinkable fill up to the under side of the pavement. Internal vibrators or other methods of consolidation shall be used to ensure that any undercut areas of pavement are fully supported. Temporary plating or other means of supporting traffic loads shall be used to provide a safe driving surface until the unshrinkable fill has set and the pavement has been replaced. Temporary plating must be anchored to prevent movement.

3.7.5 Concrete Encasement and Capping

Where adequate cover cannot be provided, or additional protection is required, the pipe may be concrete encased or capped as shown on Standard Drawing T2, subject to the Engineer's approval. Concrete encasement should not be used on watermain installations; concrete capping, ductile iron pipe, or a protective sleeve should be used instead.

3.7.6 Testing

The Consulting Engineer shall arrange for periodic testing of compaction within the pipe zone and the trench. Test results shall be submitted to the Engineer for review.

3.7.7 Large Excavations

Backfilling of large excavations containing structures such as vaults and manholes shall be to the same standard as the backfilling of trenches. Particular care shall be taken to ensure that placement of backfill and compaction is evenly distributed around the structure in order to avoid undue pressures at any one location.

3.7.8 Subsurface Drainage

Special attention shall be paid to accommodating subsurface drainage that might accumulate in utility trenches. Where necessary, trench dams and subsurface inlets connected to the storm drain system or other approved outlet shall be installed to intercept drainage.

3.7.9 Trench Dams

Trench dams shall be constructed as required in order to control the migration of bedding and backfill in areas with steep grades. Spacing and location shall suit site conditions. Trench dams shall be constructed so as to encase the pipe and key into the trench walls to form a water-tight dam. The minimum width at the base shall be 0.75 m.

Concrete trench dams shall be constructed of wetted sandbag sacks filled with wet pre-mixed concrete. Sacked concrete shall be laid in courses such that joints in succeeding courses are staggered. Courses shall be a minimum of nine (9) per vertical metre.

Clay trench dams shall be installed in 150 mm lifts at the locations shown on the drawings or as directed by the Engineer. Relief drains shall be installed at trench dams as directed by the Engineer.

3.8 Restoration

3.8.1 Roads

(a) Gravel filled trenches or cold-mix asphalt paved trenches shall be restored to the original surface prior to final paving.

(b) Collector roads must be paved immediately following backfilling. Cuts in all other roads must be paved within 3 days of backfilling. If weather conditions do not permit hot-mix asphalt, cuts shall be paved using cold-mix asphalt and replaced as weather permits.

(c) In all cases, existing asphalt must be cut back a minimum distance of 300 mm from the top of the trench wall as shown on Standard Drawing T1.

(d) Where the edges of any area requiring repaving extend outside the straight lines cut, further cuts shall be made so that the final patch will have a neat appearance.

(e) Any area of pavement adjacent to the excavation which has become deformed due to excavation practices or blasting shall be removed and repaved as above.

(f) Pavement cuts which have settled shall be removed and the trench recompacted and repaved.

(g) All pavement markings shall be restored to match original.

3.8.2 Concrete Curbs and Sidewalks

a) Concrete curbs and sidewalk panels shall be removed to the nearest joint.

b) Following backfilling, sidewalks shall be restored immediately with crush gravel or a plywood walkway to match the existing sidewalk. Barricades and signs shall be placed as required.

c) Concrete curbs and sidewalks shall be replaced within three days of backfilling. If conditions do not permit the pouring of concrete, asphalt shall be used and replaced.

d) Concrete curb and sidewalk installation shall be in accordance with the requirements of Section 7B.6.

e) Temporary access around or over the curing concrete shall be provided, and barricades and signs shall be placed as required.

3.8.3 Other Areas

(a) Untravelled areas shall be restored to a condition equal to that found prior to construction.

(b) Where topsoil is required it shall be placed at a thickness of 200 mm. If the installation is under a developed lawn, the soil shall be fine raked during the appropriate season, sown with a top quality grass seed at the rate of 50 grams of seed per square metre and rolled.

(c) Untravelled areas which have settled shall be filled, regraded and restored as required.

TRENCHING, BACKFILLING AND RESTORATION 3

4A.1 Scope

This section shall cover design standards and material specifications for municipal water systems.

4A.2 Water Demand Calculation [BL3986]

The water distribution system shall be designed according to the following minimum demand rates.

The design population shall be computed in compliance with the Official Community Plan or based on the planned development, whichever is larger. In the absence of detailed population information, the following minimum design population densities shall be used.

Archetype/Use	Population Density	Units
Residential		
Manufactured Home	1.44	pers/unit
Single Family Home	2.31	pers/unit
Single Family Home w Suite (per dwelling unit)	2.09	pers/unit
Duplex	2.09	pers/unit
Townhome	2.41	pers/unit
Apartment	1.49	pers/unit
Non-Residential		
Institutional	90	pers/ha
Commercial	50	pers/ha
Industrial	90	pers/ha

1. per/unit = persons per unit.
2. per/ha = persons per hectare.

4A.2.1 Residential Water Demand

Water demand associated with residential loads shall be calculated using the demand rates below.

Average Day Demand (ADD) Rate	450 L/c/d
Maximum Day Demand (MDD) Rate	960 L/c/d
Peak Hour Demand (PHD) Rate	1,470 L/c/d

4A.2.2 Institutional, Commercial, Industrial (ICI) Water Demand

ICI demands shall be determined on a case-by-case basis.

In the absence of detailed water demand information, the minimum design population densities set out in Section 4A.2.2 and the residential water demand rates set out in Section 4A.2.3 shall be used. The design water demand shall be calculated by first calculating the equivalent ICI population based on the site area. The equivalent ICI population is then multiplied by the maximum day demand rate of 960 L/c/d (litres per capita per day).

It is generally assumed that there is no peak hour demand for ICI uses.

4A.2.3 Fire Flow Requirements

Required fire flows shall be in accordance with the latest release of "Water Supply for Public Fire Protection" as published by the Fire Underwriter's Survey.

During a fire situation, the system shall be designed to supply an adequate volume of water at a minimum residual pressure of 140 kPa (20 psi).

The following table is meant to be a general guide only. In certain circumstances a design based directly on and required fire flow calculated as prescribed in the latest release of "Water Supply for Public Fire Protection" may be required.

Use Description	Required Fire Flow (L/s)	Duration (hrs)
Residential		
Single Family Residential	60	1.40
Multi-Family Residential	120	2.00
Non-Residential		
Institutional	150	2.00
Commercial	150	2.00
Industrial	225	2.90
1. L/s = liters per second. 2. hrs = hours.		

4A.3 Water Pressures

Maximum and minimum design pressures are:

- maximum desirable	700 kPa	(100 psi)
- minimum, MDD	275 kPa	(40 psi)
- minimum, PHD	240 kPa	(35 psi)
- minimum, MDD + Fire at Hydrant	140 kPa	(20 psi)
- minimum, static at building site	275 kPa	(40 psi)

Where distribution pressures will exceed 700 kPa (100 psi) due to a drop in elevation a pressure reducing station shall be installed as part of the distribution system. Individual pressure reducing valves shall be installed by the home owner on all service connections where the pressure exceeds 580 kPa (84 psi). Individual pressure reducing valves are also recommended on all services in multi-pressure zone areas.

4A.4 [Deleted: BL3986]

4A.5 Hydraulic Network

Depending upon the complexity and extent of the proposed distribution system the Municipality may require a hydraulic network analysis diagram showing design flows and pressures. The hydraulic network shall be designed to distribute the design flows at the pressure specified. A standard grid main network is required throughout a residential subdivision. Except in cul-de-sacs of less than 150 metres length, all watermains shall be looped.

4A.6 Distribution System

4A.6.1 Piping

(a) Location

Unless otherwise approved by the Engineer, watermains shall be located in the road right-of-way in accordance with Standard Drawings R7 and R8. In accordance with the Ministry of Health requirements, no storm or sanitary sewer is to be constructed within 3.0 m of a watermain, nor within 0.45 m vertical clear separation at sewer cross-unders without the written permission of the Public Health Engineer.

(b) Depth

All watermains shall have at least 1.0 m of cover to finished grade. Where 1.0 m cover cannot be provided, installation at a shallower depth may be approved by the Engineer, subject to there being adequate cover to support live loads and provide frost protection. Use of ductile iron pipe or a protective sleeve should be considered. Concrete encasement of watermains will not be permitted.

(c) Size

Watermains shall be sized as determined by the network analysis to provide design flows and pressures. No watermain shall be less than 150 mm diameter.

(d) Curvature

Radius of curvature shall be uniform throughout the curve and shall not be less than 60 metres; in no case shall the deflection required to achieve the design curvature exceed the manufacturer's recommended deflection for the material being used.

4A.6.2 Valves

In general, valves shall be located at intersections and at a spacing not exceeding 300 m. Valves shall be positioned so that generally no more than one hydrant or 25 homes are isolated. In larger trunk and feed mains where no interconnections are made, the spacing of valves should not exceed 600 metres. Main valves should be placed at hydrant tees wherever possible.

4A.6.3 Hydrants

Hydrant distribution shall be in general conformance with the "Water Supply for Public Fire Protection", but in all cases spacing shall be such that the maximum distance from the hydrant to the centre of the building site measured along the centre line of the street is 150 metres. The maximum lineal spacing between hydrants shall be 150 metres unless otherwise approved by the Municipality.

4A.6.4 Blow Offs

Where a water main ends in a dead end, a blow off shall be provided for flushing purposes. Where a blow off is used, it shall be a temporary blow off if there is a possibility the line could be extended in the future. If there is no possibility of future extension, a permanent blow off shall be used as shown in the detailed drawings.

4A.6.5 Health Certificate

The design drawings for the distribution system shall be forwarded to the local Ministry of Health Public Health Engineer for approval in accordance with Section 21 of the Health Act. Construction shall not commence until a Final Certificate has been received.

4A.7 Materials

All materials in the watermain installation shall conform to the following specifications, and shall be subject to inspection and testing at the discretion of the Engineer.

4A.7.1 Watermains

(a) Ductile Iron Pipe

Ductile Iron Pipe shall conform to the latest AWWA designation C151. Pipe manufactured to these specifications shall be at least Class 50. The ductile iron pipe shall be cement mortar lined in accordance with the latest AWWA C104. Where corrosive soil conditions exist, the Engineer may require special protection for the pipe. Joints for pipe shall be rubber gasket in accordance with the latest AWWA C111.

(b) Polyvinyl Chloride (PVC) Pressure Pipe

PVC pressure pipe shall conform to AWWA designation C900 and CSA B137.3. Unless otherwise specified on the drawings all pipe shall be Class 150, DR 18, minimum. All PVC pipe shall have rubber gasket bell and spigot joints with cast iron outside diameter dimensions.

(c) Steel Pipe

Steel pipe shall only be used in applications as approved by the Engineer. Steel pipe, fittings and specials, shall conform to the following standard specifications:

AWWA C200 - Standard for Steel Water Pipe 150 mm and larger ASTM A415
AWWA C208 - Standard for dimensions for Steel Water Pipe Fittings

The size of the pipe shall be as shown on the Design Drawings. Wall thicknesses shall be determined in accordance with AWWA MII, Steel Pipe Design and Installation. The minimum wall thickness shall be 6.3 mm. The joints shall be plain ends for mechanical couplings.

The interior surface of the steel pipe fittings and specials shall be cleaned and lined with coal-tar enamel in conformance with AWWA C203 Standard for Coal-Tar Enamel Protective Coatings for Steel Water Pipe. The exterior surface of specials and fittings shall be coated with a primer and wrapped with polyethylene tape to provide a corrosion resistant coating equal to an extruded pipe coating. The exterior protective coating for fittings and pipe inside underground changers shall consist of 2 coats of coal tar epoxy, as per AWWA C-210.

4A.7.2 Fittings

All fittings for ductile iron and PVC pipe shall be:

(a) Cast iron fittings manufactured to AWWA C110 designed for a working pressure of 1035 kPa. (150 psi)

(b) Asphalt coated ductile iron compact fittings manufactured to ANSI/AWWA C153/A21.53-84.

Mechanical seal joints on fittings to pipe shall be formed by a bell and preformed rubber gasket suitable for the pipe to which the joint is made.

Flanged joints on fittings shall be flat faced conforming in dimension and drilling to ANSI B16.1.(125lb).

Ends shall be flanged or belled to suit pipe ends.

Thrust blocks shall be provided as shown in the drawings.

4A.7.3 Valves

All valves used on pipe 50 mm to 300 mm diameter shall be gate valves of the same size as the pipe. Unless otherwise approved by the Engineer, valves shall be Mueller or Terminal City.

Valves for pipe larger than 300 mm diameter shall be as specified by the Engineer.

Gate valves shall be in accordance with AWWA C509 and the following supplementary data:

(a) Unless otherwise specified, gate valves shall be suitable for a minimum working pressure of 1034 kPa (150 psi).

(b) Gate valves shall have a cast iron body, bronze mounted.

(c) Gate valves shall be resilient seat, with a non-rising stem.

(d) Valve ends shall be provided to fit the pipe.
(e) The position of the valve in line shall be vertical.

(f) Stem seals shall be o-ring.

(g) Valves shall open to the left (counter-clockwise).

(h) Extension pieces shall be used where valve operator nut bury is deeper than 1.2 m.

(i) Gear operators will be required on valves 400 mm in diameter and larger. Gear cases shall be totally enclosed.

(j) Valves shall be flanged to fittings.

(k) Bypasses will be provided on valves 510 mm in diameter and larger. Ends shall be bell or mechanical at junctions with pipe. Joints shall be formed with a mechanical seal which is the equivalent of that used in jointing the pipe.

(l) Valves shall have a 50 mm square operating nut.

4A.7.4 Valve Boxes

Valve boxes shall be Nelson Type of cast iron and telescoping so that surface loads are not transmitted to the valve body or pipeline. Victoria Foundries No. 30-72 or approved equal shall be used. A minimum of 300 mm of adjustment shall be available on all valve boxes. Generally valve hoods acceptable to the Engineer shall be provided on all gate valves 250 mm in diameter or larger. In cases where the valve is smaller but the valve box extension will not fit over the valve stuffing box a valve hood shall be used.

4A.7.5 Hydrants

Installed fire hydrants shall meet the following specifications:

(a) Hydrants shall be compression type complying fully with AWWA standard C502. Hydrants shall be Model C71P as manufactured by Terminal City Iron Works Limited to North Cowichan Standards.

(b) Hydrants shall be counter clockwise opening and have a standard pentagonal operating nut.

(c) The hydrant lead shall be minimum 150 mm diameter and made of the same material as the mainline piping.

(d) Hydrants shall have two nominal 65 mm (2½") diameter hose outlets without independent cut-off. The 65 mm diameter hose outlets shall conform to the BC Fire Hose Thread Standards.

There shall also be one nominal 100 mm diameter (120 mm OD) pumper outlet. The 100 mm diameter pumper outlet shall conform to the BC Fire Hose thread Standards, nominal 100 mm IP, 117.5 mm OD (4.625") male, 6 threads per 25 mm (6 TPI).

(e) Hydrants shall be painted yellow above the ground line to an average dry thickness of 2.5 mils.

(f) Drain outlets shall be provided.

(g) A gate valve shall be provided between the hydrant and the main line, flanged to a flanged tee in the main. Installation shall be in general accordance with AWWA M17. Hydrants shall not be flanged to the main or gate valve.

4A.7.6 Air Valves

All air valves shall be 25 mm diameter, Terminal City, Double Acting, for watermains up to 300 mm diameter. Bushings, reducers and unions to be used in the valve connection shall be brass manufactured to CSA specification A 40.2 using ASTM B-62 Bronze. Nipples shall be standard brass and threaded at both ends.

Service valves for use in air valve assemblies shall have screw ends and shall be brass or bronze. Gate valves 100 mm or less in diameter shall be wedge disc type with non-rising stem, hand wheel and stuffing box glands, as specified for 1375 kPa water (860 kPa steam) service.

Air valves for watermains greater than 300 mm diameter shall be as approved by the Engineer.

4A.7.7 End of Lines

End of assemblies (blow offs) shall be constructed from minimum 50 mm diameter galvanized, Sch. 40 steel pipe. All valves shall be cast iron body gate valves conforming to AWWA C506, as detailed in Section 4A.7.3. Where required, air valves shall conform to the requirements of Section 4A.7.6. Caps or air valves shall be connected to the blow off pipe with a 38 mm fire hose connection (*) to permit easy removal and connection of a fire hose. (* Specifically, No.'s F2D-11 and F2D-12 fire coupling adapters as supplied by Fleck Bros. or approved equal.)

4A.7.8 Small Diameter Valves

All valves between the sizes of 19 mm and 40 mm diameter shall be brass body, solid wedge, gate valves with inside screw, non-rising stem and screw-in bonnet. Valves shall be rated for minimum 125 lbs. saturated steam and 200 lbs. non-shock cold water, oil or gas. Valves shall be Jenkins Bros, Crane, or approved equal.

4A.7.9 Water Services

(a) Size

Service connections shall be 19 mm diameter unless otherwise designated by the Engineer. All components, e.g., corporation stop, curb stop, shall be the same size as the service pipe to which they are connected.

(b) Pipe

Pipe for underground service 50 mm diameter and smaller shall be Type K annealed copper conforming to ASTM B88 or Polyethylene pipe conforming to CSA B137.1. Poly pipe to be identified as Series 160, Municipal Potable Water tubing.

Schedule 40 PVC pipe is also acceptable for 40 mm and 50 mm diameter services.

Pipe for underground service greater than 50 mm and less than 100 mm diameter shall be PVC series pipe conforming to ASTM D2241 and certified by Canadian Standards Association

under CSA Standard B137.3 - 1973. Pipe for services 100 mm and greater diameter shall be as specified for the distribution piping.

(c) Corporation Stops

Corporation stops shall conform to AWWA C800. Sizes 19 mm and 25 mm diameter shall have AWWA standard threaded inlet and compression type outlet. Sizes 40 mm and 50 mm shall have iron pipe thread inlet and compression or iron pipe thread outlet.

Shutoff head shall be solid tee head type.

Corporation stops shall be "Ford" or "Mueller" unless otherwise approved by the Engineer.

(d) Curb Stops

Curb stops shall be supplied with compression or iron pipe thread inlets and outlets, as required.

Curb stops with compression ends shall only be "Ford" or "Mueller" unless otherwise approved by the Engineer.

Shutoff head shall be solid tee head type.

(e) Couplings and Joints

Couplings for jointing copper shall be compression type. Sweated joints shall not be permitted.

Couplings for jointing polyethylene shall be compression type.

Compression type couplings shall be "Ford" or "Mueller" unless otherwise approved by the Engineer.

(f) Pipe Saddles

Pipe saddles shall be broad band, strap type with brass body and stainless steel straps designed and approved for the size and type of pipe on which they are installed. All saddles shall be double strap, except that single strap saddles may be used for 19 mm services installed on pipe 200 mm diameter and smaller. Unless otherwise approved, saddles shall be Robar #2706.

4A.7.10 Meters

(a) General

All water meters shall conform to the following:

(i) Unit of measurement shall be Imperial gallons (Igal) with a resolution of 1000 Igal.

(ii) Meter shall be equipped with a Sensus Touchread Pitlid (TR-PL) remote reading system.

(b) Residential

Meters used for 19 mm diameter residential services shall be Sensus TR-PL 16 mm x 19 mm positive displacement meters. They shall be supplied with a bronze bonnet and plastic bottom. Meter boxes and setters shall be installed by the contractor. Water meters shall be supplied to the Municipality by the contractor, with installation by the Municipality at the time of building permit.

(c) Multifamily/Commercial/Industrial

Meters for multifamily, commercial, and industrial application shall be installed by the Municipality at the Developers' expense, unless otherwise approved by the Engineer. Following are three options for providing domestic and fire connections:

(i) Domestic Only

Meters used with services ranging in size from 19 mm to 50 mm diameter shall be Sensus TR-PL positive displacement meters. Sizes 19 mm through 40 mm shall be supplied with a brass bonnet and plastic bottom.

For applications requiring meters ranging in size from 75 mm to 200 mm diameter either Sensus SRH Compound meters or Sensus Series "W" Turbo-Meters shall be used. Meter selection shall suit high and low flow requirements.

Bypasses shall be provided on all meters 50 mm diameter and larger.

(ii) Combined Domestic and Fire

For applications where domestic and fire demands are supplied from the same internal system, a Sensus Fire Line Fire Service Assembly shall be used. This assembly includes a UL Listed, FM approved strainer and detector check valve, a Turbo-Meter for high flows, and a "W" Series Turbo-Meter for low flows.

(iii) Separate Domestic and Fire

For applications where fire demands are to be supplied from a designated fire system separate from the domestic system, a Sensus TrimLine Detector Check Valve/Meter Trim Package shall be used. This package includes a UL Listed, FM approved detector check valve with a small positive displacement meter to detect usage. Approved backflow prevention shall be provided by the Developer and installed on private property to isolate the fire system from the Municipal system. Domestic demands shall be supplied by a separate meter and service as noted above.

(d) Meter Setters

Meter setters shall be "Ford", "Mueller", or "Jones", unless otherwise approved by the Engineer. All meter setters must have the same dimensions and configuration so as to be interchangeable.

(e) Meter Boxes and Chambers

In untravelled areas as determined by the Engineer, meter service boxes for water services 40 mm diameter and smaller shall be "Ametek" or "Brooks" 300 mm standard meter boxes complete with standard lids and 150 mm box extensions as required, or approved equal.

In travelled areas (roads, driveways and sidewalks), service boxes for water services 40 mm diameter and smaller shall be "A.E. Concrete Precast Products", 300 mm x 500 mm concrete meter boxes complete with flush steel traffic cover marked "water" and extension sections as required, or approved equal.

Service boxes or chambers for water services larger than 40 mm diameter shall be as approved by the Engineer.

WATER DESIGN 4 A

4B.1 Scope

4B.1.1 This section shall govern the installation of water pipe and waterworks appurtenances within the Municipality.

4B.2 General

4B.2.1 Any installations, not covered by this section, shall be in accordance with current AWWA Standards and manufacturer's recommendations.

4B.2.2 During construction, water and debris shall be prevented from entering the new system by keeping the excavation sufficiently dewatered and also by capping or plugging any openings with watertight fittings. Pipe and fittings shall be protected from contamination during construction.

4B.2.3 Any connection to the existing system shall be carried out by Municipal Crews at the Developer's expense. Operation of existing valves or hydrants shall be by Municipal personnel only.

4B.2.4 Where installation of other services cross under Asbestos Cement watermains, the Engineer may require that a section of the A.C. main be replaced with Ductile Iron or PVC pipe such that the full trench width is bridged. This work shall be done by Municipal Crews at the Developer's expense.

4B.2.5 Ductile iron pipe shall be installed without joint conductance unless specifically required for corrosion protection.

4B.3 Piping

4B.3.1 Standards for excavation, bedding, backfilling and restoration shall be in accordance with Section 3.

4B.3.2 Pipe shall be handled, stored and laid in accordance with the recommendations of the pipe manufacturer. Particular care shall be taken to ensure that before each joint is made, the pipe is cleaned and all dirt and other debris removed.

4B.3.3 Pipe shall not be backfilled until the bedding, grade and alignment has been approved by the Consulting Engineer.

4B.3.4 All pipe shall be laid to the designed alignment and grade with the following tolerances:

a) Horizontal tolerance shall not be greater than 100 mm from designed location;

b) Vertical tolerances shall not be greater than 19 mm from designed grades on 200 mm and larger watermains.

4B.4 Gate Valves

4B.4.1 Gate valves shall be installed at the location shown on the design drawings in accordance with Standard Drawing W1.

4B.4.2 Each valve shall be provided with a valve box as specified on the Standard Drawing. The valve box shall be centred and plumb over the wrench nut of the valve, shall be set evenly on the valve bonnet, shall be supported so it does not transmit shock or stress to the valve and shall be braced against lateral movement of the sides of the trench. The top of the valve box shall be adjusted to the elevation required by the Engineer. Valve boxes, which are not plumb nor centred over the valve nut shall be dug up and reset properly.

4B.4.3 A stem extension shall be installed where the valve operating nut bury is deeper than 1.2 m.

4B.5 Hydrants

4B.5.1 Hydrants shall be installed at the locations shown on the design drawings in accordance with Standard Drawing W2.

4B.5.2 All hydrants shall be plumb and shall have their nozzles parallel with or at right angles to the street, with pumper nozzles facing the street.

4B.5.3 Hydrants shall be connected to the watermain by a hydrant lead conforming to the pipe material used for the mains. A 150 mm valve shall be connected to the watermain by a tee.

4B.5.4 A concrete pad shall be installed below the hydrant and a sump pit shall be provided containing not less than 0.2 m^3 of coarse gravel placed up to a level of 100 mm above the drain port.

4B.6 Air Valves

Air valves shall be installed at the locations shown on the design drawings and in accordance with Standard Drawing W4. Care shall be taken to ensure that the air valve is properly located in the chamber to permit maintenance and removal. The air valve chamber must also be free draining; installation of a connection to the storm drain system may be required to ensure this.

4B.7 End of Lines

Permanent or temporary end of line assemblies shall be installed as applicable at the locations shown on the design drawings in accordance with Standard Drawing W5. Care shall be taken to ensure assemblies are properly located and the chambers properly drained as required for air valve installations.

4B.8 Reaction Blocking

4B.8.1 All plugs, caps, tees, crosses, reducers, valves, and bends deflecting 11¼ degrees or more, and all points where there is unrestrained thrust, shall be anchored to prevent movement by providing suitable reaction blocking, metal harness, or tie-back rods. Reaction blocking details are shown on Standard Drawing W3.

4B.8.2 Reaction blocks shall be concrete having a compressive strength of not less than 20.7 Mpa at 28 days.

4B.8.3 Blocking shall be placed between undisturbed ground and the fitting to be anchored. The arrangement of the blocking shall be as shown on the standard drawing and all blocks shall be sized in accordance with good engineering practice for the prevailing soil conditions. The reaction blocking shall be so placed that the pipe and fittings will be accessible for repair. Where reaction blocking comes in contact with piping, burlap sacking shall be placed between the pipe and concrete.

4B.8.4 Metal harness made of steel tie rods and concrete blocking shall be used for valves and vertical leads.

4B.8.5 End of line valves and caps shall be tied back with rods anchored to concrete reaction block as shown on Standard Drawing W3.

4B.9 Water Services

4B.9.1 Water services shall be installed at the locations shown on the design drawings in accordance with the Standard Drawing W6.

4B.9.2 Water services shall generally be installed to the center of the lot frontage, however common trench servicing with sewer and storm services will be considered in special circumstances.

4B.9.3 A minimum of 100 mm of bedding shall be placed under the pipe and 300 mm of bedding shall be placed over the pipe. Trenching, bedding, and backfilling requirements shall be in accordance with Section 3.

4B.9.4 Meter boxes and meter setters shall be installed by the contractor. Plastic meter boxes shall be used in untravelled areas. Concrete meter boxes, complete with steel lid, shall be used if the meter box is located under a travelled area such as a driveway. Care shall be taken to ensure that all boxes are installed as close as possible to finished grade.

4B.9.5 Water meters shall be supplied to the Municipality by the contractor, with installation by the Municipality at the time of building permit.

4B.9.6 All water services shall be connected to the main by means of an approved service saddle. Single strap saddles may be used for 19 mm services and double strap saddles shall be used for all services larger than 19 mm. The water service pipe shall be connected to the upper half of the watermain inclined at an angle of 30 degrees with the horizontal leaving a suitable gooseneck. A corporation main stop shall be installed at the main in accordance with the manufacturer's specifications or instructions. Water services shall be installed from the watermain to the property line using the shortest and straightest route, however sufficient slack shall be provided to allow for settlement during backfilling and compaction.

4B.9.7 Wooden markers shall be installed at all curb boxes, meter boxes and/or termination of building services. The marker shall be 50 mm x 100 mm (2" x 4") wood and shall extend from the invert of the service to 600 mm above ground level. The top 600 mm shall be painted blue.

4B.10 Testing

4B.10.1 General

(a) The Contractor shall be responsible for the testing of the system under the direction of the Consulting Engineer. All necessary labour, materials, and equipment shall be provided by the Contractor including a suitable pump and measuring tank, pressure hoses, connection plugs, caps, gauges, and all other apparatus necessary for filling the main, pumping to the required test pressure and recording the pressure leakage losses.

(b) The Municipal Inspector shall be notified 24 hours in advance of any proposed testing.

(c) Operation of the existing Municipal system during testing shall be by Municipal personnel only. The Consultant shall provide 48 hours notice when requesting operation of the Municipal system.

(d) The new system shall be filled with water slowly and the air bled off each hydrant. When the line has been filled and most of the air expelled time should be allowed for the remaining air and water to reach a constant temperature. Water introduced into the watermains will be at the Contractor's risk. All damage to the pipe from freezing or other causes shall be repaired.

4B.10.2 Pressure Test

(a) After backfilling is completed, a final pressure test shall be carried out in accordance with the latest AWWA specification C603 on all lines at the maximum expected operating pressure plus 345 kPa (50 psi) or a minimum of 1550 kPa (225 psi). Each section between valves shall be brought to test pressure with the valves closed to test the valves under pressure. Test pressure shall be held without loss for five (5) minutes before opening the valve and releasing the pressure into the next section.

(b) No pipe installation will be accepted until all required tests have been successfully performed.

(c) A further test consisting of opening and closing a hydrant on or near the test section at least three (3) times in a normal manner may be performed. The test is to ensure that the new system can withstand normal surges that are likely to be encountered and will be done by Municipal crews with the Contractor or his representative present.

4B.10.3 Leakage Test

(a) The test section with all intermediate valves open shall be brought up to test pressure and held for one hour. The pressure shall be maintained for one hour by pumping additional water into the test section from a measuring tank.

(b) The test section will not be accepted if leakage in litres (gallons) measured by the above method exceeds the quantity determined by the following formula:

$$L = \frac{ND\ \ P^{1/2}}{65{,}000} \qquad L(Imp) = \frac{ND\ (6.9P)^{1/2}}{11{,}600}$$

Where:

L = Allowable Loss (litres/hr.) L = imp. gallons
N = Number of joints N = Number of joints

D = Nominal diameter (mm) D = Nominal diameter inches
P = Test Pressure (kPa) P = Test Pressure PSI gauge

in which L is the allowable leakage in litres per hour, N is the number of pipe joints in the test section, D is the nominal diameter of the pipe in mm and P is the average test pressure in Kilopascals gauge (couplings shall be considered as having one joint in the above formula). If the leakage exceeds the allowable, the defects shall be located and repaired and the test repeated until the leakage is within the allowable limit.

4B.11 Disinfection

4B.11.1 Before being placed into service all new watermains shall be chlorinated throughout their entire length in accordance with the latest AWWA specification C601. The method to be used to introduce the disinfectant into the line must be approved by the Engineer and the Provincial Ministry of Health. Extreme care shall be taken to ensure that the existing system is not contaminated during the disinfection process. Municipal personnel shall be involved in the operating of any valves interconnecting the existing and new system.

4B.11.2 Three methods of chlorination approved by AWWA are the continuous feed method, the slug method , and the tablet method. The continuous feed method is generally the most applicable to the small diameter watermain installations found in new developments. This method is briefly outlined below for reference. The slug method is suitable for use with large diameter mains which, because of the volume of water involved, the continuous feed method is not practical. The tablet method is best suited to short extensions and small diameter mains, however it does not permit preliminary flushing. Refer to the latest revision of AWWA C601 for details of all three methods.

4B.11.3 When using the continuous feed method, water from the existing system shall be fed in the mains as chlorine is also fed at a constant measured rate. The two rates shall be so proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50mg/l free residual chlorine. During the application of chlorine, valves must be controlled to stop the treatment dosage from flowing back into the existing system. Chlorine application shall not cease until the entire main is filled with the chlorine solution; appropriate valves and hydrants shall be operated to ensure this. The chlorinated water shall be retained in the system for at least 24 hours, after which time the treated water shall not contain less than 25mg/l free residual chlorine throughout the system.

4B.11.4 After chlorination is completed the mains shall be thoroughly flushed. Disinfection water shall not be discharged to the sanitary sewer, drainage system or a natural water course. Where necessary, the disinfection water shall be dechlorinated in order to ensure the discharge meets Ministry of Environment and Federal Fisheries requirements.

4B.11.5 Twenty-four hours after completion of chlorination and flushing, bacteriological sampling and testing shall be carried out by the Municipality. The system shall not be put into operation until test results have been reviewed and approval has been granted by the Engineer.

4B.11.6 After the system has been approved by the Engineer, the system shall only be operated by Municipal personnel.

4B.12 Pressure Reducing Stations

4B.12.1 Pressure Reducing Stations shall be as approved by the Municipality of North Cowichan.

WATER SYSTEM INSTALLATION 4 B

MINIMUM THRUST AREAS FOR FITTINGS AT 1030 KPA PRESSURE AND SOILS WITH MINIMUM BEARING OF 96 KPA (NOT TO BE USED FOR SOFT CLAY, MUCK, PEAT, ETC.)											
TYPE OF FITTING	FITTING SIZE	OUTSIDE FITTING BEARING FACE	RECESS TRENCH WALL	LENGTH	HEIGHT	TYPE OF FITTING	FITTING SIZE	OUTSIDE FITTING BEARING FACE	RECESS TRENCH WALL	LENGTH	HEIGHT
	D	W	W	L	H		D	W	W	L	H
90° BEND	150	300		920	460	CROSS	150	300		610	460
	200	350		1070	610		200	350		760	610
	250	380		1450	760		250	380		990	760
	300	400		1650	920		300	400		1220	920
45° BEND	150	300		400	460	45° WYE	150	300	300	460	460
	200	350		610	610		200	350	400	610	610
	250	380		760	760		250	380	500	760	760
	300	400		920	920		300	400	600	920	920
22 ½" BEND	150	300		460	230	REDUCER *	150	300	350	460	460
	200	350		610	300		200	350	200	610	610
	250	380		840	460		250	380	250	760	760
	300	400		920	460		300	400	300	920	920
TEE	150	300		610	460	CAPS & PLUGS (IF NOT BELTED)	150	300		460	460
	200	350		760	610		200	350		610	610
	250	380		990	760		250	380		760	760
	300	400		1220	920		300	400		920	920

* DIMENSIONS APPLY TO THE LARGER END OF FITTING.

NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

SANITARY SEWER DESIGN 5 A

5A.1 Scope

This section covers design standards and material specifications for municipal sewer systems.

5A.2 Sewage Flow Calculation [BL3986]

5A.2.1 Sanitary sewer systems shall be designed to accommodate peak sewage flows with an allowance for inflow and infiltration.

5A.2.2 The design population shall be construed as being that population which contributes to the flow in each section of the system under design.

5A.2.3 The design population shall be computed in compliance with the Official Community Plan or based on the planned development, whichever is larger. In the absence of detailed population information, the following minimum design population densities shall be used.

Archetype/Use	Population Density	Units
Residential		
Manufactured Home	1.44	pers/unit
Single Family Home	2.31	pers/unit
Single Family Home w Suite (per dwelling unit)	2.09	pers/unit
Duplex	2.09	pers/unit
Townhome	2.41	pers/unit
Apartment	1.49	pers/unit
Non-Residential		
Institutional	75	pers/ha
Commercial	50	pers/ha
Industrial	90	pers/ha

1. pers/unit = persons per unit.
2. pers/ha = persons per hectare.

5A.2.4 Residential Sewage Flows

The average dry weather sewage flow shall be calculated by multiplying the average dry weather flow (ADWF) per capita flow rate of 240 L/c/d (litres per capita per day) by the contributory connected population.

The design peak dry weather sewage flow shall then calculated by multiplying the average dry weather sewage flow by a peaking factor. The peaking factor shall be calculated using the Harmon formula:

PFHarmon = 1 + 14 / (4 + P0.5)

P is the design contributory population in thousands.

5A.2.5 Institutional, Commercial, Industrial (ICI) Sewage Flows

ICI sewage flow rates shall be determined on a case-by-case basis.

In the absence of detailed sewage flow information, the minimum design population densities set out in Section 5A.2.3 shall be used. The design sewage flows shall be calculated by first calculating the equivalent ICI population based on the site area. The equivalent ICI population is then multiplied by the average dry weather flow (ADWF) per capita flow rate of 240 L/c/d (litres per capita per day).

It is generally assumed that there is no peak flow for ICI uses.

5A.2.6 Peak inflow and infiltration (I&I) shall be calculated based on a minimum rate of 22,500 L/ha/d (liters per hectare of design tributary area per day).

5A.2.7 The discharge of storm water into the sanitary sewer system is prohibited.

5A.3 Sewer Hydraulics

5A.3.1 System capacity for a sanitary sewer shall be designed using Mannings formula.

$$Q = \frac{1}{n} AR^{2/3} S^{1/2}$$

where
- Q = volume flow rate (m^3/s)
- N = resistance factor (Manning's N)
  - = 0.011 for PVC pipe
  - = 0.013 for Concrete pipe
- A = cross sectional area (m^2)
- R = hydraulic radius (m)
- S = slope (m/m)

5A.3.2 No sewer main shall be less than 200 mm in diameter unless otherwise approved by the Engineer. Installation of 150 mm diameter mains will only be considered for the last section of non-extendable lines where the grade is 2 percent or greater.

5A.3.3 No service connections shall be less than 100 mm in diameter. Service connections serving more than duplex family dwellings shall be minimum 150 mm in diameter and sized in accordance with design flows and available grades.

5A.3.4 The following shall be the minimum grades for each size of pipe:

SIZE	GRADE
100	2.0%
150	1.0%
200	0.5%
250	0.35%
300	0.25%

5A.3.5 All sewer mains shall be designed to provide a minimum velocity of 0.75 metres per second, and a maximum velocity of 4.5 metres per second. The minimum velocity for a curved sewer shall be 0.9 metres per second.

5A.3.6 Manholes shall be designed so as not to impede the hydraulic flow. The design shall incorporate a minimum elevation differential of 30 mm, in addition to the normal grade of the sewer.

5A.4 Depths

5A.4.1 Depths of all sewer mains shall be such that all basements in the area the sewer is intended to serve can be serviced by gravity.

5A.4.2 Minimum cover on sewer mains shall be 1.5 metres in travelled areas and 0.9 metres elsewhere unless otherwise approved by the Engineer.

5A.4.3 Where the specified cover cannot be provided, installation at a shallower depth may be approved by the Engineer. Use of alternative pipe types or concrete encasement may be required.

5A.5 Locations

5A.5.1 (a) Unless otherwise approved by the Engineer, sanitary sewers shall be located in the road right-of-way in accordance with Standard Drawings R7 & R8.

(b) Sanitary sewers may be installed in common trench with storm drains, provided the maximum invert elevation difference is 300 mm and the minimum lateral clearance between the walls of adjacent pipes is 500 mm. Where deflections are required to accommodate manholes and other works, only the storm drain shall be deflected from the design alignment.

(c) In accordance with Ministry of Health requirements, no storm or sanitary sewer is to be constructed within 3.0 m of a watermain nor within 0.45 m vertical clear separation at sewer cross-unders without the written permission of the Public Health Engineer.

5A.5.2 Where topography makes placement of sanitary sewers in the road right-of-way unfeasible, sanitary sewers may be located in a statutory right-of-way (SRW) over private property, subject to the following conditions:

(a) Municipal service locations and SRW widths shall conform to Standard Drawing R21.

(b) In general, manholes and cleanouts shall not be located in SRW's, however, where this cannot be avoided, only one manhole or cleanout should be located in a SRW without making provision for direct vehicular access.

(c) Where vehicular access to manholes or cleanouts in a SRW is required, a paved access lane shall be provided in accordance with Standard Drawing R21.

5A.6 Manholes and Cleanouts

5A.6.1 Manholes

(a) Manholes shall be located at grade changes, size changes, at the upstream end of all sewer mains, and at the junction of sewer mains and service connections 150 mm in size and larger as shown on Standard Drawing S2.

(b) Distances between manholes shall not exceed 120 metres.

(c) Where the difference in elevation between incoming and outgoing sewers exceeds 0.6 metres, standard drops shall be used as shown on Standard Drawing S3.

5A.6.2 Cleanouts

(a) Cleanouts shall only be used where approved by the Engineer.

5A.7 Curved Sewers

5A.7.1 Horizontal curves will be permitted where the right-of-way requires curvature for a constant offset and where the design velocity exceeds 0.9 metres per second. Vertical curves will be permitted under special circumstances where excessive cuts are to be avoided and where energy dissipation is required. Horizontal and vertical curves may not be used in combination on the same section.

5A.7.2 Radius of horizontal curvatures shall be uniform throughout the curves and shall be not less than 60 metres; in no case shall the deflection required to achieve the design curvature exceed the manufacturer's recommended deflection for the particular material being installed.

5A.8 Sanitary Service Connections

5A.8.1 Connections shall be installed in accordance with Standard Drawing S4.

5A.8.2 Minimum grade for a 100 mm service shall be two percent; minimum grade for a 150 mm service shall be one percent.

5A.8.3 Minimum cover on services shall be 0.9 m unless otherwise approved by the Engineer.

5A.8.4 Services shall be extended a minimum of 2.0 m into the lot in order to prevent undermining of the boulevard and to protect cleanout when connecting to service.

5A.8.5 Cleanouts shall be installed at property line on all sanitary sewer connections. Cleanout riser, complete with cast iron cap, shall be left 600 mm above ground at time of installation. Risers shall be adjusted by lot owner to suit finished grade.

5A.8.6 Where horizontal bends are required in the service pipe these shall be made with long radius bends.

5A.8.7 Where a horizontal bend greater than 45 degrees is required, a cleanout shall be constructed.

5A.8.8 Where the service connection on public property exceeds 15 m in length, the service shall be connected directly to a manhole.

5A.9 Pipe Materials

5A.9.1 The following materials may be used for sanitary sewer installations in the Municipality subject to the specifications and conditions listed below.

5A.9.2 Sanitary Sewer Mains

PVC (Polyvinyl Chloride)

- SDR35 PVC pipe may be used for sanitary sewer installations 150 mm diameter and larger.
- PVC pipe shall conform to the latest standards specified by ASTM D3034 and CSA B182.1.
- Connection of services shall be in accordance with manufacturer's recommendations using PVC fittings or saddles.

5A.9.3 Sanitary Sewer Services

PVC

- SDR28 PVC pipe shall be used for 100 mm diameter sewer service installations.
- SDR35 PVC pipe may be used for 150 mm diameter and larger sewer service installations, subject to adequate cover being provided
- PVC pipe standards shall be as per 5A.9.2 above.

5A.9.4 Alternate Materials

Alternate materials will be considered in special circumstances such as inadequate cover, subject to the approval of the Engineer.

5A.9.5 Pipe Selection

The class and type of pipe and fittings, together with required class of bedding and trench widths shall be so selected that the pipe will support the anticipated gravity earth and any surface dead and live loads with a safety factor of 1.5. In no case shall the depth of cover be less than 300 mm for rigid pipe or 750 mm for PVC pipe.

5A.9.6 Testing of Pipe Materials

All pipe is subject to testing and inspection at the discretion of the Engineer. The basis of acceptance shall be confirmation with the applicable ASTM and CSA specification. The cost of all testing shall be borne by the Developer/Contractor.

5A.9.7 Appurtenances

All appurtenances shall be of a type and standard compatible with the pipe on which it is being installed.

5A.10 Sanitary Sewer Force Mains

5A.10.1 The following shall be considered in the design of forcemains:

(a) All forcemains shall be designed for a 1.0 m/s minimum velocity and a detention time at minimum design flow not exceeding 12 hours.

(b) Forcemains should be designed without high points if possible so that air-relief valves will not be needed. Otherwise, an air-relief valve shall be provided at high points in the line.

(c) The top of the forcemain should be below the hydraulic grade line at minimum pumping rate.

5A.10.2 Forcemain materials and appurtenances shall be CSA approved and must be approved by the Engineer.

5A.11 Sanitary Pumping Stations

Where pumping stations are required on the sanitary sewer system, detailed design shall be submitted to the Engineer for approval. Some general criteria to be included in the design are:

(a) Duplex pump installations shall be required in all cases.

(b) The minimum storage time in the wet well shall be 10 minutes at peak design flow.

(c) The station shall be completely automated with standby power, alarm systems and controls all to be approved by the Engineer.

(d) Unless otherwise approved, Flygt pumps shall be used.

(e) The frequency of pump starts shall be in accordance with manufacturers' recommendations.

SANITARY SEWER DESIGN 5 A

SANITARY SEWER INSTALLATION 5 B

5B.1 Scope

5B.1.1 This section shall govern the installation of all sanitary sewer mains and their appurtenances within the Municipality.

5B.2 General

5B.2.1 Provision shall be made to maintain the flow of all drains, ditches, watercourses and service connection which may be encountered during the progress of the work. Where existing systems are anticipated or located during construction, the existing system shall be connected to the new installation or replaced. In every case the contractor and/or Consulting Engineer shall notify the Municipality when previously unidentified systems are found. The contents of any sewer, drain or service connection shall not be allowed to flow into the trench or into the main.

5B.2.2 The Contractor shall ensure debris and mortar droppings do not enter any part of the sanitary sewer system and shall leave all pipe lines, manholes, cleanouts, and other appurtenances in a thoroughly clean condition.

5B.2.3 Any connection or modification to existing works shall be by Municipal crews at the Developer's expense, unless specifically approved otherwise.

5B.3 Pipe Installation

5B.3.1 Standards for excavation, bedding, backfilling and restoration shall be in accordance with Section 3.

5B.3.2 Pipes shall be handled, stored and laid in accordance with the recommendations of the pipe manufacturer and in all cases gaskets shall be installed. Particular care shall be taken to ensure that before each joint is made the pipe is cleaned and all dirt and other debris is removed.

5B.3.3 Pipe laying shall commence at the lowest point of the length being laid and the pipes shall be placed with spigot ends pointing in the direction of flow.

5B.3.4 Pipe shall not be backfilled until the bedding, grade and alignment has been approved by the Consulting Engineer.

5B.3.5 All pipe must be laid to the designed grades and alignment within the following tolerances:

a) Horizontal tolerance from true alignment shall not be greater than 60 mm from the designed location and the rate of deviation shall not exceed 40 mm in 10 m.

b) Vertical tolerance from true grade shall not exceed the limitations as detailed in the table below:

Grade	Maximum Departure from Design Elevation	Maximum Rate of Deviation
over 5%	30 mm	6 mm in 3 m
2 % to 5%	15 mm	3 mm in 3 m
less than 2%	6 mm	3 mm in 3 m

5B.3.6 Where a sanitary sewer is being constructed as an extension to an existing Municipal system, gravel traps must be installed by the Municipality at the Developer/Contractor's expense.

Alternatively, the Engineer may require that the existing pipe remain sealed until the sewer extension is completed, flushed, tested and accepted by the Municipality. Upon acceptance, the seal may be removed and one length of pipe installed to connect the extension to the existing system.

5B.3.7 Where storm drains and sanitary sewers are installed in a common trench, there shall be a minimum 500 mm lateral clearance between the walls of adjacent pipes. Where deflections are required to accommodate manholes or other works, only the storm drain shall be deflected from the approved alignment.

5B.4 Manhole and Cleanout Installation

5B.4.1 The Contractor shall install all manholes, cleanouts and other appurtenances at the locations shown on the drawings. Installation shall be in accordance with the Standard Drawing for each appurtenance.

5B.4.2 Manholes, cleanouts, and other appurtenances shall generally be constructed of precast concrete sections as shown on the standard drawings. Precast concrete shall conform to ASTM C478.

5B.4.3 Manholes must be constructed so as to ensure that there is no infiltration or exfiltration.

5B.4.4 The base of the manhole or cleanout shall be poured in place concrete or precast by an approved supplier. The bases shall be constructed in accordance with the standard drawings.

5B.4.5 Manhole channelling shall be constructed as shown on the standard drawings. The channelling shall be shaped and finished to provide smooth passage for the sewage in order to minimize head losses and deposits at bends and at junctions. The drop from inlet to outlet must be provided as shown on the drawings.

Channels shall be accurately formed. The practice of forming channels roughly to shape and finishing with mortar cement will not be permitted. The channels shall be steel trowel finished.

Benching in manholes shall be sloped to drain as specified on the standard drawings. Prior to curing, the concrete benching shall be given a broom finish to produce a non-skid surface.

Where connecting to an existing main, the concrete channelling and benching may be formed around the existing pipe. The new channel shall then be cut out of the existing pipe and the concrete finished to conform to a standard manhole.

5B.4.6 Branch lines entering the manhole shall be channelled to join the main sewer at an angle with the flow that is less than 90 degrees.

5B.4.7 All pipes entering manholes must be sealed using approved water stop gaskets installed in accordance with manufacture's recommendations.

5B.4.8 Manholes and other precast sections shall be joined and sealed using cement mortar, mastic sealer or rubber gaskets to produce a watertight joint.

(a) Where cement mortar is used a layer of mortar shall be placed on the tongue of each section prior to lowering the following section into place. All lifting holes shall be plugged with cement mortar and finished flush with the manhole wall. The outside surface of the joint shall be sealed with a asphalt emulsion treatment or approval equal.

(b) Where rubber gaskets or mastic sealers are used, installation must be in strict accordance with manufacture's recommendations to ensure that a watertight joint is achieved.

5B.4.9 Ladder rungs shall be constructed of 20 mm diameter galvanized iron or aluminum and set at 300 mm on centre. In accordance with Worker's Compensation Board requirements, the maximum

distance down from entry level (top of the manhole cover) to the centre line of the top rung in any manhole or wall is 500 mm (20 inches) where no handhold is provided above. Where a handhold is provided between the entry level and the top rung, the maximum distance may be extended to 660 mm (26 inches).

5B.4.10 Manhole frames shall sit on at least one course of mortared concrete brick or approved alternate which shall be parged on both sides with a mortar paste composed of one part cement and three parts of sand and only sufficient water for workability. Grade adjustment of this type shall not exceed 200 mm.

5B.4.11 Heavy duty frames and covers, as specified on the Standard Drawings, shall be installed on manholes and cleanouts. Low profile frames and covers shall only be used in special circumstances as approved by the Engineer. Within the travelled portion of a road, manhole covers shall be set to 6 mm below finished grade. Manhole covers not within the travelled portion of the road shall be set to finish landscaped elevation or 75 mm above grade if landscaped elevation is not available.

5B.4.12 In special circumstances, cast-in-place manholes may be allowed subject to written approval being obtained from the Engineer. They must meet the following criteria :

a) Minimum wall thickness shall be 150 mm;

b) Minimum internal dimensions shall be as detailed on Municipal Standard Drawings for standard manholes.

5B.4.13 All cast-in-place and precast concrete used in the construction of the above noted appurtenances shall have a compressive strength of not less than 20.7 Mpa (3,000 psi) in 28 days.

5B.5 Service Connection Installation

5B.5.1 Service connections shall be installed in accordance with Standard Drawing S4.

5B.5.2 Standards for excavation, bedding and backfilling of service connections shall be in accordance with Section 3.

5B.5.3 Service connection installations shall conform to the specific sizes, locations and grades indicated on the design drawings and the general requirements noted below:

(a) Minimum grade for a 100 mm service shall be two percent; minimum grade for a 150 mm service shall be one percent.

(b) Minimum cover on services shall be 0.9 m unless otherwise approved by the Engineer.

(c) Where horizontal bends are required in the service pipe these shall be made with long radius bends.

(d) Where a horizontal bend greater than 45 degrees is required, a cleanout shall be constructed.
(e) Where the service connection on public property exceeds 15 metres in length, the service shall be connected directly to a manhole.

5B.5.4 Services shall be extended a minimum of 2.0 m into the lot in order to prevent undermining of the boulevard and to protect cleanout when connecting to service.

5B.5.5 Cleanouts shall be installed at property line on all sanitary sewer connections. Cleanout riser, complete with cast iron cap, shall be left 600 mm above ground at time of installation. Risers shall be adjusted by lot owner to suit finished grade.

5B.5.6 The ends of the service pipes shall be marked with a 50 mm x 100 mm (2 x 4) stakes with the depth to invert indicated on the stakes. Sanitary sewer connections shall be identified by painting the stakes red.

5B.5.7 The connection to the main shall be made either with "T" or "Y" branches installed during construction of the main sewer, or by tapping the main as permitted by the Engineer. Installation procedures for PVC shall be as follows:

PVC Pipe:

- Fittings for service branches in new construction shall be moulded or fabricated with all gasketed connections.

- Saddles may be mounted on pipe with solvent cement or gasket but shall be secured by metal banding. Saddles shall be installed in accordance with manufacturer's recommendations.

- Holes for saddle connections shall be made by mechanical hole cutters. Holes for wye saddles shall be laid out with a template and shall be de-burred and carefully bevelled where required to provide a smooth hole shaped to conform to the fitting.

- Fittings which are prefabricated using pipe sections, moulded saddles and PVC solvent cement may be used, provided the solvent cement used in fabrication has cured at least 24 hours prior to installation. Cemented mitred connection without socket reinforcement shall not be used. PVC primer and solvent cement shall be used in accordance with the cement manufacturer's recommendations. After solvent cementing saddles, temporary band clamps shall be quickly placed both upstream and downstream of the saddle and tightened.

5B.6 Testing

5B.6.1 Pipework

Upon completion of the backfilling, sewer mains shall be tested for alignment, obstructions, defects, and infiltration/exfiltration. Testing shall be done to the satisfaction of the Engineer at no cost to the Municipality.

(a) Lamp Test

The mains shall be checked for alignment by means of a light test. For satisfactory alignment the illuminated interior of the pipe shall not show any substantial misalignment, displaced pipe or other defects.

(b) Video Inspection

A video inspection of the mains shall be carried out by an approved video inspection company. The video inspection report shall be in a format approved by the Engineer and in accordance with Section 12, Video Inspection.

Where defects or obstructions are encountered, the main shall be repaired and/or flushed as required. The main shall be re-videoed to confirm that the problem has been remedied. Copies of the final video inspection reports and tapes shall be submitted to the Engineer prior to final approval of the works.

(c) Infiltration or Exfiltration

Each section of pipe between manholes must be tested for exfiltration or infiltration. Generally this is done with an air test. Infiltration and exfiltration test procedures are also provided for reference.

(i) Air Testing

When an air test is required, in lieu of water exfiltration test, the instructions of the manufacturer shall be followed. The minimum time requirements for air testing for the 3.45 Kpa (0.5 psig) pressure drop, from 24.13 Kpa to 2.068 Kpa (3.5 psig to 3.0 psig) shall not be less than that shown in the table shown below:

Pipe Size	**Time**
100 mm	2 min. - 32 sec.
150 mm	3 min. - 50 sec.
200 mm	5 min. - 6 sec.
250 mm	6 min. - 22 sec.

Pipe Size	**Time**
300 mm	7 min. - 39 sec.
355 mm	8 min. - 56 sec.
375 mm	9 min. - 35 sec.
406 mm	10 min. - 12 sec.
450 mm	11 min. - 34 sec.
508 mm	12 min. - 45 sec.
525 mm	13 min. - 30 sec.

For larger diameter pipe use the following -

Minimum time in seconds equals 141 times pipe diameter in metres (462 times pipe diameter in feet).

Should any test on any section of pipe line disclose an air loss rate greater than that permitted, the defect shall be located and repaired and the pipe retested until the air loss rate is within the specified allowance.

(ii) Infiltration

The maximum amount of infiltration measured by test shall be at a rate not greater than 11.13 cubic decimeters per mm of pipe diameter per kilometre per twenty-four (24) hours (100 imperial gallons per inch of pipe diameter per mile per twenty-four (24) hours). Should any test on any section of pipe exceed the allowable rate, the defect shall be located and repaired until the infiltration is within the specified allowances.

(iii) Exfiltration

The maximum amount of exfiltration measured by test shall be at a rate not greater than 11.13 cubic decimeters per mm of pipe diameter per kilometre per twenty-four (24) hours (100 imperial gallons per inch of pipe diameter per mile per twenty-four (24) hours). The maximum internal pressure in any part of the system under test shall not be greater than 3.5 m waterhead (5 psi). Should a test on any section of pipe indicate an exfiltration rate greater than the allowable the defect shall be located and repaired until the exfiltration is within specified allowances.

5B.6.2 Manholes

Manholes shall be tested for exfiltration using a water test. The test shall consist of plugging all inlet and outlet pipes, then filling with water to the bottom of the casting. The manhole shall be deemed acceptable if the water level does not drop more than 2mm per metre of manhole depth per hour.

6A.1 Scope

This section covers design standards and material specifications for municipal storm drainage works. This section does not cover requirements that may be imposed by the Ministry of Environment and/or Federal Fisheries for storm drainage works in or about natural watercourses, creeks, rivers, lakes or oceans. It shall be the Consultant's responsibility to ensure that the design requirements of the Ministry of Environment and/or Federal Fisheries are met.

6A.2 Storm Water Quantity

6A.2.1 Storm drain design calculations shall be submitted with design drawings and must be approved by the Engineer. Adjacent contributory areas must be determined and included in the design calculations. As well, existing systems that are to be included in the design shall be proven.

6A.2.2 A drainage area plan showing the proposed storm drainage system, the contributory drainage areas and the 200-year storm flood routing shall be submitted conforming with the requirements of Section 2.5.

6A.2.3 In general, for catchment areas greater than 20 ha. (49 ac.) the rate of flow of storm water shall be determined using the U.S. Soil Conservation Service Method, as outlined in the North Cowichan Master Drainage Plan. A copy of this study is available at the Engineering Department.

6A.2.4 For catchment areas of 20 ha. or less the rate of flow of storm water shall be determined using the Rational Method as follows:

$$Q = \frac{CIA}{360}$$

where:
- Q = flow (m^3/s)
- C = runoff co-efficient (dimensionless)
  - = 0.3 for most undeveloped areas
  - = 0.5 for normal residential subdivisions
  - = 0.7 for most rocky areas
  - = 0.9 - 0.95 for most paved areas
- A = contributing area (ha.)
- I = average intensity (mm/hr)

6A.2.5 Generally systems shall be designed for a 10-year return period, however large trunk systems (600 mm diameter and larger) shall be designed for a 25-year return period or as required by the Engineer.

6A.2.6 Intensity is determined by comparing the time of concentration (Tc) with the graph for the appropriate return period.

- Tc = Total time of concentration in minutes at the low end of each drain segment
  - = Te + Tf

where:
- Te = time of entry (minutes)
  - = usually 10 minutes, at most distant point upstream.
- Tf = time of flow, in the pipe or open channel.

Standard Drawing D12 shows the Rainfall Intensity/Duration Curve for North Cowichan.

6A.2.7 Provision shall be made to accommodate flows in excess of the design return period in a manner that will minimize damage and danger. Overland flood routing for the 200 year storm shall be considered when designing the drainage system.

6A.3 Storm Drain Hydraulics

6A.3.1 Storm water facilities shall be designed to carry peak flows. Flows shall be calculated in accordance with the methods noted above.

6A.3.2 System capacity for an enclosed storm drain or open channel flow shall be designed using Mannings formula.

$$Q = \frac{(1)}{n} AR^{2/3} S^{1/2}$$

where:
- Q = volume flow rate (m3/s)
- N = resistance factor (Manning's N)
  - = 0.011 for PVC pipe
  - = 0.013 for Concrete pipe
  - = 0.024 for CMP
- A = cross sectional area (m²)
- R = hydraulic radius (m)
- S = slope (m/m)

6A.3.3 No storm drain shall be less than 200 mm in diameter and no connection to a catchbasin shall be less than 200 mm in diameter.

6A.3.4 No service connections shall be less than 100 mm in diameter. Service connections serving more than duplex family dwellings shall be minimum 200 mm in diameter and sized in accordance with design flows and available grades.

6A.3.5 The following shall be the minimum grades for each size of pipe.

Size	Grade
100	2.0%
150	1.0%
200	0.5%
250	0.35%
300	0.25%

6A.3.6 All storm drains shall be designed to provide a minimum velocity of 0.75 metres per second, and a maximum velocity of 4.5 metres per second. The minimum velocity for a curved storm drain shall be 0.9 metres per second.

6A.3.7 Manholes shall be designed so as not to impede the hydraulic flow. The design shall incorporate a minimum elevation differential of 30 mm, in addition to the normal grade of the storm drain.

6A.4 Depths

6A.4.1 Depths of all storm drains shall be such that the areas the storm drain is intended to serve can be drained by gravity. In particular, storm drain depth must permit building footings to be drained by gravity.

6A.4.2 Minimum cover on storm drains shall be 1.5 metres in travelled areas and 0.9 metres elsewhere unless otherwise approved by the Engineer.

6A.4.3 Where the specified cover cannot be provided, installation at a shallower depth may be approved by the Engineer. Use of alternative pipe types or concrete encasement may be required.

6A.5 Locations

6A.5.1 (a) Unless otherwise approved by the Engineer, storm drains shall be located in the road right-of-way in accordance with Standard Drawings R7 & R8.

(b) Storm drains may be installed in a common trench with gravity sanitary sewers provided the maximum invert elevation difference is 300 mm and the minimum lateral clearance between the walls of adjacent pipes is 500 mm. Where deflections are required to accommodate manholes and other works, only the storm drain shall be deflected from the design alignment.

(c) In accordance with the Ministry of Health requirements, no storm or sanitary sewer is to be constructed within 3.0 m of a watermain, nor within 0.45 m vertical clear separation at sewer cross-unders without the written permission of the Public Health Engineer.

6A.5.2 Where topography makes placement of storm drains in the road right-of-way unfeasible, storm drains may be located in a statutory right-of-way (SRW) over private property, subject to the following conditions:

(a) Municipal service locations and SRW widths shall conform to Standard Drawing R21.

(b) In general, manholes and cleanouts shall not be located in SRW's, however, where this cannot be avoided, only one manhole or cleanout should be located in a SRW without making provision for direct vehicular access.

(c) Where vehicular access to manholes or cleanouts in SRW's is required, paved access lanes shall be provided in accordance with Standard Drawing R21.

6A.6 Curved Storm Drains

6A.6.1 Horizontal curves will be permitted where the right-of-way requires curvature for a constant offset and where the design velocity exceeds 0.9 metres per second. Vertical curves will be permitted under special circumstances where excessive cuts are to be avoided and where energy dissipation is required. Horizontal and vertical curves may not be used in combination on the same section.

6A.6.2 Radius of horizontal curvatures shall be uniform throughout the curves and shall be not less than 60 metres; in no case shall the deflection required to achieve the design curvature exceed the manufacturer's recommended deflection for the particular material being installed.

6A.7 Manholes, Catchbasins and Cleanouts

6A.7.1 Manholes

(a) Manholes shall be located at grade changes, size changes, at the upstream end of all storm drains, and at the junction of storm drains and service connections 150 mm in size and larger.
(b) Distances between manholes on storm drain sizes 600 mm or less in diameter shall not exceed 120 m.

(c) Distances between manholes on storm drains larger than 600 mm shall generally not exceed 150 m.

(d) Where the differences in elevation between incoming and outgoing storm drains exceed 600 mm, standard drop sections shall be installed.

6A.7.2 Catchbasins

(a) Catchbasins shall be spaced so as to adequately control surface runoff. Catchbasins shall be located at the low points of roads and at intersections to prevent runoff from crossing intersections.

(b) The maximum drainage area for a catchbasin draining a paved area should not exceed 400 m². For roads, the maximum distance between catchbasins shall be as follows:

Road Width	Spacing
9.0m	90m
12.0m	70m

(c) On roads with superelevation the maximum spacing shall be one half of the above figures.

(d) Double catchbasins shall be installed on downhill cul-de-sacs and at low points in road.

(e) Catchbasin leads shall be minimum 200 mm Ø in new systems. Extensions to existing leads shall be the same diameter as the existing lead unless otherwise required.

6A.7.3 Cleanouts

Cleanouts shall only be used where approved by the Engineer

6A.8 Storm Drain Service Connections

6A.8.1 Connections shall be installed in accordance with Standard Drawing D6.

6A.8.2 Minimum grade for a 100 mm service shall be two percent; minimum grade for a 150 mm service shall be one percent; minimum grade for a 200 mm service shall be one-half percent.

6A.8.3 Minimum cover on services shall be 0.9 m unless otherwise approved by the Engineer.

6A.8.4 Services shall be extended a minimum of 2.0 m into the lot in order to prevent undermining of the boulevard.

6A.8.5 Where horizontal bends are required in the service pipe these shall be made with long radius bends.
6A.8.6 Where a horizontal bend greater than 45 degrees is required, a cleanout shall be constructed.

6A.8.7 Where the service connection on public property exceeds 15 m in length, cleanouts shall be installed as directed by the Engineer and the service shall be connected directly to a manhole.

6A.9 Ditches and Culverts

6A.9.1 Open ditches, where permitted, are to be designed to intercept surface water from the roadways and the backslopes. Ditches must be designed with the capacity to carry a minimum 25-year flood at a velocity that will not cause silting or erosion of the channel. Where required by the Engineer, ditches shall be designed for higher design flows. In all cases the maximum allowable velocity is 3.0 metres per second. Where velocities exceed these maximums, flumes, rip-rap or other energy dissipators will be required.

6A.9.2 Ditch cross-section shall be as shown on Standard Drawing D5. In no case shall ditch depth be less than 600 mm.

6A.9.3 No culverts shall be less than 300 mm diameter.

6A.9.4 Where the inlet of a culvert is located at a depth greater than 3.0 m below the road surface, a secondary inlet may be required as shown on Standard Drawing D5a.

6A.10 Silt and Grease Traps

6A.10.1 Open ditches shall enter an enclosed storm drain system through a silt trap as shown on Standard Drawing D4.

6A.10.2 Discharge from developments such as service stations, auto repair facilities and similar commercial/industrial operations shall be intercepted by a combination silt trap/grease interceptor prior to entering the Municipal storm drain system. Special requirements as determined by Ministry of Environment and/or Environment Canada may apply in some situations.

6A.11 Inlet and Outlet Structures

6A.11.1 Headwalls shall be provided at the inlet and outlets of all storm drains and culverts in accordance with Standard Drawing D5 or D5a.

6A.11.2 The inlet and outlet of storm drains are to be protected from debris by suitable grates. All grates are to be at least the same diameter of the storm drain and be sized to handle the design flow of the storm drain as shown on Standard Drawing D5.

6A.11.3 Sand/cement sandbag headwalls as shown on Standard Drawing D7 shall only be used as approved by the Engineer.

6A.12 Sub-surface Drainage

6A.12.1 Where sub-surface drainage is anticipated or encountered it may be intercepted using perforated drains (French drains) where approved by the Engineer. Proposed installations must be submitted for approval prior to construction.

6A.12.2 When sub-surface drainage is encountered in utility trenches, trench dams and inlets to the storm drainage system shall be installed in accordance with Section 3.

6A.12.3 Installation of perforated drains shall be in accordance with the following:

(a) Pipe shall be as specified under Section 6A.13.7.

(b) Filter material (drain rock) shall be a clean, round rock ranging in size from 20 mm to 40 mm diameter.

(c) Geotextile fabric shall be used as required to ensure the drain rock does not become contaminated by surrounding soils.

(d) Drain rock shall be placed around pipe in accordance with bedding cross-section shown on Standard Drawing T1.

(e) Clean-outs and/or inspection points shall be provided in accordance with good engineering practice.

6A.13 Pipe Materials

6A.13.1 The following materials may be used for storm drain installations in the Municipality subject to the specifications and conditions listed below.

6A.13.2 Storm Drain Mains

(a) PVC (Polyvinyl Chloride)

- DR35 PVC pipe may be used for storm drain installations 200 mm diameter and larger.
- PVC pipe shall conform to the latest standards specified by ASTM D3034 and CSA B182.1.
- Connection of services shall be in accordance with manufacturer's recommendations using PVC fittings or saddles.

(b) Concrete

- Concrete pipe may be used for storm drain installations 300 mm diameter and larger.
- Unreinforced concrete pipe shall conform to the latest ASTM Designation C14. Pipe manufactured according to these specifications shall be "Extra Strength Non-Reinforced Concrete Pipe", C14 Class 3 minimum.
- Reinforced concrete pipe shall conform to the latest ASTM Designation C76. Pipe manufactured to these specifications shall be identified as Class 2, 3, 4 and 5.
- All concrete pipe shall be supplied with approved rubber gasket rings.
- Unreinforced concrete pipe shall not be used for installations larger than 900 mm diameter.
- Connection of services shall be via factory installed PVC stubs.

(c) Ribbed PVC

- Ribbed PVC pipe may be used for storm drain installations 250 mm diameter and larger.
- Ribbed PVC pipe shall conform to the latest standards as specified by ASTM F794 and CSA B182.4.

- Connection of services shall be in accordance with manufacturer's recommendations using PVC fittings or saddles specifically designed for use with ribbed pipe. PVC fittings shall be used where the connection is larger than one-half the diameter of the main.

6A.13.3 Storm Drain Services

PVC

- DR28 PVC pipe shall be used for 100 mm diameter storm service installations
- DR35 PVC pipe may be used for 150 mm diameter and larger storm service installations.
- PVC pipe standards as per 6A.13.2 (a), above.

6A.13.4 Catch Basin Leads

(a) PVC

- 200 mm diameter DR35 PVC pipe with standards as per 6A.13.2, above.

(b) Other

- Subject to the Engineer's approval, other materials such as DR28 PVC, Ductile Iron or C900 PVC water pipe may be used in areas where there is not sufficient cover to use DR35 PVC pipe.

6A.13.5 Road Cross Culverts

(a) Asphalt Coated CMP (Corrugated Metal Pipe):

- Asphalt Coated CMP shall conform to CSA Standard CAN3-G401-M81, or the latest revision thereof.
- The minimum gauge for 300 mm to 600 mm diameter pipe shall be 1.6 mm.
- The minimum gauge for pipe larger than 600 mm diameter pipe shall be 2.0 mm.

(b) Aluminized CMP

- Aluminized CMP shall conform to CSA Standard CAN3-G401-M81, or the latest revision thereof.
- The minimum gauge for 300 mm to 600 mm diameter pipe shall be 1.6 mm.
- The minimum gauge for pipe larger than 600 mm diameter pipe shall be 2.0 mm.

(c) Concrete

- Concrete pipe standards and permitted uses shall be as per 6A.13.2 (b), above.

6A.13.6 Driveway Culverts

Galvanized CMP

- Galvanized CMP shall conform to CSA Standard CAN3-G401-M81, or the latest revision thereof.

- The minimum gauge shall be 1.6 mm.

6A.13.7 Perforated Drains

(a) PVC

- Must be CSA approved, SDR 35 minimum.

- Minimum diameter shall be 150 mm.

- Perforations shall be 13 mm diameter, located in the bottom half of the pipe.

(b) Other

- Other pipe types shall be approved by the Engineer. Big-O pipe will not be accepted.

6A.13.8 Alternate Materials

Alternate materials will be considered in special circumstances, such as inadequate cover, subject to the approval of the Engineer.

6A.13.9 Pipe Selection

The class and type of pipe and fitting, together with required class of bedding and trench widths shall be so selected that the pipe will support the anticipated gravity earth and any surface dead and live loads with a safety factor of 1.5. In no case shall the depth of cover be less than 300 mm for rigid pipe or 750 mm for PVC pipe.

6A.13.10 Testing of Pipe Materials

All pipe is subject to testing and inspection at the discretion of the Engineer. The basis of acceptance shall be confirmation with the applicable ASTM and CSA specification. The cost of all testing shall be borne by the Developer.

6A.13.11 Appurtenances

All appurtenances shall be of a type and standard compatible with the pipe on which it is being installed.

STORM DRAIN DESIGN 6 A

STORM DRAIN INSTALLATION 6 B

6B.1 Scope

6B.1.1 This section shall govern the installation of storm drains and their appurtenances within the Municipality.

6B.2 General

6B.2.1 Provision shall be made to maintain the flow of all drains, ditches, watercourses and service connection which may be encountered during the progress of the work. Where existing systems are anticipated or located during construction, the existing system shall be connected to the new installation or replaced. In every case the contractor and/or Consulting Engineer shall notify the Municipality when previously unidentified systems are found. The contents of any sewer, drain or service connection shall not be allowed to flow into the trench or into the main.

6B.2.2 The Contractor shall ensure debris and mortar droppings do not enter any part of the storm drain system and shall leave all pipe lines, manholes, cleanouts, silt traps, catchbasins, and other appurtenances in a thoroughly clean conditions.

6B.2.3 Any connection or modification to existing works shall be by Municipal crews at the Developer's expense, unless specifically approved otherwise.

6B.2.4 Any work in or about natural watercourses, creeks, rivers, lakes or oceans shall be carried out in accordance with the requirements of the Ministry of Environment and/or Federal Fisheries.

6B.3 Pipe Installation

6B.3.1 Standards for excavation, bedding, backfilling and restoration shall be in accordance with Section 3.

6B.3.2 Pipes shall be handled, stored and laid in accordance with the recommendations of the pipe manufacturer and in all cases gaskets shall be installed unless otherwise specified by the Municipal Engineer. Particular care shall be taken to ensure that before each joint is made the pipe is cleaned and all dirt and other debris is removed.

6B.3.3 Pipe laying shall commence at the lowest point of the length being laid and the pipes shall be placed with spigot ends pointing in the direction of flow.

6B.3.4 Pipe shall not be backfilled until the bedding, grade and alignment has been approved by the Consulting Engineer.

6B.3.5 All pipe must be laid to the designed grades and alignment within the following tolerances:

a) Horizontal tolerance from true alignment shall not be greater than 60 mm from the designed location and the rate of deviation shall not exceed 40 mm in 10 m.

b) Vertical tolerance from true grade shall not exceed the limitations as detailed in the table below:

Grade	Maximum Departure from Design Elevation	Maximum Rate of Deviation
over 5%	30 mm	6 mm in 3 m
2 % to 5%	15 mm	3 mm in 3 m
less than 2%	6 mm	3 mm in 3 m

6B.3.6 Where a storm drain is being constructed as an extension to an existing Municipal system, gravel traps must be installed by the Municipality at the Developer/Contractor's expense. Alternatively, the Engineer may required that the end of the existing pipe remain sealed until the drain extension is completed, flushed, tested and accepted by the Municipality. Upon acceptance, the seal may be removed and one length of pipe installed to connect the extension to the existing system.

6B.3.7 Where storm drains and sanitary sewers are installed in a common trench, there shall be a minimum 500 mm lateral clearance between the walls of adjacent pipes. Where deflections are required to accommodate manholes or other works, only the storm drain shall be deflected from the approval alignment.

6B.4 Manhole, Cleanout and Catchbasin Installation

6B.4.1 The Contractor shall install all manholes, drop inlets, cleanouts, catch basins, silt-traps, junctions, and risers and other appurtenances at the locations shown on the drawings. Installation shall be in accordance with the Standard Drawing for each appurtenance.

6B.4.2 Manholes, cleanouts, catchbasins and other appurtenances shall generally be constructed of precast concrete sections as shown on the Standard Drawings. Precast concrete shall conform to ASTM C478.

6B.4.3 Manholes must be constructed so as to ensure that there is no infiltration or exfiltration.

6B.4.4 The base of the manhole or cleanout shall be poured in place concrete or precast by an approved supplier. The bases shall be constructed in accordance with the Standard Drawings.

6B.4.5 Manhole channelling shall be constructed as shown on the Standard Drawings. The channelling shall be shaped and finished to provide smooth passage for the drainage in order to minimize head losses and deposits at bends and at junctions. The drop from inlet to outlet must be provided as shown on the drawings.

Channels shall be accurately formed. The practice of forming channels roughly to shape and finishing with mortar cement will not be permitted. The channels shall be steel trowel finished.

Benching in manholes shall be sloped to drain as specified on the Standard Drawings. Prior to curing, the concrete benching shall be given a broom finish to produce a non-skid surface.

Where connecting to an existing main, the concrete channelling and benching may be formed around the existing pipe. The new channel shall then be cut out of the existing pipe and the concrete finished to conform to a standard manhole.

6B.4.6 Branch lines entering the manhole shall be channelled to join the main at an angle with the flow that is less than 90 degrees.

6B.4.7 All pipes entering manholes must be sealed using approved water stop gaskets installed in accordance with manufacture's recommendations.

6B.4.8 Manholes and other precast sections shall be joined and sealed using cement mortar, mastic sealer or rubber gaskets to produce a watertight joint.

(a) Where cement mortar is used a layer of mortar shall be placed on the tongue of each section prior to lowering the following section into place. All lifting holes shall be plugged with cement mortar and finished flush with the manhole wall. The outside surface of the joint shall be sealed with a asphalt emulsion treatment or approval equal.

(b) Where rubber gaskets or mastic sealers are used, installation must be in strict accordance with manufacture's recommendations to ensure that a watertight joint is achieved.

6B.4.9 Ladder rungs shall be constructed of 20 mm diameter galvanized iron or aluminum and set at 300 mm on centre. In accordance with Worker's Compensation Board requirements, the maximum distance down from entry level (top of manhole cover) to the centre line of the top rung in any manhole or wall is 500mm (20 inches) where no handhold is provided above. Where a handhold is provided between the entry level and the top rung, the maximum distance may be extended to 660mm (26 inches).

6B.4.10 Manhole and catchbasin frames shall sit on at least one course of mortared concrete brick or approved alternate which shall be parged on both sides with a mortar paste composed of one part cement and three parts of sand and only sufficient water for workability. Grade adjustment of this type shall not exceed 200 mm.

6B.4.11 Heavy duty 200 mm frames and covers, as specified on the Standard Drawings, shall be installed on manholes and cleanouts. Low profile frames and covers shall only be used in special circumstances as approved by the Engineer. Within the travelled portion of a road, manhole covers shall be set to 6 mm below finished grade. Manhole covers not within the travelled portion of the road shall be set to finish landscaped elevation or 75 mm above grade if landscaped elevation is not available.

6B.4.12 The area around a silt trap shall be graded so that surface runoff enters the grilled lid. The ditch sides and bottom around an inlet or outlet shall be rip-rapped for a minimum length of 1.5m beyond the end of the pipe.

6B.4.13 In special circumstances, cast-in-place manholes may be allowed subject to written approval being obtained from the Engineer. They must meet the following criteria:

a) Minimum wall thickness shall be 150 mm;

b) Minimum internal dimensions shall be as detailed on Municipal Standard Drawings for standard manholes.

6B.4.14 All cast-in-place and precast concrete used in the construction of the above noted appurtenances shall have a compressive strength of not less than 20.7 Mpa (3,000 psi) in 28 days.

6B.5 Service Connection Installation

6B.5.1 Service connections shall be installed in accordance with Standard Drawing D6.

6B.5.2 Standards for excavation, bedding and backfilling of service connections shall be in accordance with Section 3.

6B.5.3 Service connection installations shall conform to the specific sizes, locations and grades indicated on the Standard Drawings and the general requirements noted below:

(a) Minimum grade for a 100 mm service shall be two percent; minimum grade for a 150 mm service shall be one percent; minimum grade for a 200 mm service shall be one/half percent.

(b) Minimum cover on services shall be 0.9 m unless otherwise approved by the Engineer.

(c) Where horizontal bends are required in the service pipe these shall be made with long radius bends.

(d) Where a horizontal bend greater than 45 degrees is required, a cleanout shall be constructed.
(e) Where the service connection on public property exceeds 15 metres in length, the service shall be connected directly to a manhole.

6B.5.4 Services shall be extended a minimum of 2.0m into the lot in order to prevent undermining of the boulevard and to protect cleanout when connecting to service.

6B.5.5 The ends of the service pipes shall be marked with a 50mm x 100mm (2 x 4) stakes with the depth to invert indicated on the stakes. Storm drain connections shall be identified by painting the stake green.

6B.5.6 The connection to the main shall be made either with "T" or "Y" branches installed during construction of the main sewer, or by tapping the main as permitted by the Engineer. Installation procedures for PVC shall be as follows:

(a) PVC Pipe:

- Fittings for service branches in <u>new construction</u> shall be moulded or fabricated with all gasketed connections.

- Saddles may be mounted on pipe with solvent cement or gasket but shall be secured by metal banding. Saddles shall be installed in accordance with manufacturer's recommendations.

- Holes for saddle connections shall be made by mechanical hole cutters. Holes for wye saddles shall be laid out with a template and shall be de-burred and carefully bevelled where required to provide a smooth hole shaped to conform to the fitting.

- Fittings which are prefabricated using pipe sections, moulded saddles and PVC solvent cement may be used, provided the solvent cement used in fabrication has cured at least 24 hours prior to installation. Cemented mitred connection without socket reinforcement shall not be used. PVC primer and solvent cement shall be used in accordance with the cement manufacturer's recommendations. After solvent cementing saddles, temporary band clamps shall be quickly placed both upstream and downstream of the saddle and tightened.

(b) Concrete Pipe:

- For new installations, factory installed PVC stubs shall be provided at service connection points.

- For connection to existing mains, the service shall be tapped into the upper half of the main. Care shall be taken while tapping to ensure the main shall not be fractured, and all broken pipe and mortar shall be removed from inside the sewer main. The tapping shall only be of sufficient size to permit a service saddle to fit snugly into the hole. The saddle shall be securely grouted to the main. In no case shall the service pipe protrude into the main.

6B.6 Testing

6B.6.1 Pipework

Upon completion of the backfilling, storm drains shall be tested for alignment, obstructions and defects. Where required by the Engineer, the storm drain shall also be tested for infiltration and/or exfiltration to the same standard as required for sanitary sewers. Testing shall be done to the satisfaction of the Engineer at no cost to the Municipality.

(a) Alignment

The main shall be checked for alignment by means of a light test. For satisfactory alignment the illuminated interior of the pipe shall not show any substantial misalignment, displaced pipe or other defects.

(b) Video Inspection

A video inspection of the mains shall be carried out by an approved video inspection company. The video inspection report shall be in a format approved by the Engineer and in accordance with Section 12, Video Inspection.

Where defects or obstructions are encountered, the main shall be repaired and/or flushed as required. The main shall be re-videoed to confirm that the problem has been remedied. Copies of the final video inspection reports and tapes shall be submitted to the Engineer prior to final approval of the works.

6B.6.2 Manholes

Manholes shall be inspected visually for infiltration. Where required by the Engineer, manholes shall also be tested for exfiltration to the same standard as required for sanitary sewers.

STORM DRAIN INSTALLATION 6 B

ROADS – CONSTRUCTION 7 B

ROADS - CONSTRUCTION

S E C T 1 0 N 7 B

ROADS - CONSTRUCTION

7B.1 Scope

This section shall govern the construction of roads, lanes, boulevards, curbs and gutters, sidewalks and driveways within the Municipality.

7B.2 General

Construction shall be in accordance with the design drawings approved by the Engineer and with these specifications.

7B.3 Materials

7B.3.1 Sub-base (Pit-run Gravel)

The sub-base material shall be pit-run gravel consisting of a natural or artificial mixture of hard, durable stones, rock fragments and soil binder, free from soft particles and excess clay. It shall be capable of being compacted by rolling into a dense firm course which will, at an average moisture condition, hold the weight of construction equipment and loaded trucks without leaving pronounced indentations.

Sub-base material shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard Sieve Size	% Passing (by Weight)
75 mm	100%
25 mm	50-85%
0.15 mm	0-16%
0.075 mm	0-5%

7B.3.2 Base (Crush Gravel)

The base material shall be composed of unwashed natural gravel, crushed gravel, a blend of commercial sand and rock products, or combinations of the above. These aggregates shall consist of sound, hard durable particles and shall be free from clay, organics, decomposed rock, shale, or other soft, thin, pliable or laminated pieces or other detrimental matter. They shall be capable of being compacted by rolling into a dense, firm course which will at any moisture condition hold the weight of loaded trucks without leaving pronounced indentations.
Base material shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard Sieve Size	% Passing (by Weight)
9 mm	100%
9.5 mm	60-100%
4.75 mm	40-80%
2.36 mm	30-60%

1.18 mm	20-45%
0.3 mm	8-20%
0.075 mm	2-4%

A minimum of 50% of all material retained on the 4.75 mm. Sieve shall have at least one crushed face.

7B.4 Clearing and Stripping

7B.4.1 Site Clearing

The full width of the road allowance shall be cleared of all standing and fallen trees, stumps, logs, roots, brush, all vegetation and accumulated rubbish which, in the opinion of the Engineer, is detrimental to construction of roads and services. At the direction of the Engineer, certain trees or shrubs may be required to remain near property lines and the Contractor will take all precautions to ensure that they remain undamaged during the construction period. All material resulting from site clearing shall be disposed of by the Contractor in compliance with all current Municipal and Provincial regulations.

7B.4.2 Stripping of Overburden

All overburden and topsoil shall be stripped from the road allowance to such widths as will be affected by the road grading and the construction of sidewalks, curbs and gutters or ditches. All topsoil shall be stored onsite during construction and upon completion shall be spread between the back of the curb or ditch and the property line to form a boulevard. Surplus overburden shall be disposed of by the Contractor.

7B.5 Road Base Construction

7B.5.1 Design Cross-section

The design cross-section shall comply with standard drawings RI-R6 as applicable, unless otherwise approved by the Engineer.

7B.5.2 Sub-grade Preparation

(a) Cuts

i) In cut areas, the subgrade shall be excavated, graded and compacted to the design subgrade cross-section. Any soft spots that develop during the process of compaction shall be excavated and filled with pit-run gravel.

ii) Where cuts are in rock, no points or pinnacles shall be left protruding above the subgrade cross-section; subgrade rock shall be shattered at least 300 mm below the subgrade to permit uniform grading and compaction. Where rock excavation results in an uneven subgrade that does not permit uniform grading and compaction, the subgrade shall be left 100 mm low to permit installation of additional sub-base material.

iii) Rock cuts shall be scaled to remove any loose or unstable material.

iv) Material excavated from cut areas shall be disposed of unless approved for fill material as specified below.

(b) Fills

i) Fills constructed with pit-run gravel shall be placed in maximum 300mm lifts and compacted to 98% Standard Proctor Density. Compaction of the top 150 mm shall be to 100% Standard Proctor Density.

ii) Any fills constructed with material other than pit-run gravel must have the Prior approval of the Engineer and be installed under the direction of a geotechnical engineer.

iii) When considering approval of fill other than pitrun gravel, the Engineer will require that an assessment of the fill material, prepared by a geotechnical engineer, be submitted for review. This assessment should include recommendations related to placement and compaction, and indicate the level of onsite monitoring required.

(e) Utility Trenches

i) All utility trenches within the subgrade area shall be backfilled with pit-run gravel only, in accordance with Section 3.

ii) Special attention shall be paid to subsurface drainage that might accumulate in utility trenches and adversely affect the subgrade.

(d) Compaction and Grading

i) The subgrade shall be compacted and graded to conform to the design grades and cross-section. In particular, the subgrade must be shaped to permit proper drainage and ensure that water is not trapped on or in the subgrade.

ii) Compaction of the top 150 mm shall be to 100% Standard Proctor Density. Compaction below the top 150mm shall be as specified above.

7B.5.3 Sub-base Course

(a) The sub-base shall be the required width and shall form an integral part of the base for the curb and gutter, and shall be laid to the consolidated thickness required by the design cross-section. Each layer or lift of gravel shall be adequately consolidated with the use of vibratory type compactors. Where deemed necessary, water shall be used to aid compaction. A grader shall be used in conjunction with the compaction roller to maintain an even and uniform compaction surface. The finished sub-grade surface shall conform to grades with a tolerance of 25 mm.

(b) The surface shall be graded to provide a finished surface in accordance with the design cross-section. All underground services shall be installed and the trenches backfilled and consolidated prior to the application of the sub-base course.

(c) A minimum compaction of 100% of Standard Proctor Density for the sub-base material shall be attained.

7B.5.4 Base Course

(a) Base course materials shall be placed over the sub-base in accordance with the design cross-section.

(b) No base course gravel shall be placed on the sub-base surface until the latter has been approved by the Engineer.

(c) The base course shall be spread in uniform layers over a previously shaped, compacted and approved sub-base. Each layer shall be watered and mixed or aerated as directed by the Engineer to bring all the material to its optimum moisture content. Each layer shall be compacted by the use of a roller. A grader shall be used in conjunction with the compaction rollers to obtain an even and properly shaped surface, conforming to the lines and grades as required.

(d) Compaction of the granular base course is required to attain 100% of Standard Proctor Density in each lay er.

(e) The finished grade surface of the compacted base course shall be within 15mm of the design grade and cross section and shall be free from ridges, humps or depressions exceeding l0mm when measured with a 3m long straight-edge placed parallel to or perpendicular to the road centre line. Care shall be taken along the gutters if such gutters are existing, to leave exactly the specified depth for the subsequent placing of the final asphalt layer(s). Note: Finished asphalt shall be left 6mm above concrete gutter to ensure positive drainage to gutter.

7B.5.5 Proof Rolling

Before proceeding further with the work each finished layer of subgrade, subbase and base course shall be proof rolled by receiving one complete coverage using a single axle truck having an 9,000 kg (20,000 lbs) rear axle load. Should any areas of rutting or displacement result, they shall be excavated, refilled and compacted. Excavated and refilled areas shall be proof rolled to confirm rutting and/or displacement has been eliminated.

7B.6 Concrete Curb, Gutter and Sidewalk

7B.6.1 Base

(a) Sub-grade and sub-base preparation shall be as detailed above in Section 7B.5 to the cross-sections shown on the detail drawings.

(b) Crushed gravel shall be placed and compacted to a depth shown on the detail drawings before placing any concrete. The gravel shall be rolled and compacted to produce a uniform bearing capacity through the entire width and length of the work.

7B.6.2 Concrete

All concrete shall conform to the detailed specifications contained in Section 10 and shall have the following properties:

(a) Compressive Strength

All concrete for the work shall attain a compressive strength of 27.6 Mpa (4,000 psi) in 28 days.

(b) Slump

The concrete shall have a uniform consistency and slump. The slump shall be between 25mm and 75mm for handvibrated concrete, between 50mm and 100mm for hand tamped or spaded concrete, and between 12mm and 50mm for concrete placed by a slipform/extrusion machine.

(c) Air Content

The air content shall average 6%, with a minimum of 5% and a maximum of 7%.

7B.6.3 Placing

(a) Curb and Gutter - Machine Method

i) The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section.

ii) The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed.

iii) The machine shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be co-ordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

iv) Contraction and surface joints shall be provided in accordance with Section 7B.6.6.

(b) Curb and Gutter - Form Method

i) The forms shall be of wood, metal, or other suitable material that is straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature shall be used for curves having a radius of 30m or less. Division plates shall be metal.

ii) The front and back forms shall extend for the full depth of the concrete. All of the forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them.

iii) The concrete shall be deposited into the forms without segregation and then it shall be tamped and spaded or mechanically vibrated for thorough consolidation. Low roll or mountable curbs may be formed without the use of a face form by using a straightedge and template to form the curb face as per cross-sections shown on Standard Drawing R12. When used, face forms shall be removed as soon as possible to permit finishing. Front and back forms shall be removed without damage to the concrete after it has set.

iv) Contraction and surface joints shall be provided in accordance with Section 7B.6.6.

(c) Sidewalks

i) Special care shall be taken to place the concrete, particularly in corners, in order to prevent voids, pockets, rough areas and honeycombing.

ii) The concrete shall be tamped in such a manner as to work the coarse aggregate away from the exposed surfaces. Vibrators or vibrator screeds used in placing concrete shall be a minimum of 5,000 cycles per minute. The technique and use of vibrators and vibrator screeds shall be at the discretion of the Engineer.

iii) Every precaution shall be taken to make all concrete masonry solid, compact, watertight, and smooth.

iv) After placing, the concrete shall be adequately worked with wood and steel trowels. Excessive trowelling is to be avoided.

v) The edges shall be neatly rounded with contraction, surface and expansion joints constructed in accordance with Section 7B.6.6.

7B.6.4 Finishing

(a) Curb and Gutter

Concrete curb and gutter shall have a steel trowel finish. Maximum deviation from the designated horizontal or vertical alignment of any point on curb and gutter sections shall be 8mm.

The finish on curb and gutter sections shall be true within 5mm in 3m as determined by a 3m straight-edge placed anywhere along the curb and gutter. The surface shall have a smooth even dense texture free from blemishes.

(b) Sidewalk

Sidewalks shall have a broom finish unless otherwise specified. Maximum deviation from the designated horizontal or vertical alignment of any point on the sidewalk shall be 8mm.

The broom finish shall provide a uniform non-skid surface. Finished surfaces shall be true in all planes within 5mm in 3m as determined by a 3m straight-edge placed anywhere on the surface.

7B.6.5 Stripping the Forms

(a) The forms shall not be stripped less than 24 hours after the concrete has been placed. Adequate care shall be taken in removing the forms to avoid spoiling or marring the concrete.

(b) Such patching as may be necessary shall be started immediately after the removal of forms.

7B.6.6 Joints

(a) Contraction Joints

i) Contraction joints in curbs, gutters and sidewalks shall be constructed at right angles to the curb line at intervals not exceeding 3m as shown on the detail drawings. Contraction joints in sidewalk must align with contraction joint in curb and gutter.

ii) Joint depth in sidewalks shall average at least one-fourth of the cross-section of the concrete; joint depth in curbs and gutters shall be within 75mm of bottom.

iii) Contraction joints may be sawed, handformed, or made by 3 mm. thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be handformed either by (1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete, or (2) inserting 3mm thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set and while the forms are still in place.

(b) Surface Joints

i) Surface joints shall be constructed in sidewalks at intervals half-way between the contraction joints as shown on the detail drawings.

ii) Joint depth shall be 12mm.

(c) Expansion Joints

i) Expansion joints shall be.constructed in curbs and gutters and sidewalks at right angles to the curb lines at immovable structures and at points of curvature for short-radius curves or at centres not exceeding 90m. Filler material for expansion joints shall be asphalt impregnated fibre expansion material conforming to A.S.T.M. D1751, and shall be furnished in a single 13mm thick piece for the full depth and width of the joint.

ii) Expansion joints in sidewalks shall be installed as the sidewalk is being poured. Care shall be taken to ensure that the filler material does not protrude above the rounded panel edge.

iii) Expansion joints in a slipformed curb and gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall only be wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then trowelled and edged.

iv) Alternatively, an expansion joint may be installed by removing a short section of freshly extruded curb-and-gutter immediately, installing the expansion joint temporary forms, placing filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.

(d) Other Joints

i) Cold joints shall be provided between the back of curb and sidewalk. .41

ii) Construction joints may be either butt or expansion type joints.

iii) Curbs and gutters and sidewalks constructed adjacent to existing concrete shall have the same type of joints as the existing concrete, with similar spacing, however, contraction joint spacing shall not exceed 3m.

7B.6.7 Crossings

At lane and driveway crossings the required sidewalk slab thickness shall be 150mm as shown on Standard Drawing R14 and shall extend the full width and required length of the crossing. The crossing shall be grooved and brushed transversely. A construction joint shall be placed on each side of the crossing and the required sidewalk slab shall be at the full thickness required for the crossing for the full distance between the construction joints.

7B.6.8 Wheelchair Ramps

Wheelchair ramps shall be provided where required by the Engineer. Wheelchair ramp details shall be as shown on Standard Drawings R15 and R16.

7B.6.9 Breaking Out

The Developer shall not break out any existing sidewalk and/or curb and gutter without first receiving approval to do so from the Engineer.

7B.6.10 Protection

(a) The Contractor shall supply and place all tarpaulins or other necessary material to protect the work from rain, dust, frost, snow, or other similar weather action.

(b) The Contractor shall also barricade the work and keep all humans, animals, and vehicles off the work for a minimum period of five (5) days after the finishing of the concrete has been completed. Any damage occurring to the work during this five day period regardless of origin, shall be replaced or repaired immediately.

7B.6.11 Backfilling and Backsloping

(a) Where an excavation has been made wider than the finished concrete width, this area between the edge of the excavation and the finished concrete surface when both are level, shall be filled with suitable material and well compacted. This work shall be done at the end of the five day period after the finishing of the concrete has been completed.

(b) Backfill shall be placed behind the curb and gutter or sidewalk section at a maximum grade of 4% to property line. The remainder shall be graded to a maximum slope of 1.5:1 when fronting undeveloped properties; the maximum slope shall not exceed 3:1 where fronting developed properties.

7B.6.12 Clean-up

(a) All refuse shall be removed from each site before the concrete finishers move to

another location. Concrete debris shall not be flushed into the storm drain system or natural water courses, and shall not be left in boulevard areas.

(b) On existing streets, complete clean-up including the removal of all surplus excavation from backsloping shall be made within two weeks from the time the excavation was started, excepting main streets, which shall be cleaned up immediately after the forms have been stripped.

7B.6.13 Testing

Concrete testing shall be carried out in accordance with the requirements of Section 10.9. In general, the following tests shall be carried out for each 300 lineal metres of curb and gutter, or sidewalk placed, with a minimum of one set of tests per day:

(a) One set of three test cylinders for compressive strength tests.

(b) Slump test.

(c) Air test.

Additional testing may be required at the discretion of the Engineer.

7B.6.14 Defects

All finished concrete shall be in accordance with the approved dimensions, tolerances, and properties, as specified in these standards and on the approved design drawings.

The finished concrete shall be free of honeycombing, cracking, spalling, surface irregularities, and other defects. Unless otherwise approved by the Engineer, all defective concrete shall be removed and replaced at the Contractor's expense.

7B.7 Boulevards

7B.7.1 Boulevards shall be graded in accordance with the cross sections shown on the Standard Drawings.

7B.7.2 A minimum of 200 mm of native topsoil shall be placed in boulevard areas. Where native topsoil is not available, importing of topsoil may be required. Note: In accordance with Section 7B.4.2, Stripping of Overburden, all topsoil shall be stored onsite during the construction and used to complete the boulevards; topsoil shall not be exported from the site.

7B.7.3 In existing areas, boulevards shall be restored to a condition equal to that found prior to construction as detailed in Section 3.8.2.

7B.8 Protection and Adiustment of Valves. Manholes, and Catchbasins

7B.8.1 It is the responsibility of the Contractor to adjust all appurtenances such as valve boxes, manholes and catch basins to the finished grade of roads, sidewalks and boulevards. There will not be any tolerance in the shape of the finished surface in the vicinity of an appurtenance.

7B.8.2 The methods or materials used in raising or lowering an appurtenance must be in accordance with the standards for the utility involved. The Contractor will be responsible for maintaining these items during the maintenance period.

7B.8.3 The Contractor will be responsible for removing immediately any earth, gravel, or debris and all materials that fall into a manhole, catchbasin, or other appurtenances, as a result of adjusting these appurtenances.

7B.9 Asphalt Surfacing

7B.9.1 Municipal roads shall be surfaced with hot-mix asphaltic pavement to the lines, grades and cross-sections shown on the approved design drawings and as detailed in these standards.

7B.9.2 Preparation and placement of hot-mix asphaltic pavement shall be in accordance with the detailed specifications contained in Section 11.

7B.9.3 Asphalt testing shall be carried out in accordance with the requirements of Section 11.7. In general, the following tests shall be carried out for each 300 tonnes of asphalt placed, with a minimum of one set of tests per day:

(a) one set of three briquettes to determine hot mix quality.

(b) One set of three cores to determine field density and thickness.

Additional testing may be required at the discretion of the Engineer.

7A.1 Scope

This section shall govern the design of roads, lanes, boulevards, sidewalks and driveways within the Municipality.

7A.2 General

Design shall be in accordance with the latest edition of the "Manual on Geometric Design Standards for Canadian Roads and Streets" As prepared by the Roads and Transportation Association of Canada (RTAC). Not limiting the foregoing, the design criteria listed below shall also apply.

7A.3 Classifications

7A.3.1 Major

A street usually providing a continuous route primarily for through traffic with land access a secondary consideration. Average daily traffic (ADT) volumes generally range from 5000 to 30,000 vehicles. Not covered under these standards, but considered because residential streets may intersect with majors.

7A.3.2 Collector

A street performing the dual function of land access and distribution of traffic between local and major streets. ADT generally range from 1000 to 12,000 vehicles. A speed of 60 km/hr shall generally be used for design purposes.

7A.3.3 Residential

A street providing land access with little or no provision for through traffic. Direct access is allowed to all abutting properties. A speed of 50 km/hr shall generally be used for design purposes.

7A.3.4 Rural/Urban

All of the above road classifications can be classified as rural or urban with rural having gravel shoulders and urban having concrete curbs and gutters.

7A.4 Standard Cross-Sections

7A.4.1 The cross-section of roads shall be designed in accordance with the following dimensions and requirements:

Classifications	R/W Width	Road Width	Standard Drawing
Rural Residential	15 m	7.3 m	R1
Urban Residential	15 m	9.0 m	R2
Rural Collector	20 m	8.5 - 10.0 m*	R3
Urban Collector	20 m	12.0 m	R4

* 8.5 m for 1.2 m paved walkway on one side; 10.0 m for paved walkway on both sides with an asphalt water control curb.

7A.4.2 The toe of a fill or top of a cut shall not encroach on private property. The containment of these cuts or fills within the road allowance may required the use of retaining walls or the widening of the right-of-way to contain the cut or fill. In general, the right-of-way width shall be minimum 20 m in hillside locations where on average the hillside slope exceeds 15%.

7A.4.2 In areas where subgrade soils are of low strength, or where substantial cuts or fills are required, the Engineer may require that the road cross-section be designed by a Geotechnical Engineer.

7A.4.3 Service access lanes shall conform to Standard Drawing R5.

7A.5 Vertical Alignment

7A.5.1 Vertical alignment elements shall conform to the following:

(a)	Maximum road grade	12.0%	
(b)	Minimum road grade	0.5%	
(c)	Minimum grade at curb returns	0.5%	
(d)	Maximum grade for cul-de-sac	5.0%	
(e)	Maximum grade for residential road intersecting residential through-road	4.5%	for minimum 15 m tangent length back from intersecting road edge to centre of vertical curve
(f)	Maximum grade for residential road intersecting collector road	2.0%	for minimum 15 m tangent length back from intersecting road edge to centre of vertical curve
(g)	Normal Crown	2.0%	Crown may be increased to 3.0% if required to ensure good drainage

7A.5.2 Vertical curves shall be designed in accordance with the requirements of Standard Drawing R20.

7A.5.3 The vertical alignment of a road shall be set to serve adjacent properties with access driveways in accordance with Standard Drawing R11.

7A.5.4 Horizontal curves on residential roads shall not be super-elevated. Collector roads shall be super-elevated in keeping with good engineering practice.

7A.5.5 The length of a transition between a crowned and super-elevated road section should not be less than 10 metres for each 1.0% of change in crossfall.

7A.6 Horizontal Alignment

7A.6.1 The horizontal alignment of the road shall be centred in the road allowance.

7A.6.2 Minimum radius of curvature and maximum superelevation for roads not exceeding a grade of 8.0% shall be in accordance with the following:

	Design Speed	Minimum Center Line Radius	Maximum Superelevation
Residential	50 km/hr	65 m * **	Normal Crown
Collector	50 km/hr	90 m *	0.04 (4%)
Collector	60 km/hr	130 m *	0.06 (6%)
Major Road	Special Design		

* Larger curvatures may be required on roads with grades exceeding 8.0%.

** Subject to the approval of the Engineer, the curvature of crescent shaped residential roads may be reduced to a minimum centre line radius of 40 m.

7A.6.3 Curb returns for residential roads shall have a minimum radius of 9.0 m to face of curb. Curb returns located on roads with significant industrial and commercial traffic shall have a larger radius to facilitate the turning movements of trucks, buses, or other large vehicles.

7A.7 Turn-Arounds

7A.7.1 Turn-arounds and cul-de-sacs shall conform to Standard Drawing R10.

7A.7.2 Skewed turn-arounds may be permitted, subject to the review of the Engineer.

7A.7.3 Turn-arounds shall generally be crowned, however in areas of difficult topography, a 3% crossfall may be permitted subject to review by the Engineer.

7A.7.4 The maximum road grade accessing a down hill cul-de-sac should not exceed 8%.

7A.7.5 Except in special circumstances, the length of any cul-de-sac shall not exceed 160.0 m to the end of the turnaround, and shall permit a direct line of vision from the point of entry to the closed end.

7A.7.6 Temporary turn-arounds may be permitted where roads are to be extended in the future. Typical temporary turn-around designs are shown on Standard Drawing R9. Other temporary turn-around configurations may be permitted subject to the review of the Engineer.

7A.7.7 Where temporary turn-arounds are permitted, underground utilities shall be terminated at the end of the turn-around with any valve boxes, manholes, cleanouts, or other appurtenances contained within an asphalt apron.

7A.7.8 Any new deadend road not ending with a full size cul-de-sac shall be marked with a Class A Hazard Barricade installed in accordance with Ministry of Transportation and Highways standards.

7A.8 Intersections

7A.8.1 In general, intersections shall be located so as to provide the following minimum sight distances along the through-road:

Design Speed of Through-Road	Required Sight Distance *
50 km/hr	110 m
60 km/hr	135 m

* Sight distance measurement shall be based on a height of eye and height of object of 1.05 m.

Where required by the Engineer, a detailed intersection design prepared in accordance with RTAC shall be provided.

7A.8.2 Vertical alignment shall conform to Section 7A.5. When considering the vertical alignment of an intersecting road marked with a stop sign, the design speed may be reduced by 10 km/hr for a distance of 40 m from the intersection.

7A.8.3 The maximum grade of a through-road should not exceed 8% at an intersection.

7A.8.4 Roads shall intersect at right angles unless otherwise approved by the Engineer.

7A.8.5 No intersection shall be less than 76.0 m from any other intersection or likely future intersection, measured between centre lines.

7A.8.6 Where necessary, the Developer shall acquire corner cut-offs in order to accommodate curb returns when intersecting existing roads.

7A.8.7 In accordance with the Zoning By-law 1850, no obstruction to sight shall be permitted above 1.1 m from street level within the triangular area formed by the two intersection lot lines and the line joining the points on such lot lines 6.0 m from the point of intersection. As such, fences, walls, trees, cut slopes or other obstructions limiting visibility shall be removed in this area.

7A.9 Drainage

7A.9.1 Drainage works shall be provided to accommodate road drainage in accordance with the requirements of Section 6A.7.2.

7A.9.2 Catchbasin spacing and location shall be in accordance with Section 6A.7.2(b).

7A.9.3 Special attention shall be paid to accommodating subsurface drainage and ensuring that the road base is adequately drained. Where required, curtain drains shall be installed in accordance with Section 6A.12.

7A.10 Curbs

7A.10.1 Concrete curb and gutter shall conform to Standard Drawing R12.

7A.10.2 Mountable concrete curb and gutter shall generally be used on new residential roads where driveways have not yet been established; non-mountable concrete curb and gutter shall be used in most other applications.

7A.10.3 Asphalt curbs shall only be used where permitted by the Engineer and shall conform to Standard Drawing R19.

7A.11 Sidewalks

7A.11.1 Sidewalks shall be located directly behind the curb and shall conform to Standard Drawing R13.

7A.11.2 Where mountable curbs have been used sidewalks shall be 150 mm thick. Where non-mountable curbs have been used, sidewalks shall be 150 mm thick at driveways and 100 mm thick elsewhere. Driveway drops shall conform to Standard Drawing R14.

7A.11.3 Wheelchair ramps shall be formed at all intersections where curbs separate sidewalks from roadways. Wheelchair ramps shall be located at the mid point of the curb return and shall conform to Standard Drawing R15.

7A.12 Driveways

7A.12.1 Residential driveways shall be located so as to provide the following minimum sight distances:

Design Speed of Road	Required Sight Distance *
50 km/hr	65 m
60 km/hr	90 m

* Sight distance measurement shall be based on a height of eye and height of object of 1.05 m.

7A.12.2 Driveways may not be constructed within 7.0 m of a property corner at an intersection.

7A.12.3 Residential driveway grades shall conform to Standard Drawing R11.

7A.12.4 Where required, access culverts for residential driveways shall be minimum 7.0 m long, 300 mm diameter CMP conforming to Section 6A.13.6 and Standard Drawing D7. All access culverts on existing roads shall be installed by the Municipality.

7A.12.5 Residential driveway drop sections shall have a minimum width of 6.0 m.

7A.12.6 Commercial driveway grades and locations shall be reviewed by the Engineer on an individual basis.

7A.12.7 Commercial driveways shall have a minimum width of 7.6 m. Driveway drop sections shall have a minimum width of 9.0 m.

7A.12.8 A Highway Access Permit must be obtained from the Municipality prior to the construction of any driveway on an existing road.

7A.13 Appurtenances

7A.13.1 Concrete no-post barricades conforming to Ministry of Transportation and Highways specifications shall be installed along high fill sections as required by the Engineer.

7A.13.2 Traffic islands shall be installed at main intersection to delineate acceleration and deceleration lanes, and to protect road signs. Curbing shall be extruded asphalt conforming to Standard Drawing R19.

7A.13.3 Barricades shall be installed across service access lanes as directed by the Engineer. Post and chain barricades shall conform to Standard Drawing R17.

7A.13.4 Fencing shall conform to Standard Drawing R18.

7A.13.5 Supply and installation of road name and traffic signs shall be the responsibility of the Developer. Proposed sign locations shall be shown on the design drawings and submitted for approval. Sign base and sleeve shall be installed in sidewalks, traffic islands or other locations at the time of construction as directed by the Engineer. All posts and signs shall be installed by the Municipality at the Developer's expense.

7B.1 Scope

This section shall govern the construction of roads, lanes, boulevards, curbs and gutters, sidewalks and driveways within the Municipality.

7B.2 General

Construction shall be in accordance with the design drawings approved by the Engineer and with these specifications.

7B.3 Materials

7B.3.1 Sub-base (Pit-run Gravel)

The sub-base material shall be pit-run gravel consisting of a natural or artificial mixture of hard, durable stones, rock fragments and soil binder, free from soft particles and excess clay. It shall be capable of being compacted by rolling into a dense firm course which will, at an average moisture condition, hold the weight of construction equipment and loaded trucks without leaving pronounced indentations.

Sub-base material shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard Sieve Size	% Passing (by Weight)
75 mm	100%
25 mm	50-85%
0.15 mm	0-16%
0.075 mm	0-5%

7B.3.2 Base (Crush Gravel)

The base material shall be composed of unwashed natural gravel, crushed gravel, a blend of commercial sand and rock products, or combinations of the above. These aggregates shall consist of sound, hard durable particles and shall be free from clay, organics, decomposed rock, shale, or other soft, thin, pliable or laminated pieces or other detrimental matter. They shall be capable of being compacted by rolling into a dense, firm course which will at any moisture condition hold the weight of loaded trucks without leaving pronounced indentations.

Base material shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard Sieve Size	% Passing (by Weight)
19 mm	100%
9.5 mm	60-100%
4.75 mm	40-80%
2.36 mm	30-60%
1.18 mm	20-45%
0.3 mm	8-20%
0.075 mm	2-4%

A minimum of 50% of all material retained on the 4.75 mm Sieve shall have at least one crushed face.

7B.4 Clearing and Stripping

7B.4.1 Site Clearing

The full width of the road allowance shall be cleared of all standing and fallen trees, stumps, logs, roots, brush, all vegetation and accumulated rubbish which, in the opinion of the Engineer, is detrimental to construction of roads and services. At the direction of the Engineer, certain trees or shrubs may be required to remain near property lines and the Contractor will take all precautions to ensure that they remain undamaged during the construction period. All material resulting from site clearing shall be disposed of by the Contractor in compliance with all current Municipal and Provincial regulations.

7B.4.2 Stripping of Overburden

All overburden and topsoil shall be stripped from the road allowance to such widths as will be affected by the road grading and the construction of sidewalks, curbs and gutters or ditches. All topsoil shall be stored onsite during construction and upon completion shall be spread between the back of the curb or ditch and the property line to form a boulevard. Surplus overburden shall be disposed of by the Contractor.

7B.5 Road Base Construction

7B.5.1 Design Cross-section

The design cross-section shall comply with standard drawings R1-R6 as applicable, unless otherwise approved by the Engineer.

7B.5.2 Sub-grade Preparation

(a) Cuts

(i) In cut areas, the subgrade shall be excavated, graded and compacted to the design subgrade cross-section. Any soft spots that develop during the process of compaction shall be excavated and filled with pit-run gravel.

(ii) Where cuts are in rock, no points or pinnacles shall be left protruding above the subgrade cross-section; subgrade rock shall be shattered at least 300 mm below the subgrade to permit uniform grading and compaction. Where rock excavation results in an uneven subgrade that does not permit uniform grading and compaction, the subgrade shall be left 100 mm low to permit installation of additional sub-base material.

(iii) Rock cuts shall be scaled to remove any loose or unstable material.

(iv) Material excavated from cut areas shall be disposed of unless approved for fill material as specified below.

(b) Fills

(i) Fills constructed with pit-run gravel shall be placed in maximum 300 mm lifts and compacted to 98% Standard Proctor Density. Compaction of the top 150 mm shall be to 100% Standard Proctor Density.

(ii) Any fills constructed with material other than pit-run gravel must have the prior approval of the Engineer and be installed under the direction of a geotechnical engineer.

(iii) When considering approval of fill other than pit-run gravel, the Engineer will require that an assessment of the fill material, prepared by a geotechnical engineer, be submitted for review. This assessment should include recommendations related to placement and compaction, and indicate the level of onsite monitoring required.

(c) Utility Trenches

(i) All utility trenches within the subgrade area shall be backfilled with pit-run gravel only, in accordance with Section 3.

(ii) Special attention shall be paid to subsurface drainage that might accumulate in utility trenches and adversely affect the subgrade.

(d) Compaction and Grading

(i) The subgrade shall be compacted and graded to conform to the design grades and cross-section. In particular, the subgrade must be shaped to permit proper drainage and ensure that water is not trapped on or in the subgrade.

(ii) Compaction of the top 150 mm shall be to 100% Standard Proctor Density. Compaction below the top 150 mm shall be as specified above.

7B.5.3 Sub-base Course

(a) The sub-base shall be the required width and shall form an integral part of the base for the curb and gutter, and shall be laid to the consolidated thickness required by the design cross-section. Each layer or lift of gravel shall be adequately consolidated with the use of vibratory type compactors. Where deemed necessary, water shall be used to aid compaction. A grader shall be used in conjunction with the compaction roller to maintain an even and uniform compaction surface. The finished sub-grade surface shall conform to grades with a tolerance of 25 mm.

(b) The surface shall be graded to provide a finished surface in accordance with the design cross-section. All underground services shall be installed and the trenches backfilled and consolidated prior to the application of the sub-base course.

(c) A minimum compaction of 100% of Standard Proctor Density for the sub-base material shall be attained.

7B.5.4 Base Course

(a) Base course materials shall be placed over the sub-base in accordance with the design cross-section.

(b) No base course gravel shall be placed on the sub-base surface until the latter has been approved by the Engineer.

(c) The base course shall be spread in uniform layers over a previously shaped, compacted and approved sub-base. Each layer shall be watered and mixed or aerated as directed by the Engineer to bring all the material to its optimum moisture content. Each layer shall be compacted by the use of a roller. A grader shall be used in conjunction with the compaction rollers to obtain an even and properly shaped surface, conforming to the lines and grades as required.

(d) Compaction of the granular base course is required to attain 100% of Standard Proctor Density in each layer.

(e) The finished grade surface of the compacted base course shall be within 15 mm of the design grade and cross section and shall be free from ridges, humps or depressions exceeding 10 mm when measured with a 3 m long straight-edge placed parallel to or perpendicular to the road centre line. Care shall be taken along the gutters if such gutters are existing, to leave exactly the specified depth for the subsequent placing of the final asphalt layer(s). Note: Finished asphalt shall be left 6 mm above concrete gutter to ensure positive drainage to gutter.

7B.5.5 Proof Rolling

Before proceeding further with the work each finished layer of subgrade, subbase and base course shall be proof rolled by receiving one complete coverage using a single axle truck having an 9,000 kg (20,000 lbs) rear axle load. Should any areas of rutting or displacement result, they shall be excavated, refilled and compacted. Excavated and refilled areas shall be proof rolled to confirm rutting and/or displacement has been eliminated.

7B.6 Concrete Curb, Gutter and Sidewalk

7B.6.1 Base

(a) Sub-grade and sub-base preparation shall be as detailed above in Section 7B.5 to the cross-sections shown on the detail drawings.

(b) Crushed gravel shall be placed and compacted to a depth shown on the detail drawings before placing any concrete. The gravel shall be rolled and compacted to produce a uniform bearing capacity through the entire width and length of the work.

7B.6.2 Concrete

All concrete shall conform to the detailed specifications contained in Section 10 and shall have the following properties:

(a) Compressive Strength

All concrete for the work shall attain a compressive strength of 27.6 Mpa (4,000 psi) in 28 days.

(b) Slump

The concrete shall have a uniform consistency and slump. The slump shall be between 25 mm and 75 mm for hand-vibrated concrete, between 50 mm and 100 mm for hand tamped or spaded concrete, and between 12 mm and 50 mm for concrete placed by a slipform/extrusion machine.

(c) Air Content

The air content shall average 6%, with a minimum of 5% and a maximum of 7%.

7B.6.3 Placing

(a) Curb and Gutter - Machine Method

(i) The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section.

(ii) The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed.

(iii) The machine shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be co-ordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

(iv) Contraction and surface joints shall be provided in accordance with Section 7B.6.6.

(b) Curb and Gutter - Form Method

(i) The forms shall be of wood, metal, or other suitable material that is straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature shall be used for curves having a radius of 30 m or less. Division plates shall be metal.

(ii) The front and back forms shall extend for the full depth of the concrete. All of the forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them.

(iii) The concrete shall be deposited into the forms without segregation and then it shall be tamped and spaded or mechanically vibrated for thorough consolidation. Low roll or mountable curbs may be formed without the use of a face form by using a straightedge and template to form the curb face as per cross-sections shown on Standard Drawing R12. When used, face forms shall be removed as soon as possible to permit finishing. Front and back forms shall be removed without damage to the concrete after it has set.

(iv) Contraction and surface joints shall be provided in accordance with Section 7B.6.6.

(c) Sidewalks

(i) Special care shall be taken to place the concrete, particularly in corners, in order to prevent voids, pockets, rough areas and honeycombing.

(ii) The concrete shall be tamped in such a manner as to work the coarse aggregate away from the exposed surfaces. Vibrators or vibrator screeds used in placing concrete shall be a minimum of 5,000 cycles per minute. The technique and use of vibrators and vibrator screeds shall be at the discretion of the Engineer.

(iii) Every precaution shall be taken to make all concrete masonry solid, compact, watertight, and smooth.

(iv) After placing, the concrete shall be adequately worked with wood and steel trowels. Excessive trowelling is to be avoided.

(v) The edges shall be neatly rounded with contraction, surface and expansion joints constructed in accordance with Section 7B.6.6.

7B.6.4 Finishing

(a) Curb and Gutter

Concrete curb and gutter shall have a steel trowel finish. Maximum deviation from the designated horizontal or vertical alignment of any point on curb and gutter sections shall be 8 mm.

The finish on curb and gutter sections shall be true within 5 mm in 3 m as determined by a 3 m straight-edge placed anywhere along the curb and gutter. The surface shall have a smooth even dense texture free from blemishes.

(b) Sidewalk

Sidewalks shall have a broom finish unless otherwise specified. Maximum deviation from the designated horizontal or vertical alignment of any point on the sidewalk shall be 8 mm.

The broom finish shall provide a uniform non-skid surface. Finished surfaces shall be true in all planes within 5 mm in 3 m as determined by a 3 m straight-edge placed anywhere on the surface.

7B.6.5 Stripping the Forms

(a) The forms shall not be stripped less than 24 hours after the concrete has been placed. Adequate care shall be taken in removing the forms to avoid spoiling or marring the concrete.

(b) Such patching as may be necessary shall be started immediately after the removal of forms.

7B.6.6 Joints

(a) Contraction Joints

(i) Contraction joints in curbs, gutters and sidewalks shall be constructed at right angles to the curb line at intervals not exceeding 3 m as shown on the detail drawings. Contraction joints in sidewalk must align with contraction joint in curb and gutter.

(ii) Joint depth in sidewalks shall average at least one-fourth of the cross-section of the concrete; joint depth in curbs and gutters shall be within 75 mm of bottom.

(iii) Contraction joints may be sawed, handformed, or made by 3 mm thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand-formed either by (1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete, or (2) inserting 3 mm thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set and while the forms are still in place.

(b) Surface Joints

(i) Surface joints shall be constructed in sidewalks at intervals half-way between the contraction joints as shown on the detail drawings.

(ii) Joint depth shall be 12 mm.

(c) Expansion Joints

(i) Expansion joints shall be constructed in curbs and gutters and sidewalks at right angles to the curb lines at immovable structures and at points of curvature for short-radius curves or at centres not exceeding 90 m. Filler material for expansion joints shall be asphalt impregnated fibre expansion material conforming to A.S.T.M. D1751, and shall be furnished in a single 13mm thick piece for the full depth and width of the joint.

(ii) Expansion joints in sidewalks shall be installed as the sidewalk is being poured. Care shall be taken to ensure that the filler material does not protrude above the rounded panel edge.

(iii) Expansion joints in a slipformed curb and gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall only be wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then trowelled and edged.

(iv) Alternatively, an expansion joint may be installed by removing a short section of freshly extruded curb-and-gutter immediately, installing temporary forms, placing the expansion joint filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.

(d) Other Joints

(i) Cold joints shall be provided between the back of curb and sidewalk.

(ii) Construction joints may be either butt or expansion type joints.

(iii) Curbs and gutters and sidewalks constructed adjacent to existing concrete shall have the same type of joints as the existing concrete, with similar spacing, however, contraction joint spacing shall not exceed 3 m.

7B.6.7 Crossings

At lane and driveway crossings the required sidewalk slab thickness shall be 150 mm as shown on Standard Drawing R14 and shall extend the full width and required length of the crossing. The crossing shall be grooved and brushed transversely. A construction joint shall be placed on each side of the crossing and the required sidewalk slab shall be at the full thickness required for the crossing for the full distance between the construction joints.

7B.6.8 Wheelchair Ramps

Wheelchair ramps shall be provided where required by the Engineer. Wheelchair ramp details shall be as shown on Standard Drawings R15 and R16.

7B.6.9 Breaking Out

The Developer shall not break out any existing sidewalk and/or curb and gutter without first receiving approval to do so from the Engineer.

7B.6.10 Protection

(a) The Contractor shall supply and place all tarpaulins or other necessary material to protect the work from rain, dust, frost, snow, or other similar weather action.

(b) The Contractor shall also barricade the work and keep all humans, animals, and vehicles off the work for a minimum period of five (5) days after the finishing of the concrete has been completed. Any damage occurring to the work during this five day period regardless of origin, shall be replaced or repaired immediately.

7B.6.11 Backfilling and Backsloping

(a) Where an excavation has been made wider than the finished concrete width, this area between the edge of the excavation and the finished concrete surface when both are level, shall be filled with suitable material and well compacted. This work shall be done at the end of the five day period after the finishing of the concrete has been completed.

(b) Backfill shall be placed behind the curb and gutter or sidewalk section at a maximum grade of 4% to property line. The remainder shall be graded to a maximum slope of 1.5:1 when fronting undeveloped properties; the maximum slope shall not exceed 3:1 where fronting developed properties.

7B.6.12 Clean-up

(a) All refuse shall be removed from each site before the concrete finishers move to another location. Concrete debris shall not be flushed into the storm drain system or natural water courses, and shall not be left in boulevard areas.

(b) On existing streets, complete clean-up including the removal of all surplus excavation from backsloping shall be made within two weeks from the time the excavation was started, excepting main streets, which shall be cleaned up immediately after the forms have been stripped.

7B.6.13 Testing

Concrete testing shall be carried out in accordance with the requirements of Section 10.9. In general, the following tests shall be carried out for each 300 lineal metres of curb and gutter, or sidewalk placed, with a minimum of one set of tests per day:

(a) One set of three test cylinders for compressive strength tests.

(b) Slump test.

(c) Air test.

Additional testing may be required at the discretion of the Engineer.

7B.6.14 Defects

All finished concrete shall be in accordance with the approved dimensions, tolerances, and properties, as specified in these standards and on the approved design drawings.

The finished concrete shall be free of honeycombing, cracking, spalling, surface irregularities, and other defects. Unless otherwise approved by the Engineer, all defective concrete shall be removed and replaced at the Contractor's expense.

7B.7 Boulevards

7B.7.1 Boulevards shall be graded in accordance with the cross-sections shown on the Standard Drawings.

7B.7.2 A minimum of 200 mm of native topsoil shall be placed in boulevard areas. Where native topsoil is not available, importing of topsoil may be required. Note: In accordance with Section 7B.4.2, Stripping of Overburden, all topsoil shall be stored onsite during the construction and used to complete the boulevards; topsoil shall not be exported from the site.

7B.7.3 In existing areas, boulevards shall be restored to a condition equal to that found prior to construction as detailed in Section 3.8.2.

7B.8 Protection and Adjustment of Valves, Manholes, and Catchbasins

7B.8.1 It is the responsibility of the Contractor to adjust all appurtenances such as valve boxes, manholes and catch basins to the finished grade of roads, sidewalks and boulevards. There will not be any tolerance in the shape of the finished surface in the vicinity of an appurtenance.

7B.8.2 The methods or materials used in raising or lowering an appurtenance must be in accordance with the standards for the utility involved. The Contractor will be responsible for maintaining these items during the maintenance period.

7B.8.3 The Contractor will be responsible for removing immediately any earth, gravel, or debris and all materials that fall into a manhole, catchbasin, or other appurtenances, as a result of adjusting these appurtenances.

7B.9 Asphalt Surfacing

7B.9.1 Municipal roads shall be surfaced with hot-mix asphaltic pavement to the lines, grades and cross-sections shown on the approved design drawings and as detailed in these standards.

7B.9.2 Preparation and placement of hot-mix asphaltic pavement shall be in accordance with the detailed specifications contained in Section 11.

7B.9.3 Asphalt testing shall be carried out in accordance with the requirements of Section 11.7. In general, the following tests shall be carried out for each 300 tonnes of asphalt placed, with a minimum of one set of tests per day:

(a) One set of three briquettes to determine hot mix quality.

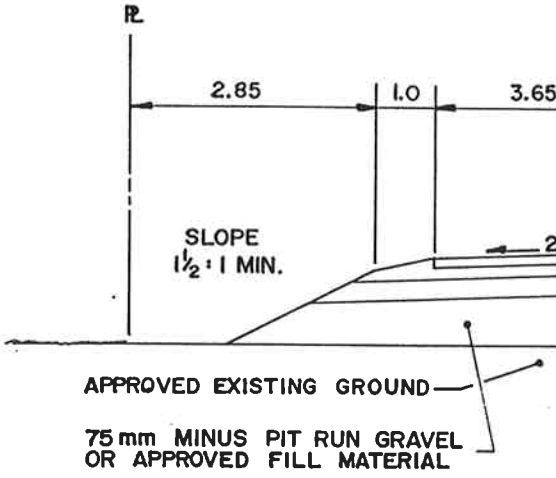
(b) One set of three cores to determine field density and thickness.

Additional testing may be required at the discretion of the Engineer.

ROADS CONSTRUCTION 7 B

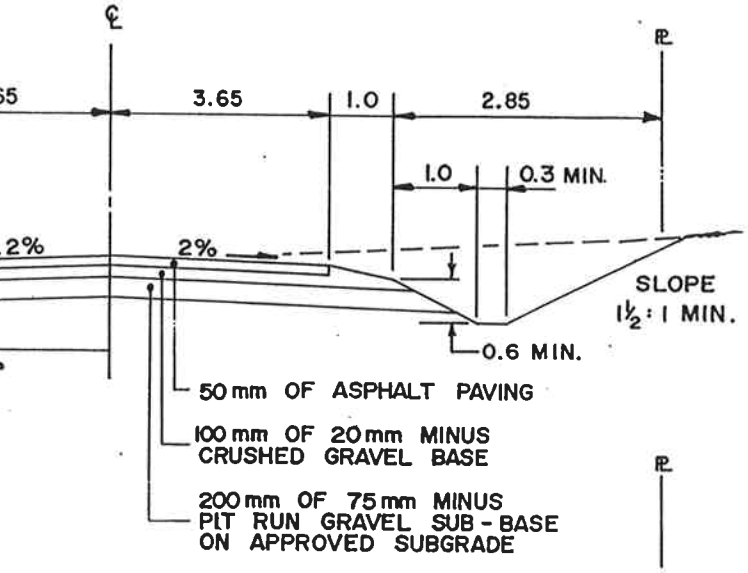
15 m ROAD ALLOWANCE

EARTH FILL

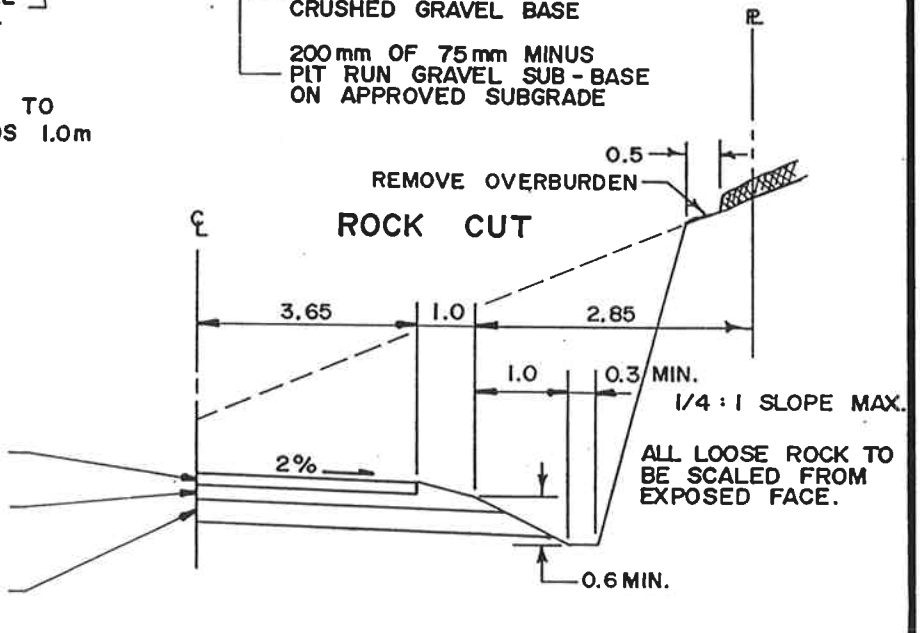


NOTE – INCREASE SHOULDER WIDTH TO 2.0 m WHEN FILL DEPTH EXCEEDS 1.0m

EARTH CUT



ROCK CUT



NOTE — DITCH TO SUIT DRAINAGE DESIGN. NO STANDING WATER PERMITTED.

— DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO PROVIDE A STABLE ROAD BED.

— WIDTH OF ROAD ALLOWANCE MAY HAVE TO BE INCREASED IN AREAS OF LARGE CUTS OR FILLS.

— CROWN MAY BE INCREASED TO 3% IF REQUIRED TO ENSURE PROPER DRAINAGE.

NOTE : DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.	DATE	REVISION	APPROVED

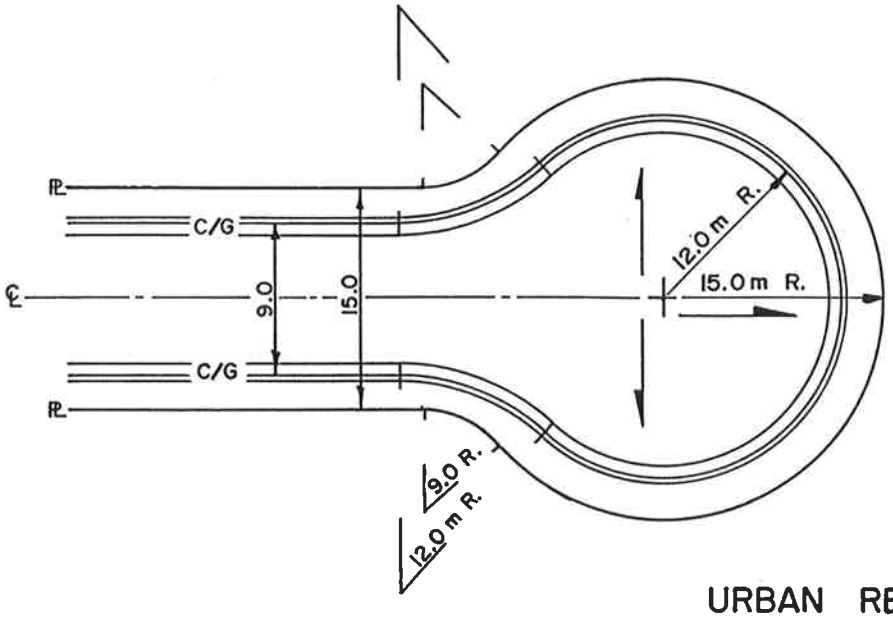
The Corporation of the District of North Cowichan

RURAL RESIDENTIAL ROAD
TYPICAL SECTION

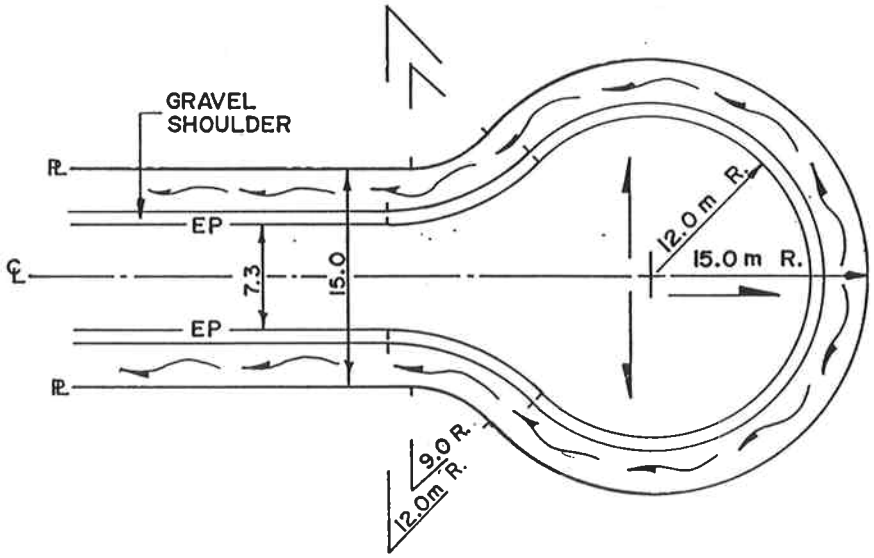
DATE : JULY 9, 1993

CHECKED : KLH

STD. DWG. NO. **R1**



URBAN RESIDENTIAL ROAD



DITCHING TO SUIT SITE CONDITIONS

RURAL RESIDENTIAL ROAD

WATER CONTROL CURBS AND CATCH BASINS MAY BE REQUIRED.

THESE STANDARDS APPLY TO RESIDENTIAL ROADS ONLY

NOTE : DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.	DATE	REVISION	APPROVED

The Corporation of the District of North Cowichan

TYPICAL PERMANENT TURNAROUNDS

DATE : JULY 9, 1993

CHECKED : KLH

STD. DWG. NO. R 10

ROADWAY LIGHTING 8

8.1 Design

8.1.1 Illumination

Roadway lighting shall be designed in accordance with the Illuminating Engineering Society, Standard Practice for Roadway Lighting. Illuminance requirements shall satisfy the following Average Maintained Illuminance Values (E avg) in lux for Pavement Classification R-3 (typical highways).

Road Classification	Area Classification	Illuminance (E. avg)	Illuminance Uniformity Ratio (E. avg to E. min)
Major	Commercial Intermediate Residential	17 13 9	3 to 1
Collector	Commercial Intermediate Residential	12 9 6	4 to 1
Local	Commercial Intermediate Residential	9 7 4	6 to 1

Road Classification Definitions:

Major or Arterial - Roadways serving principal areas of traffic generation and carrying large volumes of through traffic. Utilizing signalized intersections and having partially controlled access.

Collector - Connect local roads with arterial roads. Flow is interrupted frequently by signalized intersections in urban areas and less frequently by stop conditions or signals in rural areas. Generally, full access is allowed to adjacent properties.

Local - Are not intended for large volumes or through traffic. Pedestrian traffic is unrestricted. Primary function is to provide land access.

Area Classification Definitions:

Commercial - A densely developed business area which attracts a relatively heavy volume of nighttime vehicular and/or pedestrian traffic on a frequent basis, with a high demand for parking.

Intermediate - Areas with moderately heavy nighttime pedestrian activity, such as recreation centres, large apartment buildings or neighbourhood retail stores, with less demand for parking.

Residential - Areas characterized by few pedestrians at night, such as single family houses, townhouses, and/or small apartment buildings with a low demand for parking.

8.1.2 Distribution

Light emanating from the luminaires is to be directionally controlled and proportioned in accordance with the roadway width, luminaire spacing, and mounting locations. The Average Horizontal Illuminance (E avg.) divided by the Minimum Horizontal Illuminance (E min.) should not exceed the values shown above under Illuminance Uniformity Ratio. All luminaries to be semi-cutoff or cutoff control type.

8.1.3 Location

Spacing and location of street light poles shall be governed by road width, road configuration and property lines. Where possible, poles shall be located in line with intersecting property lines and behind sidewalks (or possible future sidewalks).

8.1.4 Control

Luminaries shall be connected to a common controller complete with service equipment, contactor, 3 position test switch (HOA), photo electric control, and branch circuit protection.

Service to and space available in the controller shall be sufficiently sized for the system as well as possible future development that is deemed foreseeable by the Engineer. Wherever possible, luminaries shall be connected to existing adjacent luminaries controlled by an existing controller. At the discretion of the Engineer, individual photo-electric control may be used on installation of 2 luminaries.

8.1.5 Conduit

Where practical, street lighting duct shall be located 2.2 metres from property line on the same side as the sidewalk.

Otherwise ducts shall be routed parallel or perpendicular to the roadway and run directly between adjacent poles.

Minimum depth of bury below finished grade shall be not less than 0.6 metres.

8.1.6 Grounding & Bonding

The combined ground resistance shall not exceed 10 ohms, by connection to artificial grounding electrodes. Grounding connections, if exposed, shall be located in the service base. Grounding shall be achieved by the use of a plate electrode and the ground wire shall enter the service base via a concealed conductor.

8.1.7 Conductors

Conductors shall be sized to not exceed a voltage drop of 5% over the length of the run.

8.1.8 Splices

Splices shall be made water tight.

8.2 Materials

8.2.1 Conductors

Conductors shall be stranded copper, with RW-90 (x-link) insulation. Minimum sizes to be as follows:

#10 AWG - for feeder runs
#12 AWG - on pole
#14 AWG - for control

Conductors shall be sized in accordance with ballast start and running loads, voltage drop of line, and anticipated future extension of circuit loads, as specified by the Engineer.

8.2.2 Conduit

Exposed conduit shall be hot-dip galvanized rigid Steel. Conduit clamps and fittings shall be hot dip galvanized malleable iron.

Buried conduit shall be rigid PVC. Couplings shall be threadless type, approved for cement welding. Minimum size shall be 32 mm Ø.

Service conduit

8.2.3 Concrete Base

Concrete shall have a minimum compressive strength of 20 Mpa after 28 days.

Precast bases to be dimensioned as per Standard Drawing L1 complete with 4 x 25 mm Ø galvanized anchor bolts as shown, or as approved by the pole manufacturer.

Anchor bolts to be continuous throughout their length.

Bases shall contain a concealed conduit for the ground wire, plus a maximum of three other conduits.

8.2.4 Fuses

Each luminaire shall be protected by a 10 amp HRC fuse with HEB waterproof fuse holders located inside the handhole of each pole. Conductors shall allow for the fuse holder to be removed from the pole base for maintenance.

8.2.5 Junction Boxes

Underground junction boxes shall only be used with special approval of the Municipal Engineer and where authorized by the Provincial Electrical Inspector. If approved, junction boxes shall be plastic or precast concrete with a bolt locking device and marked "ELECTRIC" with permanent lettering.

8.2.6 Luminaries

Luminaries shall be CSA approved, high pressure sodium, with integral ballast (120v) rated to -34 C. Luminaire bodies shall be cast aluminum and equipped with an adjustable slip fitter and adjustable lamp socket.

The luminaire of the service pole shall be equipped with a twist lock receptacle type photo control.

Lamps used for local residential applications shall be 100 watt with semi-cut off Type II or Type III distribution. Lamps used in applications requiring higher illuminance may be 150 watt or 200 watt.

8.2.7 Poles

Lighting poles shall be hot-dip galvanized steel, octagonal tapered davit type, complete with anchor base and nut covers.

Each pole shall have a reinforced type handhold with cover assembly.

Pole shall be complete with a minimum 6 mm (1/4") galvanized grounding stud and each pole shall be bonded at this stud.

Unless otherwise approved by the Engineer, poles shall be 9.14 metres (30') with 2.44 metres (8') davit arm.

The nominal length of a lighting pole on a service base shall be 0.9 m (36") shorter to allow for the height of the service base.

8.2.8 Photo-electric Controller

Photo-electric controllers shall be 120v with twist lock base.

8.2.9 Service Base

The Service Base shall be 0.9 m (36") high and sized to accommodate the service panel. It shall be galvanized steel complete with galvanized bolts and nuts of appropriate size and shall have a padlock type locking device. The assembly is to be CSA certified. The design of the base shall allow for the lid of the service entrance switch to open fully. The access opening shall be approximately 250mm x 750m. The backing plate, if required, shall be galvanized steel.

8.2.10 Service Panel

Shall be in a CEMA 3 enclosure. The service panel shall contain a service breaker, lighting contactor, selector switch (HOA), and have branch circuit breakers if required.

The service enclosure shall have only those openings necessary to accommodate conduits at the time of installation. Service conduits shall enter or leave enclosure through threaded hubs and shall be continuous to the hydro connection.

8.3 Installation

8.3.1 Permits

The contractor shall obtain and pay for all permits, connection charges, arrange for all electrical inspections covering his work, pay all other fees and charges, and make all deposits that are in any way connected with the installation of the roadway lighting. This shall include obtaining permits prior to the installation of street lighting conduit. He shall give all necessary notices to authorities having jurisdiction and shall be responsible for complying with all applicable public ordinances.

8.3.2 Rules and Regulations

The equipment, equipment installation, wiring methods and materials shall conform to the latest revision of the Canadian Electrical Code, Electrical Energy Inspection Act and the Rules for Overhead and Underground Electric-Line Construction as issued by the Ministry of Labour, Province of British Columbia, and all Bulletins issued thereto, any local or provincial by-laws or statues in effect at the site, and the Fire Marshal and Workers' Compensation Acts.

8.3.3 Pole Base

Pole bases to be installed or constructed on solid undisturbed material. Where soil conditions appear unsuitable the contractor shall notify the Engineer in order that a standard pole base design can be considered.

Pole bases shall be constructed to the dimensions and specifications of Standard Drawing L1. The top of the base shall be trowelled smooth and level and the edges shall be bevelled.

An accurate template shall be used to locate conduits and anchor bolts.

8.3.4 Conduit

Conduit shall be installed in accordance with the typical trench section, Standard Drawing L1 on approved bedding material.

During construction all conduit is to be protected from damage and the entrance of dirt or moisture.

Warning tape shall be placed 300 mm directly above conduits.

Conduit shall extend a minimum of 75 mm above the top of the concrete base.

Where future extension may occur, conduit shall be stubbed out in those directions.

8.3.5 Conductor

No conductor shall be drawn into any vacancy until all work of any nature that may cause injury to the conductor or its insulation has been completed.

Conduit systems shall be cleaned to remove all moisture and foreign substances before pulling conductors.

8.3.6 Poles

Davits and mast arms shall be installed at right angles to the centre line of the road. In the case of corner installations the Municipal Engineer shall determine which roadway is to be used for positioning.

Street light poles shall be installed plumb using not more than six shims per pole for levelling. Exposed portions of the anchor bolts and nuts shall be coated with no-oxide type grease.

Following installation, poles and luminaries shall be cleaned.

8.3.7 Junction Boxes

Use of junction boxes must have the specific approval of the Engineer.

Where approved, junction boxes shall have a concrete brick base covering the bottom of the junction box to 50 mm beyond the outside wall. The top of the box shall be flush with final grade, with the ground graded to direct drainage away from the box.

Ducts must be grouted in junction box knock-out holes.

Junction boxes must be drained to the storm drain system.

Conductor connections in junction boxes must be secured with solderless connectors and sealed with self-bonding tape, covered with PVC tape and dipped in approved silicon rubber based sealer.

8.4 Final Approval

8.4.1 Final Inspection

Prior to requesting a final inspection of the works by the Municipality, the Consulting Engineer and Contractor shall carry out a thorough review of the project to identify and remedy any deficiencies. The Inspection Checklists contained in Appendixes "A" and "B" shall be used as references. The system shall be tested to confirm it performs the intended functions and operations, and shall be energized with a generator if necessary. The Consulting Engineer shall also thoroughly review as-built record information and make any changes necessary.

Upon request for a final inspection, the Consulting Engineer shall submit the following:

(a) Two copies of the as-built drawings.

(b) A copy of the Contractor's Declaration.

(c) Completed copies of the Final Inspection Checklist.

Following receipt and review of the above noted information, a final inspection shall be carried out with the Consulting Engineer, Contractor and Engineer in attendance. If required by the Engineer, the operation of the lighting system shall be demonstrated. The Consultant shall provide the Contractor and Engineer with a written summary of the final inspection, listing any deficiencies and the proposed course of action.

8.4.2 Final Approval Submission

Prior to requesting final approval and acceptance of the works, the Consulting Engineer shall ensure that the following has been submitted to the Municipality:

(a) Two sets of certified as-built drawings and one certified, reproducible set.

(b) Confirmation that all deficiencies noted during the final inspection have been corrected.

(c) A copy of the Contractor's Declaration and confirmation that it has been sent to the Electrical Inspector and BC Hydro.

(d) Confirmation of payment of BC Hydro connection charges. System not to be energized until authorized by Municipality .

(e) Number and type of street lights installed.

(f) Date of completion and proposed maintenance bond amount.

8.4.3 Energizing System

The system shall not be energized until authorized by the Municipality. Following final approval of the works, and when deemed appropriate, the Municipality will advise BC Hydro to energize the system and initiate the billing process.

ROADWAY LIGHTING 8

NON-MUNICIPAL UTILITIES 9

9.1 Scope

This section shall govern the installation of non-municipal underground utilities in municipal rights-of-way. The utilities covered by this specification shall include underground hydro, telephone, cablevision and gas mains and services.

9.2 General

Design and installation of non-municipal utilities shall conform to applicable federal and provincial regulations, operating agreements between individual utility companies and the Municipality and the requirements stated below.

9.3 Design

9.3.1 Design of non-municipal utility installations shall be undertaken by the individual utilities companies having jurisdiction.

9.3.2 Where requested by the Engineer, the design drawings shall be sealed and signed by a Professional Engineer registered to practice in the province of British Columbia.

9.3.3 Design drawings shall be submitted to the Municipality for review. These drawings shall show the location of proposed utility installations with respect to proposed and existing municipal services as follows:

a) In new subdivisions, the Developer's Consulting Engineer shall show proposed utility installations schematically on plan/profile design drawings of municipal services as specified in Section 2.7.3(f). Copies of utility design drawings produced by the utility company shall also be provided for reference.

b) In the case of a single utility being installed in an existing Municipal right-of-way, the utility company shall provide an overall design based on municipal as-built information and additional field survey work as may be required. The design drawings shall be at a scale of 1:500 and shall show the proposed utility alignment and all municipal services that exist in the right-of-way along the utility route. Drawing standard shall be in general compliance with Section 2.7.

9.4 Utility Locations

9.4.1 In new developments, utility mains shall be located in accordance with the line assignments shown on Standard Drawings R7 and R8, and utility services shall be located in accordance with Standard Drawings U1 and U2.

9.4.2 In existing areas, utility mains and services shall be located in accordance with standard line assignments wherever possible. Where this cannot be achieved, the proposed locations must be reviewed on an individual basis by the Engineer.

9.5 Approvals

9.5.1 Three sets of design drawings shall be submitted to the Municipality for review a minimum of 15 working days prior to the proposed start of construction.

9.5.2 Construction shall not commence until design drawings stamped "Approved For Construction" have been returned by the Engineer.

9.5.3 Work shall be carried out by qualified personnel who are insured as specified in Section 1. Construction must also comply with the safety requirements specified in Section 1 and 3.

9.5.4 Prior to construction, a Highway Construction Permit shall be obtained for any work within a municipal right-of-way.

9.6 Installation

9.6.1 The minimum depth of cover for non-municipal utilities installed in Municipal rights-of-way shall be 750mm unless otherwise approved by the Engineer.

9.6.2 In areas where it is anticipated that future road improvements may require lowering of the road grade, the utility shall be installed at an elevation that will be compatible with the future road grade.

9.6.3 Laying and bedding of the utility shall be in accordance with installation specifications for the particular utility being installed.

9.6.4 Excavation, backfilling and restoration shall be in accordance with Municipal Specifications as outlined in Section 3.

9.6.5 Should any Municipal services be altered or damaged during the installation of non-municipal utilities, the municipality shall be notified immediately. Repair of damaged municipal services shall be carried out by Municipal forces only, with the costs charged to the Developer or utility company involved.

9.7 Inspection

9.7.1 Sufficient resident inspection shall be provided to ensure that the utility installation is constructed in accordance with the approved design drawings and specifications.

9.7.2 Municipal inspection personnel shall be notified 24 hours in advance of any construction.

9.8 As-Built Drawings

9.8.1 Following completion of construction, as-built drawings shall be provided showing the location of the distribution system and services. Requirements shall be as follows:

(a) In new subdivisions, the Developer's Consulting Engineer shall show as-built utility installations schematically on plan/profile design drawings of municipal services as specified in Section 2.9.4(e). Copies of as-built drawings produced by the utility company shall also be provided for reference.

b) In the case of a single utility being installed in an existing Municipal right-of-way, the utility company shall show the as-built utility alignment with respect to municipal services that exist in the right-of-way along the utility route. Drawing standard shall comply with Section 2.9.

9.8.2 All as-built dimensions shall be referenced to legal pins or monuments.

9.8.3 Where requested by the Engineer, the as-built drawings shall be sealed and signed by a Professional Engineer registered to practice in the province of British Columbia.

NON-MUNICIPAL UTILITIES 9

CONCRETE 10

10.1 Scope

This section shall cover the preparation and placement of concrete used in the construction of Municipal works.

10.2 Properties

Unless otherwise specified, concrete used in the construction of Municipal works shall have the following properties:

10.2.1 Compressive Strength

All concrete for the work shall attain a compressive strength of 27.6 Mpa (4,000 psi) in 28 days.

10.2.2 Slump

The concrete shall have a uniform consistency and slump. The slump shall be between 25 mm (1 inch) and 75 mm (3 inches) for hand-vibrated concrete, between 50 mm (2 inch) and 100 mm (4 inch) for hand tamped or spaded concrete, and between 12 mm (1/2 inch) and 50 mm (2 inch) for concrete placed by a slipform/extrusion machine.

10.2.3 Air Content

The air content may range between 4% and 7% for normal applications; however, the air content for concrete exposed to freezing and de-icing agents must average 6%, with a minimum of 5% and a maximum of 7%.

10.3 Materials

10.3.1 Cement

Cement used on the work shall be Portland Cement. Bulk or bag cement may be used, but bulk cement shall be batched by an approved weighing device. The cement shall meet the requirements of A.S.T.M. Des. C150-59, Type 1 (Portland Cement).

10.3.2 Aggregates

(a) Fine Aggregate shall meet the requirements of ASTM Des. C33-59 except as modified by the following:

i) Fine aggregate shall be natural sand, washed clean, having hard, strong, sharp, durable uncoated grains, and shall be free from injurious amounts of dust, lumps, soft or flaky particles, mica shale, alkali, organic matter, loam or other deleterious substance.

ii) Sand containing more than 3% by weight of clay or loam shall be washed before using. Deleterious substances shall not exceed one percent of each substance and not more than five percent (5%) altogether. Should the necessity for frequent rejections occur, no further sand will be accepted from this source and another and approved source will be required.

(b) Coarse Aggregate shall conform to the requirements of ASTM Des:C33-59 except as modified by the following:

Coarse aggregate shall consist of gravel or broken stone composed of strong, hard, durable, uncoated pebbles, or rock fragments, washed clean and free from injurious amounts of shale, coal, clay, lumps, soft fragments, dirt, glass, and organic or other deleterious substances.

10.4 Ready Mix Concrete

10.4.1 Ready mix concrete shall be mixed and delivered in accordance with the requirements set forth in A.S.T.M. Des. C94-58.

10.4.2 The rate of delivery of the mixed concrete shall be such that the interval between placing of successive batches shall not exceed 30 minutes, unless the last load completed the work to a proper expansion joint. The elapsed time between the introduction of mixing water to the cement and aggregates and depositing concrete in the work, shall not exceed 70 minutes.

10.5 Placing

10.5.1 Special care shall be taken to place the concrete, particularly in corners, in order to prevent voids, pockets, rough areas and honeycombing. The concrete shall be tamped in such a manner as to work the coarse aggregate away from the exposed surfaces. Vibrators or vibrator screeds used in placing concrete shall be a minimum of 5,000 cycles per minute. The technique and use of vibrators and vibrator screeds shall be at the discretion of the Engineer.

10.5.2 Every precaution shall be taken to make all concrete masonry solid, compact, watertight, and smooth.

10.6 Curing

10.6.1 During the first 72 hours, concrete surfaces shall protected from excessive changes in temperature. Particular care shall be taken to ensure that the concrete surface is kept moist during the initial curing stage.

10.6.2 In certain circumstances, the Engineer may require that the following procedure be followed to ensure proper curing of the concrete surface:

(a) The surface of the concrete shall be protected from the sun and from the air by an approved membrane curing material which shall be accomplished by coating the entire exposed surface of the concrete with a liquid compound within a maximum of two hours after the placing of the concrete.

(b) The membrane material shall contain a temporary colour indicator and shall be applied uniformly by means of an approved pressure spray distributor at an average 6.13 square metres per litre (300 square feet per imperial gallon) to give a minimum of 92% water retention in three days or a minimum of 68% water retention in twenty-eight days.

(c) The membrane material shall be so applied that the concrete surface is completely coated and sealed at one application. It shall conform to the requirements of A.S.T.M. Des:C309-58.

(d) Under no circumstances shall any material be added to the curing compound as delivered by the manufacturer.

10.6.3 The Contractor shall also be responsible for the protection of the work from damage resulting from inclement weather and all other possible sources of damage. No works shall be accepted where foot marks, depressions, or other irregularities exist.

10.7 Admixtures

10.7.1 Sufficient air entraining agent material shall be added to the concrete mix for entraining from five percent (5%) to seven percent (7%) with an average of six percent (6%) of air in the concrete by volume.

10.7.2 Determination of the volume of entrained air shall be made by means of an air meter of approved design. Air entraining admixtures for concrete shall conform to A.S.T.M. Des. C260-58T.

10.8 Cold Weather Concreting

10.8.1 During cold weather concrete may be placed when the natural air temperature in the shade is 2°C (35°F) and there are indications that the temperature is rising. If, however, the temperature in the shade is 4°C (40°F) and is falling, no concrete shall be deposited. In no cases shall concrete be deposited on frozen sub-grade, sub-base or base.

10.8.2 If the concrete is placed in accordance with the above conditions and the temperature drops to 2°C (35°F) within the next 24 hours, the concrete shall be adequately covered and protected to maintain it at 4°C (40°F). The period of protection shall be a minimum of 72 hours.

10.8.3 Concrete damaged by freezing shall be removed from the site and replaced with new concrete.

10.9 Concrete Tests

10.9.1 During the progress of the work test cylinders will be made by the Consulting Engineer or a recognized Testing Laboratory appointed by the Consulting Engineer. The test cylinders shall receive, insofar as practicable, the same protection during the first twenty-four hours as is given to the construction they represent.

10.9.2 At all times cylinders shall be handled in a manner that will provide adequate protection against damage to ensure that test results will provide a sound basis for evaluation of concrete quality.

10.9.3 One set of three test cylinders shall be taken for each 300 lineal metres (1000 feet) of curb and gutter or sidewalk, with a minimum of one set per day. One cylinder shall be tested at 7 days and two at 28 days. Test cylinder shall be taken and secured in accordance with C.S.A. Spec. A23.2.21 and tested in accordance with C.S.A. Spec. A23.2.12 and 13. A copy of the test results shall be submitted to the Engineer.

10.9.4 For every test made or as often as required by the Engineer, a slump test shall be made in accordance with A.S.T.M. Des:C143-58 and an air test by means of an air meter of approved design.

10.9.5 The cost of testing and inspections of the work shall be borne by the Developer with a report on the concrete tests to be forward to the Engineer.

10.10 Tolerances

10.10.1 The finished surfaces of all concrete work shall be true to the required cross-section with a tolerance of plus or minus 6 mm (1/4 inch) from the required elevation and dimensions.

10.10.2 Surfaces of curbs or gutters shall not show any depressions or bumps exceeding 6 mm (1/4 inch) under a straight edge 3 m (10 feet) long placed parallel to the curb or sidewalk.

10.10.3 Concrete not meeting the requirements specified shall be removed to the nearest joint and replaced at the Contractor's expense.

10.11 Defects

All finished concrete shall be in accordance with the approved dimensions, tolerances, and properties as specified in these standards and on the approved design drawings.

The finished concrete shall be free of honeycombing, cracking, spalling, surface irregularities, and other defects. Unless otherwise approved by the Engineer, all defective concrete shall be removed and replaced at the Contractor's expense.

CONCRETE 10

HOT MIX ASPHALTIC PAVEMENT 11

11.1 Scope

This section shall apply to asphalt pavements composed of coarse and fine aggregate, mineral filler and hot asphalt cement, mixed in a central plant, and placed in accordance with these specifications and in conformity with the lines, grades, and typical cross-sections shown on the plans.

11.2 Materials

11.2.1 Asphalt Cement

The asphalt cement used as the binder shall have a penetration of 85-100 and shall meet the specifications of the Asphalt Institute.

11.2.2 Aggregates

The crushed mineral aggregate shall meet the following specifications for grading and mix composition:

(a) The coarse aggregate for asphaltic mixtures shall be crushed stone having a percentage wear by the Los Angeles abrasion machine test of not more than 35%. It must be clean, free from dust, elongated or flat fragments and all foreign matter.

(b) The aggregate shall conform to the following grading:

TOTAL PASSING	PERCENT
19mm (3/4") square screen	100%
12mm (1/2") square screen	80 - 100%
9mm (3/8") square screen	70 - 94%
#4 Sieve	50 - 80%
#8 Sieve	35 - 65%
#16 Sieve	25 - 52%
#30 Sieve	18 - 40%
#50 Sieve	13 - 30%
#100 Sieve	8 - 20%
#200 Sieve	2 - 10%

(c) The actual grading of the job mix when plotted shall so range from coarse to fine, that it will approximate, as closely as possible, the shape of the plotted average grading for the mix above. For that portion of aggregate passing the # 4 sieve, gradings which range from the maximum of one sieve to the minimum of the next larger shall not be permitted. Sixty percent (60%) of the material retained on the #4 sieve shall have at least one (1) crushed face.

11.3 Properties of Asphaltic Cement Mixes

11.3.1 The Municipality may require a mix design prior to the placement of any asphalt pavement. Unless specified otherwise, the mix design shall conform to the requirements of the B.C. Ministry of Transportation and Highways.

11.3.2 The asphalt cement and aggregate shall reach the mixer at a temperature of 135° - 150° C.

11.3.3 The asphalt cement content of the mixture shall not be less than 5% or more than 7% by weight.

11.3.4 The Engineer may from time to time conduct tests on the asphaltic hot mix material for the purpose of maintaining the highest possible quality. If materials are proven to be of inferior quality either due to temperature or physical characteristics from these tests, the Engineer shall reject any such material. In cases where asphaltic materials have already been laid and are later proven to be inferior, they shall be removed and replaced with a proper mix.

11.3.5 The laboratory-compacted mixtures, when compacted by the "Marshall Test Procedure" shall have the test properties shown on the following table:

Property of Compacted Paving Mixture (75 blows on each face)	Minimum	Maximum
Marshall Stability lbs at 60°C (140°F)	750	---
Flow Index, units of 0.25mm (0.01")*	8	16
Percentage voids in mineral aggregate**	14	---
Percentage air voids **	3	5

* Percentage Voids in Mineral Aggregate to be calculated on the basis of A.S.T.M. bulk specific gravity for the aggregate.

**Portion of bituminous cement absorbed into aggregate to be allowed for when Percentage Air Voids.

11.3.6 The above table provides the test requirements for laboratory compacted mixtures, however, where required quality control of job mixed and compacted mixtures shall be further evaluated with reference to the "Marshall Mix Design" recommendations available for each individual project.

11.4 Preparation of the Asphalt Mixture

11.4.1 The asphalt mixture shall be prepared from the materials previously described in an approved mixing plant, capable of heating and drying the aggregate and thoroughly mixing the materials at a temperature suitable for the asphalt cement specified.

11.4.2 The plant methods shall meet all the requirements of the B.C. Ministry of Transportation and Highways.

11.5 Placing of Asphalt Concrete

11.5.1 Transporting

(a) The transportation of all asphaltic mixes to the work shall be done by trucks equipped with tight boxes. The inside of all boxes for hauling shall be lightly lubricated with thine oil. Excessive lubricant or use of gasoline, kerosene, diesel fuel or similar products will not be permitted. While in transit, the mixture shall be covered with tarpaulins.

(b) Temperature variation between loads shall not exceed plus or minus 11°C of preceding load. Asphalt mixes delivered at temperatures other than those specified shall not be accepted.

11.5.2 Laying

(a) The temperature of the asphalt mixture at the time of laying shall be 115-138°C.

(b) The asphalt cement mixture shall be laid upon a dry firm base and no mixture shall be laid when the air temperature is below 7°C or during periods of precipitation. When there is free water on the surface to be paved, construction shall be suspended until the surface is dry.

(c) When required by the Engineer and prior to placing the asphalt concrete, a prime coat of MCo asphalt shall be applied to the base and allowed to cure. The prime coat shall be applied to a dry base at a uniform rate of 0.8 to 1.3 l/m^2.

(d) The asphaltic cement mixture shall be laid to the desired thickness applicable to the street or road classification as shown on the drawings or as directed by the Engineer. The thickness requirements indicated in all cases refers to the compacted thickness of the finished surface layer.

(e) The mixture shall be spread for compaction by means of a crawler-mounted self-propelled mechanical spreader. The design of the self-propelled mechanical spreader should meet the following minimum requirements:

i) Overall length and width 4.5m and 3.0m respectively;

ii) Centre to centre distance between crawlers 2.1m;

iii) Width of crawler treads 250mm.

iv) The spreader shall be capable of laying a 3.0m width of asphaltic cement mixture without the use of any extensions.

(f) Any irregularities in the surface of the pavement shall be corrected directly behind the paver, but hand raking shall be kept to a minimum. Excess material forming high spots shall be removed with a shovel or rake. Indented areas shall be filled with hot mix and smoothed with a rake or the edge of a shovel being pulled over the surface. Casting of mix over such areas shall not be permitted.

(g) Where hand spreading methods must be used, the work shall be performed carefully to avoid segregation and excessive cooling of the mix. Broadcasting of the material shall not be permitted.

11.5.3 Joints

(a) Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 75mm and transverse joints in succeeding courses shall be offset at least 600mm.

(b) Edges against which additional pavement is to be placed shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.

(c) In making the joint along any adjoining edge such as curb, gutter to an adjoining pavement and after the hot mixture is placed by the finishing machine, just enough of the material shall be carried back to fill any space left open. This joint shall be properly "set-up" with the back of a lute at proper height and level to receive the maximum compression under the rolling. Asphalt shall be left 6mm above concrete curb following compaction.

(d) The exposed edges of all cold asphalt joints and the face of concrete gutter shall be cleaned and painted with a thin coat of asphalt cement. When the ambient air temperature is less than 10°C joints must be heated using an infrared heater prior to painting with hot asphalt cement.

(e) When a transverse joint is to be made with a cold asphalt mat, the joint will be made on a vertically true line. Cold jointing will be done in such a manner as to ensure a thorough and continuous bond between the cold and hot mats.

(f) A cold asphalt will be one where the surface temperature, taken within 600mm of the edge of the mat, is less than 65°C.

11.5.4 Rolling

(a) After spreading, the mixture shall be thoroughly and uniformly rolled. Initial or breakdown rolling shall commence as soon as the hot mix material can be rolled without buckling alongside the roller, excessive shoving or displacement, hairline or roller cracks showing, or material sticking to the roller. An approved tandem type roller weighing from 10,000 to 13,000 Kg (11 - 14 tons) shall be used.

(b) Rolling shall start longitudinally at the sides and proceed toward the centre of the mat. Whenever it is possible or feasible, the driving wheel of the roller shall lead towards the lay-down or spreading operation as the roller approaches the most recently laid and hottest portion of the work. If feasible, the reverse shall take place when the direction of flow of the spreading operation is up a steep slope. To prevent adherence of the asphaltic mixture to the rollers, the rollers shall be kept properly moistened but excess water shall not be permitted.

(c) Rolling of the first layer of the asphaltic mixture shall not be any closer than 150mm from the edge of the longitudinal joint, consequently the adjacent layer shall be laid to the same uncompacted thickness as the former layer.

(d) Back rolling shall be carried on until all roller marks are eliminated and until no further compaction is possible.

(e) Final rolling to remove marks and high spots shall be done with an approved pneumatic tired roller while the mixture is still warm. The nearly finished mat is at approximately the right degree of warmth when the palm of the hand can be held on top of the pavement for about 5 to 6 seconds.

(f) In areas too small for the power roller, a hand roller and a vibrating plate compactor or road tamper shall be used to achieve thorough compaction and a smooth surface.

(g) The field density of the asphalt mixture shall at no place be less than 97% of the laboratory density.

11.5.5 Finished Surface

(a) The surface of the finished asphalt mat shall, after the rollings, be smooth and true to the established profile, and crown; depressions exceeding 6mm as measured with a 3m straight edge shall not be permitted. In areas with curb and gutter, the asphalt shall meet the gutter at an elevation of 6mm above the lip of the gutter.

(b) Any defective areas shall be remedied immediately by removing the surface course mixture and replacing it with fresh hot mix which shall be compacted to conform with the surrounding area. At the end of each day's paving operation transverse joints shall be cut perpendicular to the mat. On resuming laying of the paving mixture the exposed edge shall be trimmed and painted with a thin coat of hot asphalt cement.

11.6 Thickness of Pavement

11.6.1 The maximum compacted thickness of any one layer of asphaltic hot mix shall not be greater than 75mm. If the drawings show, or the Engineer specified, that the asphalt surface course shall be greater than 75mm, the asphaltic hot mix shall be placed in two layers of equal thickness.

11.6.2 When a second layer of surface course mixture is specified the surface of the first layer shall first be thoroughly cleaned of dirt and other deleterious material by sweeping where necessary. A tack coat of light asphaltic oil shall then be applied uniformly at a rate of 0.54 to 0.36 litres per square metre (1/10 to 1/15 gallon per square yard) by means of an approved pressure distributor. After the tack coat has cured, the second layer of surface course mix shall be spread and compacted in a manner similar to that detailed for the first layer.

11.7 Quality Control Testing

11.7.1 Required Tests

In general, the testing required shall consist of hot-mix quality testing and field density and thickness testing as outlined below. Preparation of a mix design may also be required at the discretion of the Engineer. The Consulting Engineer shall arrange for a testing firm to carry out the required tests. Where initial testing indicates inadequacies additional testing may be required by the Engineer.

11.7.2 Mix Design

Prior to commencement of laying asphalt concrete, the Engineer may instruct the testing firm to prepare a mix design, job mix formula for a batch plant, and a plant calibration for a continuous mix plant. The mix design shall be based on the Marshall method. The job mix formula shall list the following information:

i) Sieve analysis of combined aggregate in mix.
ii) Aggregate size range in each bin separation to be used.
iii) Weight of material to be used from each bin for one batch of mix.
iv) Weight of asphalt to be used in each batch.

11.7.3 Mix Quality

One test of three briquettes for each 300 tonnes of production, or a minimum of one test per day shall be performed to determine the following:

i) Marshall stability
ii) Specific gravity
iii) Air voids and void in mineral aggregate (VMA)
iv) Flow index
v) Asphalt content extraction
vi) Aggregate Graduation

11.7.4 Field Density and Thickness

i) After asphaltic concrete has been laid and compacted, the testing firm shall obtain pavement cores for determining the compacted (in-place) density and thickness of the pavement. Three cores from each 300 tonnes of pavement shall be obtained at locations determined by the Engineer. Test holes shall be patched immediately.

ii) Final compaction results shall be expressed as a percentage compacted density which is defined as follows:

$$\text{Percentage Compacted Density} = \frac{\text{Density of Sample}}{\text{Laboratory Design}} \times 100$$

iii) Test result data will be subjected to statistical analysis and the final compaction shall not be considered 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 shall be as follows:

For All Classes of Pavement	
Minimum Percentage Mean Compacted Density	Maximum Acceptable Standard Deviation of Test Data
98	1.25

If test results fail to satisfy the compaction requirements detailed above, the Contractor shall immediately modify his compaction procedure to the satisfaction of the Engineer to produce a uniformly compacted surface which will satisfy the mean density and variation requirements. Sections with inadequate compaction shall be recompacted or rejected and removed as may be direct by the Engineer.

11.7.5 Test Program

The test program outlined above may be changed at the discretion of the Engineer. Full testing may be required during the first few days of paving to determine, and thus allow control of, the quality and construction procedure. As paving progresses sufficient tests to maintain uniformity will be required.

11.7.6 Test Results

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

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CRACKFILLING 13

13.1 Scope

This section shall cover the materials, equipment and procedures associated with the filling of asphalt cracks in municipal roads.

13.2 Materials

The rubberized asphalt crack sealant material shall be one of the following materials:

- Hydrotech Sealz (Uniroyal 6160)
- Shell Cariphalte ELT
- Bakelit 590-13
- Tremco

13.3 Equipment

13.3.1 The sealant melter should be a self-contained unit capable of transmitting heat to the sealant material and keeping the material at the recommended temperature without over or under heating the material. The sealant material should be vigorously and continuously agitated to ensure even heating if large quantities of material are being heated.

13.3.2 The sealant should be poured from a pour pot complete with a trigger to control flow and sealant application rate.

13.4 Procedure

The Contractor shall supply all equipment, labour, traffic control and materials in sufficient quantities to complete rubberized filling as detailed below.

13.4.1 Preparation of Cracks

Cracks are to be cleaned using a hot compressed air lance to remove all dust, debris and moisture.

The lance shall be capable of producing a propane-heated air jet of 1100°C at a pressure of 690KPa.

13.4.2 Sealing of Cracks

Cracks must be filled immediately following treatment with the hot lance.

Cracks are to be filled with sealout from the bottom up to the surface level in a manner which does not result in sealout bridging or entrapped air pockets. Excess settlement may occur in deep cracks, thus necessitating an application of a second layer of material.

Material shall be placed so as to overfill the groove. It should be struck off using the squeegee so as to leave a bead of seal out directly over the crack, with the edges of the spread feathered out to overlap on the pavement surface a minimum of 40mm on each side of the groove.

The squeegee shall be a push-type, V-shaped squeegee with a crescent cut out in back to allow formation of a bead of material.

13.4.3 Traffic Control

All traffic control during the crack sealing operation is to be supplied by the Contractor. Interference to traffic flow shall be kept to a minimum, where traffic flow is impeded, certified traffic control personnel and approved signage shall be provided. In areas of heavy traffic the Contractor is to apply sand over the crack to prevent the material being lifted by vehicle tires.

CRACKFILLING 13