TOWN OF RAYMOND

ENGINEERING STANDARDS

AMENDED 2008

TABLE OF CONTENTS

SECTION I - GENERAL CONDITIONS & PROCEDURES 1
- A. Scope 1
- B. Engineering Design 1
- C. Submission of Engineering Design 1
- D. Design Review 2
- E. Design Approval 2
- F. Right-of-Way Documents 2
- G. Construction Approval 2
- H. Engineering Supervision 2
- I. Testing/Inspection 3
- J. Municipal Acceptance 3
- K. As-Built Drawings 4

SECTION II - PREPARATION OF ENGINEERING DRAWINGS 5
- A. Design Drawings 5
- B. Drawing Size, Material and Basic Layout 5
- C. Scales 5
- D. General Requirements for all Services 5

SECTION III - WATER MAINS & ACCESSORIES 7
- A. Network 7
- B. Mains/Design 7
- C. Pipe and Fitting 8
- D. Hydrants 9
- E. Valves and Valve Boxes 9
- F. Zinc Anode 10
- G. Backfilling 10
- H. Testing 11

SECTION IV - SANITARY SEWER AND ACCESSORIES 14
- A. Mains/Design 14
- B. Manholes 15

SECTION V - STORM SEWER AND ACCESSORIES 17
- A. Stormwater Management Design 17
- B. Manholes 21
- C. Catch Basins and Inlets 22
- D. Pipes 24
- E. Dry Ponds, Wet Ponds and Constructed Wetlands 24
- F. Backfilling 25

SECTION VI - SERVICE CONNECTIONS 26
- A. General 26
- B. Water Service Connections 26
- C. Sanitary Service Connections 27

SECTION VII – ROADS AND STREET, ROADS AND LANES 29
- A. Classification / Design 29
- B. Design Criteria 29
- C. Sidewalks, Curb and Gutters 30
- D. Roadway Construction 31

DETAIL DRAWINGS:

SERVICING DETAILS:	SE-01 Single Service Detail
	SE-02 Double Service Detail
	SE-03 Service Connection Details
	SE-04 Water and Sewer to House
	SE-05 Sump Pump Connection Detail
STORM SEWER DETAILS:	SM-01 Standard Manhole Detail
	SM-02 Perched Manhole Detail
	SM-03 T-Riser Manhole Detail
	SM-04 Precast Catch Basin Detail
	SM-05 900mm Catch Basin Detail
	SM-06 Standard Catch Basin Manhole
	SM-07 Catch Basin Frame & Covers
	SM-08 Catch Basin Frame & Covers
	SM-09 K-2 Catch Basin Grate & Frame
	SM-10 F-51 Catch Basin Set in Curb and Gutter
	SM-12 Splash Pad Detail
	SM-13 Lot Grading Details
	SM-15 Vertical Bar Screen Detail
	SM-17 Steel Culvert Detail
	SM-18 Rip-Rap Details
	SM-19 Sump Pump Detail / Lot Grading
INTERSECTION DETAILS:	SN-01 Signage Details
SANITARY SEWER DETAILS:	SY-01 Standard Manhole Detail
	SY-02 Interior Drop Manhole Detail
	SY-03 Sanitary Riser Details
	SY-04 NF / TF-80 Manhole Detail San.
TRANSPORTATION DETAILS:	TN-01 Local Residential Roadways
	TN-02 Residential Collector Roads
	TN-03 Industrial / Commercial Collector Roads
	TN-05 Typical Lane
	TN-06 Standard Curb and Gutter
	TN-07 Rolled Curb and Gutter
	TN-08 Rolled Mono Curb and Walk
	TN-09 Concrete Swale Detail
	TN-10 Separate Sidewalk
	TN-11 Paraplegic Ramp Details
	TN-14 Manhole Adjustment to Grade
	TN-18 "CC" Stamp
WATER MAIN DETAILS:	WR-01 Hydrant and Valve Detail
	WR-02 Valve Installation Detail
	WR-03 Butterfly Valve Detail
	WR-04 Hot Tap Detail
	WR-05 Thrust Block Details
	WR-06 Vertical Thrust Blocking
	WR-08 Hydrant Anode Detail
	WR-09 Valve / Fitting Anode Detail
	WR-11 Meter Setting Guidelines
	WR-13 Fire Hydrant Clearance Detail

SECTION I - GENERAL CONDITIONS AND PROCEDURES

A. SCOPE

1. These Municipal Engineering Standards will apply to all the design and installation of services within the public right of way for the Town of Raymond. They apply to the design and installation of storm sewer systems and sanitary sewers systems, water mains/systems and roads, together with their respective connections and appurtenances and any other services, which requires design and/or installation.

2. These design standards do not cover the design or installation of street lighting, power, gas, telephone and television services, but does include coordination with the various utility companies. All new developments in the Town of Raymond shall have telephone, electrical power, cable television and infrastructure placed underground. Street lighting wiring shall also be place underground.

3. The Standard Drawings as referred to in various sections will form an integral part of these design standards.

B. ENGINEERING DESIGN

1. The Developer shall retain a Consulting Engineer who will be responsible for the design and preparation of drawings and specifications for all services (except lighting, telephone and power) as required within the Town of Raymond. These services will be designed in accordance with the Municipal Development Standards that are available from Development and Planning and the Public Works Department.

2. The Design Drawings will show all existing and proposed services. It will be the Developers/Consulting Engineer's responsibility to coordinate with the utility companies and the location of their existing and proposed services.

C. SUBMISSION OF THE ENGINEERING DESIGN

1. Upon completion of the Design Drawings, the Developer/Consulting Engineer will submit them to the Development Officer/MGCL, together with two complete sets of plans and specifications for the proposed project and the following:

    a) Calculations of sanitary and storm sewer capacity and pipe loading, where these services are to be installed;
    b) Water distribution analysis;
    c) The results of a geotechnical investigation conducted by a qualified geotechnical engineer;
    d) A print of the registered plan of the subdivision;
    e) A digitized (AutoCAD) copy of the subdivision plan suitable for updating the Town's file mapping system.

2. All proposed streets should be named, when available, on the drawings. The names must been approved by the Town of Raymond.

3. The Developer/Consulting Engineer will bring to the attention of the Town of Raymond the need for any right-of-ways outside the subdivision to which the Developer/Consulting Engineer/Town of Raymond may have to obtain.

D. DESIGN REVIEW

The Town of Raymond will review all design drawings, specifications and relevant data. Any revisions discussed with the Developer/Consulting Engineer shall be incorporated in the final design drawings. The Town of Raymond will review the drawings with respect to adherence to the Municipal Development Standards, but will not accept responsibility for engineering omissions and errors on or relating to the plans.

E. DESIGN APPROVAL

1. Upon completion of all revisions, the Developer/Consulting Engineer will submit three sets of Contract Drawings to the Town of Raymond.

2. Once the design has been reviewed, to the satisfactory of the Town of Raymond's' Development & Planning and Public Works Department, one signed copy of the plan will be returned to the Developer/Consulting Engineer indicating of the Town's review.

3. No physical work will commence within any new parcel of land by the Developer until the Town has reviewed, signed and returned the Design Drawings.

F. RIGHT-OF-WAY DOCUMENTS

Where easement documents and/or right-of-way plans are deemed necessary, they will be prepared by a registered Land Surveyor at the Developers' expense.

G. CONSTRUCTION APPROVAL

1. Upon receipt of reviewed Drawings and Specifications, the Developer may proceed to install Municipal services subject to:

   a) Satisfactory execution of Development Agreement or a Development Permit if applicable.

2. Underground subdivision services will <u>not</u> be permitted to operate as part of existing Municipal Services until the respective subdivision services have been inspected, tested and approved by the Town of Raymond.

H. ENGINEERING SUPERVISION

1. The Developers/Consulting Engineer will be responsible for the layout, inspection & approval of materials and the supervision of installation of all services that are the responsibility of the Applicant. The Consulting Engineer

or his authorized representative will be available at all times to inspect the site during the installation of services.

2. The Developer/Consulting Engineer will be responsible for maintaining field surveys from which services may be installed if such installations are to be made before the acceptance of work being done by the Developer.

3. In addition to supervision carried out by the Consulting Engineer, the Town will periodically inspect the work and assist in coordinating the subdivision works with any related Municipal works. The Town will notify the Consulting Engineer of the use of any unacceptable materials or practices to the attention of the Contractor. If remedial action is not taken to the satisfaction of the Town, the Town may order the work to cease.

4. If the Developer/Consulting Engineer wishes to make any changes in design either before or during the execution of the work, he will first submit a marked print showing proposed revisions to the Development & Planning and Public Works Department. If approval is granted for revision, the original drawing shall be immediately revised and new prints issued. These two operations may be carried out simultaneously.

5. The Town of Raymond reserves the right to construction of all services and roads that it will assume ownership of with its own forces on behalf of the developer and at the cost of the developer.

I. TESTING/INSPECTION

1. It will be the responsibility of the Developer/Consulting Engineer to ensure that the Contractor disinfects and tests all water mains and tests all sewers prior to the acceptance by the Town. The Town's Public Works Department shall be notified prior to this testing of the water mains and all sewers.

2. A CCTV inspection of both the sanitary sewer and storm sewer is to be supplied to the Town prior to acceptance.

J. MUNICIPAL ACCEPTANCE

1. Upon satisfactory completion of the project and after all the deficiencies have been corrected, the Developer/Consulting Engineer will issue a Construction Completion Certificate to the Town of Raymond, notifying:

   a) Acceptance of the work;
   b) Commencement date of maintenance period. One year for underground utilities and two years for surface works

2. The applicant will be responsible for and at his own expense, remedy any defect, fault or deficiency in completed work during maintenance periods outlined in the Development Agreement.

3. Upon completion of the maintenance period and after final inspection and correction of all deficiencies, the Developer/Consulting Engineer will issue a Final Acceptance Certificate to the Town.

K. AS-BUILT DRAWINGS

After the issuance of a Construction Completion Certificate, the Consulting Engineer will deliver "as-built" drawings to the Town within 3 months following the issuance of the Construction Completion Certificate. The Consulting Engineer will supply two paper copies, one Mylar and one CD AutoCAD sets of the "as-built" drawings.

SECTION II - PREPARATION OF ENGINEERING DRAWINGS

A. DESIGN DRAWINGS REQUIREMENTS

B. DRAWING SIZE, MATERIAL AND BASIC LAYOUT

1. The Drawing size of 600 mm x 930 mm will be used. The Detailed Drawings size will be 23 mm x 30 mm will be used. Reduced or Half sized drawings may be accepted for submission

2. Use plan profile sheets with profile at bottom of sheet. Leave enough clear space in the lower part of plan for title block and legend.

3. Paper Drawings are acceptable for submission, however Mylar are required at the as-constructed stage

4. Reduced or half size drawings will not be accepted for the As –Constructed drawings submission.

C. SCALES

When practical, Full Size Drawing Scales shall be:

Overall plans	1:1000
Plan/Profile	Horizontal 1:500 Vertical 1:50
Cross Sections	Horizontal 1:100 Vertical 1:10

D. GENERAL REQUIREMENTS FOR ALL SERVICES

1. Elevations will be relative to the geodetic datum. Benchmark numbers, property locations and elevations (If available?) can be obtained from Development and Planning. The reference benchmark and elevation shall be shown on the design drawing.

2. Where there is more than one profile, each profile will be clearly identified.

3. Text sizes will be a minimum of 3 mm for full size and half size drawings

4. A north arrow, adjacent lots and plan numbers, street names, and the legal description of the parcel being subdivided will be shown on the drawings. In general the north arrow should be orientated towards the top of the plan.

   a) <u>Plan Requirements</u>
   The following overall plans will form a part of the whole design drawing set.

b) Cover Sheet
This will show the name of the subdivision, stage of development and names of the developer and consulting engineer.

c) Index Plan
This plan will be prepared on a scale of 1:1000 or a reduction to fit the standard size sheet and will indicate that portion of the street that relates to a particular plan/profile sheet.

d) Road, Sidewalk and Walkway Plan
This plan will be drawn to a scale of 1:1000 and will indicate all locations and widths of roads, sidewalks and walkways; and locations of catch basins shall be shown.

e) Lot Grading Plan
This plan will be drawn to a scale of 1:1000 and will indicate the original contours, proposed finished lot corner elevations, proposed lot grade, sewer connection inverts, directions of surface drainage flows.

f) Sanitary Sewer, Storm Sewer & Water Main Overall Plan
This plan will be drawn to a scale of 1:1000 and will indicate the alignments and locations of mains, size of mains, direction of flows and locations of appurtenances.

g) Power, Gas, Telephone and Shaw Cable
This plan will indicate the alignments of power, gas, telephone and cable television and shall be drawn to the same scale as the Index Plan.

h) Overall Street Furniture Plan
This plan will be drawn to a scale of 1:1000 and will indicate all surface features, i.e.: Power poles, hydrants, valves, Telus pedestals, Community mail boxes, future driveway locations, service locations, etc.

i) Detailed Plan/Profile
Generally all underground services and surface improvement profiles are shown on the same drawing.

j) Landscaping Plans
This plan will be drawn to a scale of 1:1000 and will show all proposed landscaping improvements including trees, grading, pathways, berms, uniform fencing, etc. This may be a separate submission.

k) Traffic Signage Plan
This plan will be drawn to a scale of 1:1000 and shall indicate all appropriate traffic and street identification signage. This may be a separate submission.

Note: All signage will conform to the Town's Sign Bylaw.

SECTION III- WATER MAINS AND ACCESSORIES

A. NETWORK

A Standard main network system shall conform to the Water Distribution System as outlined by the Town of Raymond.

The minimum size of distribution main shall be:

Residential	minimum 200 mm diameter except for cul-de-sacs less than 10 lots where minimum size shall be 150 mm diameter.
Industrial/Commercial	minimum 250 mm diameter.

Per capita consumption for residential will be:

Average Day Demand	500 l/d
Maximum day demand	1000 l/d
Maximum Hourly demand	2500 l/d

No less that 75 people per Ha (Pop equivalent) for industrial, no less than 50 people per Ha (Population equivalent) for commercial and no more than 35 people per Ha for residential.

B. MAINS/DESIGN

1. New subdivisions will be designed and constructed such that the water distribution and transmission systems through the area will be looped. For the initial stages of a larger development, the Development Officer and/or CAO, at his/her sole discretion may waive this requirement.

    a) The design population will be the ultimate population in the area under consideration.
    b) An analysis will be made for Maximum Hourly Demand and the mains sized such that there shall be A Minimum Residual Pressure of 350 kPa at ground level at any node in the network.
    c) Separate analysis shall also be made for Maximum Day Demand plus a two hydrant Fire Flow of 4,000 L/min The residual pressure in all cases for the Hydrants under consideration shall not be less than 140 kPa at ground level. (Residential)
    d) Separate analysis shall also be made for Maximum Day Demand plus a three hydrant Fire Flow of 5,000 L/min The residual pressure in all cases for the Hydrants under consideration will not be less than 350 kPa at ground level. (Commercial/industrial)
    e) For future reference to the Town of Raymond, a set of printouts plus accompanying schematic diagrams of the network system showing notation used for the pipes and nodes and also the diameters and lengths of the pipes will be requested together with the design plans.

2. **Alignments**

Water mains in streets shall generally be located at an alignment of 3 m from the centerline of the right-of-way. Water mains will generally be located on the side of the right-of-way having the most number of lots and will continue at the same alignment the entire length of the street.

3. **Depth of Bury**

Water mains shall be designed at a recommended minimum depth of bury according to current Alberta Environment regulations, or 2.5 m from the road, lane or utility lot grade to top of the main.

C. PIPE AND FITTING

1. All polyvinyl chloride pressure pipe and fittings shall conform to CSA B137.3 Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications. The pipe shall be made from clean, virgin approved class 12454-B PVC compound conforming to ASTM resin specification D1784. PVC water pipe shall be colored blue and shall utilize integral bell gasket joints. Pipe to be delivered in 6.1 m nominal lengths.

   a) PVC Class Pipe and Fittings: To AWWA C900, pressure class 150.
   b) PVC Series Pipe is to be designed for a pressure rating of 1620 kpa (235 psi) and will be designated DR 18 with cast iron outside diameters. The pipe shall be hydrostatic proof tested at 27.60 kpa (400 psi). Fittings to Uni-Bell Pipe Specification UN-B-12, CSA B137.3, and designed for a pressure of 1620 kpa.
   c) PVC Molded fittings to CSA B137.2 Class 150.

2. Cast iron fittings from 150 mm to 1200 mm in diameter shall conform to the following specifications: ASA A21.10 and AWWA C-110. Fittings shall be supplied with bell and spigot joints complete with rubber gaskets, to conform to the following specifications: ASA A21.11 and AWWA C-111. Cast iron fittings shall be encased in polyethylene in accordance with AWWA C-105.

3. Stainless Steel Couplings: to be Robar 1606 Style 2 &3 couplings, complete with stainless steel nuts and bolts, compatible with outside diameters of pipes to be coupled in locations approved by the Engineer. All couplings to be wrapped with densotape after installation.

4. All sub-surface bolted connections in contact with the soil shall be made using stainless steel nuts and bolts and shall be wrapped in densotape (i.e., hydrants, valves, couplings, etc.). Bolts and nuts shall be of ANSI type 304 stainless steel conforming to ASTM specification A-3200.

5. Thrust blocking shall be concrete having a minimum compressive strength of 32 mpa at 28 days. Concrete shall be made using Type 50 sulfate resisting cement.

6. Timber blocking will be either hemlock or fir, which has been pressure creosote treated.

D. HYDRANTS

1. General

Hydrants shall be located at maximum spacing of 200 m in single-family residential areas and 100 m in multiple family, commercial and industrial areas. Hydrant location shall be such that the distance to any building does not exceed 100 m. Additional hydrants shall be installed at high value properties if deemed necessary by the Town of Raymond. Hydrants shall be located at the end of all "dead end" distribution lines and at the projection of lot lines except where installed at intersections they shall be installed at the beginning of the curb return. Hydrants are required at the entrance to all Cul-de Sacs and at the dead end of cul-de sacs

2. Dry Barrel Hydrants

Dry Barrel Hydrants to conform to AWWA C502 with two (2) 65 mm threaded hose outlets, threads to local standard (Alberta Mutual Aid Thread), on (1) 1.25 mm "*Storz*" internal lug type 3, pumper quick connect coupler, 150 mm riser barrel, 125 mm bottom valve and 150 mm connection for main and to match existing hydrants in community. All caps to be 5-sided hex type. Hydrants to open counter clockwise. Hydrants to be McAvity M-67.

a) Valve stem seal to be complete with "O" ring seals.
b) All exterior bolts to be stainless steel.
c) Operating nuts to be 5 sided.
d) Bottom connection to be a push-on type joint.
e) Wrap all exterior bolts with Denso Mastic and Denso Tape.
f) Drain outlet that can be plugged or unplugged from the hydrant interior.
g) The hydrant depth of 2.8 includes a 600 mm hydrant extension and breakaway flange.
h) After installation, paint hydrants and barrels to an approved color equal to community standards using exterior enamel CGSB 1-GP-59M. Red / Black Caps

E. VALVES and VALVE BOXES

1. General

Valves shall be located such that:

a) No more than 20 single family lots are affected by a shutdown
b) No more than 2 hydrants are taken out of service during a shutdown.
c) No more than 3 valves are required to affect a shutdown.

Valves shall be located at the projection of lot lines.

In addition to the foregoing, the Town of Raymond may require additional valves in order to sequentially isolate water mains as part of a scheduled water main flushing program.

2. **Gate Valves**

To AWWA C509, standard iron body, epoxy coated, bronze mounted, resilient seat with non-rising stems, suitable for 1 MPa with push-on type coupling joints.

a) All exterior bolts to be stainless steel and wrapped with Denso Mastic and Denso Tape.
b) Valves to open counter clockwise.

3. **Valve Boxes**

Cast iron valve boxes: three piece sliding type adjustable over a minimum of 450 mm complete with valve operating extension rod, 25 x 25 mm cross section, of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover. Base to be large round type with minimum diameter of 300 mm. Top of box to be marked "WATER".

F. ZINC ANODE

1. All couplings, fittings and valves must be cathodically protected with 2.3 kg (5 lb.) zinc anodes and all hydrants must be cathodically protected with a 5.5 (12 lb.) zinc anode.

2. Anodes shall be packaged in a permeable cloth bag or cardboard chip type tube containing a backfill mixture.

3. Connect wires to fittings with a tack-weld.

4. A certificate of compliance is required from manufacturer stating that the specifications as noted above have been met.

5. A minimum of 2 liters (0.5 gallon) of water is to be poured on each 2.3 kg (5 lb) anode and 3 liters (0.75 gallons) on 5.5 kg (12 lb) anode to initiate the anode operation. An alternative is to soak the above anodes in water for a minimum of 10 minutes.

G. BACKFILLING

1. **Backfilling in Pipe Zone**

Backfill material in the pipe zone shall be sand free from organic material and shall conform to the following gradation specification:

ASTM Sieve Size (mm)	% Passing
9.50	100
4.75	50 – 100
2.00	30 – 90
0.40	10 – 50
0.075	0 - 10

Backfilling shall be done uniformly on both sides of the pipe in 100 mm layers to a minimum of 97% STANDARD Proctor density.

2. Backfilling Above Pipe Zone

The backfill material above the pipe zone shall be free from organic material and shall be compacted in maximum 200 mm layers to the following standards:

a) Within carriageway, lane or walkway to minimum 98% of a STANDARD Proctor density.
b) Within landscaped areas to minimum 98% of a one-mold proctor density in maximum 300 mm layers.

Compaction testing will be based on a minimum of one density test per 150 lineal meters of trench for each 1.5 m of depth. If a density test indicates insufficient compaction at any depth, then two more densities, which are proportionally representative of the trench length will be taken at that depth. Then if the average of the three tests is below the required density, the area will be re-compacted to meet the specified density.

H. TESTING

1. Disinfection of Completed Pipeline

Before being placed in service, and before certification of completion by the Town of Raymond, all new water systems, renewal/upgrading construction, extension to existing systems or valved section of such extensions, any replacement in the existing water systems, or any exposed section of the existing systems, shall be disinfected according to AWWA Standard C651-86 and tested for bacteria content and chlorine residual to the satisfaction of the Town of Raymond.

Prior to chlorination, all construction must be thoroughly flushed and the Town notified of the scheduled chlorination. Extreme care must be taken during these operations to ensure no contamination of the adjacent works occurs prior to, during, and subsequent to any flushing and chlorination. Note that special measures must be taken during flushing of heavily chlorinated water from service lines.

A standard disinfection procedure consists of:

a) Preventing contaminating materials from entering the water main during storage, construction, or repair.
b) Removing, by flushing and other means, those materials that my have entered the water main.
c) Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
d) Determining the bacteriological quality by certified laboratory test after disinfection.

Boundary valves to be operated by Town of Raymond Staff only.

2. **Bacteriological Tests**

Refer to AWWA C651-86, Section 7.1 with additional requirements for the minimum acceptable bacterial level as follows:

a) A sample must show the absence of coliform organisms; and
b) The total bacteria count shall not be greater than 300 organisms per milliliter.
c) If 1 to 10 coliform organisms are detected in the initial sampling, then the site should be re-sampled. If the presence of coliforms is confirmed, the disinfection, bacteriological sampling cycle shall be repeated.
d) If there are 10 or more coliform organisms and/or the total bacteria count is greater than 300, the disinfection-bacteriological sampling cycle shall be repeated.
e) It shall be the responsibility of the Developer to ensure that water from newly constructed water mains will not be used for drinking or other domestic purposes until the mains have been disinfected, and samples have been taken and approved by a certified laboratory as being free from bacterial contamination.

3. **Combined Pressure and Leakage Testing**

Prior to any combined pressure and leakage testing, the Town of Raymond's Public Works Department must be notified to witness the test. All distribution mains or sections of distribution mains shall be subject to a pressure test of not less than 1035 KPa for a minimum of 2 hours. Test section shall not exceed 450 m of distribution main. The overall permissible leakage is specified on the following table:

Leakage Allowance in Liters Per 100 Joints per Hour

Pipe Diameter (mm)	1050 Kpa Test Pressure to be used
150	3.76
200	5.02
250	6.27
300	7.52
450	11.28
600	15.05
750	18.81
900	22.57

* Above leakage allowances calculated from the following formula from AWWA Manual No. M23 (PVC Pipe - Design and Installation):

$$L = \frac{NDIP}{1283}$$

where L = allowable leakage, L/h
N = total number of joints
D = pipe diameter in mm
P = test pressure kPa

*Leakage allowance for new construction of materials other than PVC shall be in accordance with the applicable AWWA Standard or as specified by the Engineer.

SECTION IV SANITARY SEWER AND ACCESSORIES

A Standard Main Network system shall conform to the Sanitary Distribution System as outlined by the Town of Raymond. The minimum size of the main shall be 200 mm.

A. MAINS/DESIGN

1. Design Criteria

The design criteria for sanitary sewers are as follows:

a) Residential Sewage Dry weather Flows - 400 L/capita/d (4 people/home minimum) Commercial/Institutional -20 cu m/ha/d; Industrial (light and medium) - 30 cu m/ha/d; Industrial (Heavy) (Process specific)
b) Residential Sewage Wet Weather flows -500 L/capita/d in addition to Dry weather Flows
c) Commercial/Institutional/industrial –7.5 cu m/ha/d in addition to Dry Weather Flows
d) Infiltration allowance (Ground water is at 3.0 m or less below surface) Residential -150 L/capita/d and Industrial/Commercial/Institutional - 2.25 cu m/ha/d
e) Population Densities
   i) Residential areas 35 persons per hectare (p/ha)
   ii) Commercial areas (equivalent populations) 50 p/ha
   iii) Industrial areas (equivalent populations) 75 p/ha or (Process specific)
f) There shall be no flows from weeping tiles or sag manholes. However, Town Council shall have discretion to make such rare allowances for this if the mitigating factors involved merit such allowance.
g) The peaking factor will be calculated as follows:
   Average Daily Flow x $(1 + (14/(4+p^{0.5})))$
   Where p = population /1000
   Minimum peaking factor to be used will be 4
h) Pipe sizing shall be determined by utilizing the Manning Formula (80% of Full) using an "n" value as follows:
   i) PVC - 0.013
   ii) Concrete 0.015

NOTE: The above design criteria are as per normal standards and when criteria differ from that stated in the Infrastructure Master Plan (2006), the IMP would prevail.

2. Alignments

Sanitary Sewers shall be generally located at an alignment along the centerline of the road right-of-way.

3. Curved Sewers or Dead-end Sewers

Although it is recommended that the sanitary sewers be laid in straight alignment between manholes, curved sewers will be permitted with the following restrictions:

a) The sewer shall be laid along a simple curve with a minimum radius of 60 m.
b) Manholes shall be installed at the beginning and end of the curve and spaced at intervals not exceeding 60 m.
c) The minimum grade at dead ends or curves will be 50% greater than straight sewers.
d) The curve shall run parallel to the street centerline.
e) Lengths of pipe shall be such that deflections at each joint shall be less than the allowable maximum recommended by the manufacturer.

4. **Depth of Bury**

Sanitary Sewers shall be designed at a minimum depth in accordance with Alberta Environment. The depth shall be such as to provide gravity flow from all basements into the system.

5. **Material**

Approved materials for use are as follows:

a) Concrete Pipe conforming to ASTM C14, ASTM C76 and manufactured with Sulfate Resistant Cement.
b) Polyvinyl Chloride Pipe conforming to ASTM D3034 minimum Class SDR-35. PVC pipe shall be any color except blue.

B. MANHOLES

1. Manholes shall be provided at the following locations:

a) At a maximum spacing of 150 m.;
b) At the end of each line;
c) At all grade changes;
d) At all alignment changes;
e) At all junctions;
f) At changes in pipe diameter.

2. **Drop Manholes**

An external/interior drop manhole is required when the difference in elevation between the incoming and outgoing inverts is greater than 600 mm and the incoming pipe diameter is 300 mm or less.

3. **Types of Manholes**

a) Standard 1200 mm diameter pre-cast manhole shall be used
b) Pre-cast manhole vaults may be used if approved by the Town of Raymond.

c) All manholes shall be supplied with the TF/NF-80 Frame and Cover. Sanitary manholes located in low areas or potential ponding areas shall be supplied with the TF/NF-90 Frame and Cover.

4. Backfilling

1. Backfilling in Pipe Zone

Backfill material in the pipe zone shall be sand free from organic material and shall conform to the following gradation specification:

ASTM Sieve Size (mm)	% Passing
9.50	100
4.75	50 – 100
2.00	30 – 90
0.40	10 – 50
0.075	0 - 10

Backfilling shall be done uniformly on both sides of the pipe in 100 mm layers to a minimum of 97% STANDARD Proctor density.

2. Backfilling Above Pipe Zone

The backfill material above the pipe zone shall be free from organic material and shall be compacted in maximum 200 mm layers to the following standards:

a) Within carriageway, lane or walkway to minimum 98% of a STANDARD Proctor density.
b) Within landscaped areas to minimum 98% of a one-mold proctor density in maximum 300 mm layers.

Compaction testing will be based on a minimum of one density test per 150 lineal meters of trench for each 1.5 m of depth. If a density test indicates insufficient compaction at any depth, then two more densities, which are proportionally representative of the trench length will be taken at that depth. Then if the average of the three tests is below the required density, the area will be re-compacted to meet the specified density.

SECTION V - STORM SEWER AND ACCESSORIES

A. STORMWATER MANAGEMENT DESIGN

1. Dual-Drainage Design

Urban storm runoff will be directed through two paths to a receiving water body (stream, river, lake, etc):

a) Via a system of underground sewers, usually by gravity (although pumps, force-mains and inverted siphons are occasionally used). This is known as the "minor" system.

b) Overland in roads, gutters, ditches, roofs, etc…. This is the "major" system and it is intended to drain higher intensity events with longer return periods that exceed the capacity of the minor system. This system is entirely drained by gravity.

These two systems are interdependent. An acceptable design requires the analysis of both systems and their interface.

2. Unit Release Rate

As part of a master drainage plan, subdivision outline plan or other stormwater management plan, one or more unit release rates (URR) may be defined for a catchment or sub-catchment within a watershed. The URR is the maximum allowable peak discharge to be permitted to enter or exit a specific drainage facility per hectare of gross catchment area.

Where a unit release rate is defined for a catchment, the Developers and the Town of Raymond must design drainage and stormwater management features so that this rate is not exceeded for the return period specified.

3. Runoff Estimation

A suitable design storm shall be used for the estimation of runoff for the design of hydraulic structures conveying stormwater runoff.

4. Historical Data and IDF-Curves

The Meteorological Service of Canada (previously the Atmosphere and Environment Service or AES) has records of rainfall for the years 1965 to 1993. These consist of records of depth of precipitation per hour. The most recent data available for the development of IDF (Intensity-Duration-Frequency) curves will be made available at the request of the developers consulting engineer.

5. Rainfall Distribution

For all new developments, a storm hyetograph (relation of rainfall intensity to time) based on the Chicago rainfall distribution (Keifer & Chu, 1957) using IDF (intensity-duration-frequency) parameters for Raymond shall be used.

6. Design Storm Durations

The selection of applicable storm durations is at the discretion of the Engineer. The duration selected should be that which gives the most conservative values for the feature being designed. The duration selected should be equal or greater than the time of concentration for the basin in question. In general, the following durations are used for the design of the following structures:

a) 1-hour to 12-hour storm: pipes in small, hard-surfaced catchments;
b) 1-hour to 24-hour storm: commercial and industrial sites requiring detention storage for runoff attenuation; culverts and ditches draining catchments with time of concentration less than 4 hours;
c) 24 hour storm: large detention/retention ponds; hydraulic structures for large basins.

It is left to the designer to select the appropriate storm duration(s) for the design being performed.

7. Continuous Modeling

For the design of stormwater detention and retention facilities, continuous modeling may also be required where the facility designed will rely on pumps, infiltration, evaporation or a drain with a low release rate for drawdown to permanent water level or for the calculation of pollutant removal efficiencies, and water-quality modeling.

For continuous modeling, designers should rely on data available from Environment Canada for the years 1965-1993. Annual extreme values of the volume required shall be obtained from the model, regression analysis shall be used to "fit" the results to a statistical distribution and extrapolate to the 100-year return period.

8. Runoff Losses

A certain amount of the rainfall over a catchment will not contribute to runoff as it is trapped by soil, infiltrated, evaporated, taken up by vegetation, etc…. To account for this in hydrologic modeling, several methods have been devised. Most prevalent in Canada are the following:

a) SCS Method
b) Horton's Equation
c) Green-Ampt Method
d) Depression Storage

9. Computer Models

For the above analyses, use of computer modeling is essential. Alberta Environment describes numerous models designed for the analysis of hydrologic and hydraulic systems. While not necessarily excluding other models (see below), the following computer models are accepted by the Town for hydrologic and hydraulic analyses:

a) SWMHYMO.
b) QHM
c) EPA SWMM and EXTRAN
d) HEC-RAS and WS-PRO:

Computer models for hydrologic and hydraulic analysis are constantly developing. As such the Town will review the software available as required.

10. The Rational Method

For the design of storm sewers and culverts for basins of less than 2.0 ha where detention storage is not to part of the design the Rational Method is acceptable.

11. Runoff Coefficient

The amount of rainfall that will runoff from a catchment is estimated using a runoff coefficient (C). This is estimated as follows:

Surface	5-year return	100-year return
Grassed areas (lawns, boulevards, parks, golf courses, cemeteries)	0.25	0.35
Paved areas (roads, parking lots, other hard surfaces)	0.9	1.0
Roofs	1.0	1.0
Gravel	0.7	0.8

12. Hydraulic Design of the Minor System

The following provides a brief discussion of the methods to be used for hydraulic design of the storm drainage system in Raymond. The designer is expected to be familiar with hydraulics of open channels. The basis of hydraulic design is Manning's equation for determining the average velocity of flow in a channel:

$v = (1/n)R^{2/3}S^{1/2}$ where

v is the average velocity of flow in a channel in m/s
n is the channel roughness
R is the "hydraulic radius" of the channel in m
S is the bed slope of the channel in m/m

13. Channel Roughness

Tables of suggested values of Manning's roughness coefficient are published in various texts. The following provides a list of values commonly used in Raymond:

Smooth-wall pipe (concrete, PVC, PE): n = 0.013
Corrugated metal pipe: n = 0.024
Concrete and asphalt roads and gutters n = 0.015
Grassed channels n = 0.025-0.15

Rip-rap channels n = 0.04-0.15

14. Minor System Hydraulics

The piped or minor system shall be designed to convey the peak flow a 5-year return period design event without surcharging. Pipes shall be designed with minimum slopes such that, when flowing full, the velocity of flow in the pipe is not less than 0.9 m/s..

15. Lot Grading

Residential lots must be graded to provide positive drainage of runoff to the major drainage system. As such, lot grading plans must provide adequate detail so that effective elevation control can be practiced during the grading of subdivisions. Drainage must be channeled around the foundation walls in swales. A minimum 10% slope must be provided for 2.0 m away from the foundation wall around the entire building. Runoff must not be allowed to pond against foundation walls. Lot grading must comply with standard drawing SM-13.

a) Where flows cross a road, the depth of flow should not exceed 0.05 m.

16. Alberta Environment Guidelines

To protect the safety of the public, the Town of Raymond adopts Alberta Environment's guidelines for allowable depths and velocities of overland flows. The guidelines are based on the theoretical force of flow required to push a 20-kg child downstream..

17. Drainage Swales, Ditches and Open Channels

To convey overland flows outside of street gutters and on roads where not curb exists, it is often necessary to design channels to carry major flows.

18. Rear Lot Swales

Where lots back onto other lots (as opposed to lanes or other public property), it is necessary to provide for drainage from the back of the lots. This will be accomplished with a legal easement through which is constructed a concrete swale. The swale is not designed to carry the entire major flow – it is installed to ensure lots are graded as required to ensure drainage to a public right of way (street, lane, park, etc…). The easement is intended to contain all the flow expected in the major event.

19. Ditches and Open Channels

Drainage ditches are usually provided on roads and highways without curbs and gutters. Ditches are also installed on major roads where no storm sewers exist and/or large overland flows are expected and it is undesirable to carry such flows in the gutter.

The Town of Raymond requires that flows in ditches do not exceed the elevation of the bottom of the road sub-base and that velocities do not exceed Alberta Environment Guidelines.

20. Culverts

Where open channels cross under roads, a culvert must be provided. In the Town of Raymond, culverts must safely discharge the peak flow expected in the major design event without overtopping and flowing over the road surface.

21. Erosion Control and Channel Lining

In situation where the erosion of soil by either channelized or sheet overland flows, best management practices designed by a professional engineer must be employed to protect the environment from the deleterious effects of eroded sediment.

To prevent erosion, various methods can be applied – individually or Collectively:

a) Channels are lined with materials that are less susceptible to erosion (rock rip-rap, concrete, and geotextiles). Regardless of the lining material used, it is the engineer's responsibility to ensure and provide evidence that the material selected is appropriate for the application.

b) The velocities in the channel are controlled by reducing the slope of the channel by providing check-dams or providing drop structures at various points to decrease the energy of flows. Such designs require detailed design to ensure scour due to the falling water at the drop structure does not further exacerbate erosion.

c) Properly designed stilling basins or other energy dissipaters are provided at outfalls to decrease channel flow velocities.

B. MANHOLES

Manholes provide access to minor system pipes for routine and emergency maintenance. They may also provide inlets to the minor system for runoff as required.

Manholes must be provided at the following locations:

1. At the high point of a run of pipe and at such a spacing that pipe runs between manholes do not exceed 200 m (150 m for curved sewers).

2. At all junctions where the lateral pipe diameter exceeds one-half the diameter of the trunk sewer pipe.

3. At all horizontal deflections greater than 45°. Where pre-cast deflection fittings are used a manhole should be located within 20 m. Where practical, the use of curved sewers is encouraged.

4. At all vertical deflections.

5. At all changes in pipe size.

All manholes must conform to the designs shown in Figures SM-01. Where specialized features (weirs, multiple chambers, orifices, sluice gates, control structures, energy dissipaters, etc…) are to be included, additional details must be provided for approval.

C. CATCH BASINS AND INLETS

1. Catch Basin Designs

For new developments, the Town of Raymond uses catch basins of a similar design to those used in the City of Calgary. The City of Calgary publishes rating curves for the types of catch basins used. Four catch basin grate designs are specified:

a) Type C – The type-C catch basin consists of a 600-mm wide by 900-mm long grate with bars aligned at 45° to the direction of the gutter and a 900-mm long by 150-mm height vertical storm back.
b) Type K2 – The type-K2 catch basin consists of twin grates of a profile similar to the cross-section of a rolled curb.
c) Type K3 – The type-K3 catch basin consists of a similar grate to the type-C without the vertical storm back. It is commonly used as an area drain or in a gutter where a driveway crossing located.
d) Open-grated manhole cover – Storm-sewer manholes can be equipped with an open-grated cover for use as area drains.
e) Special designs will be approved on a case-by-case basis.

2. Locations of Catch Basins

Town of Raymond has adopted the following standards for the location of catch basins:

a) In all areas on streets where ponding is expected (low points of vertical sag curves, curb returns, changes in super-elevation).
b) Catch basins on continuous grades shall be located such that the spread of flows in the road gutters does not exceed the following:
    i) Local roads: not less than one lane with less than 0.05 m depth of water in the 100-year return period event.
    ii) Minor collector: gutter spread of flow not exceeding 3.5 m wide on each side of the road 100-year return period event. Where flows cross the road, the depth of sheet flow should not exceed 0.05 m.
    iii) Major road/industrial collector: gutter spread such that at least one lane of traffic in each direction is passable in the 100-year return period event. Flows crossing the road should not exceed 0.05 m depth.
c) In lanes, catch basins not more than 150 m apart.
d) Catch basins shall be located as required to keep overland flows within Alberta Environment guidelines.
e) Where catch basins are located in low points of vertical sag curves and ponding in excess of 0.15 m is possible, a twin Type-C catch basin must be used (i.e., two catch basins placed 0.3 m apart and tied

together as per Figure XX). Twin catch basins may also be used to increase capture on continuous grades. No more than two catch basins should be tied to the same lead. Should a situation necessitate more capture capacity than a twin type-C catch basin, a "special" catch basin shall be specifically designed and approved by the Town.

3. "Special" Catch Basins

Special catch basins, which are specifically designed for a given location, shall be used where necessary. Their designs shall be approved on a case-by-case basis. Locations which may require a special catch basin design include:

a) Drains from dry ponds where K3 or manhole grates will not allow adequate discharge.
b) In street gutters where particularly high discharges are needed into the minor system.
c) Where blockage problems are particularly acute and could result in flooding which would result in serious safety or property damage issues. This could include low points where no overland flow route is available.

4. Other Inlet Structures

In some locations, direct inlets to the storm sewer system are required. These must be specifically designed to ensure the following:

a) Unauthorized access is prevented by means of a heavy, iron grate bolted to the structure,
b) A suitable trash rack for large debris is provided,
c) Scour is prevented due to high velocities at the inlet by armouring adjacent soil,
d) A suitable low-permeability (usually compacted clay) plug is provided to prevent inlet of water into pipe bedding,
e) The structure is suitably bedded and provided with reaction blocks to ensure stability,
f) The structure's connection to the storm sewer pipe is water tight,
g) The structure is hydraulically designed to minimize head losses.

5. Minor System Inlet Control

To ensure minor system piping is protected from excessive surcharge, the inlet of runoff into the system must be controlled. This can be accomplished using various methods, must common are as follows:

a) The design of grading and placement of catch basins allows the catch basin grate to control the discharge into the minor system.
b) Orifice plates are placed on outlet pipes from catch basin barrels or critical manholes to control flows based on the level of water ponded at inlets.

D. PIPES

1. The following materials are presently approved for use as storm sewer pipe:

    a) Reinforced concrete conforming to ASTM C-76 with rubber-gasket joints,
    b) Reinforced concrete box sections conforming to ASTM-C476,
    c) Polyvinyl chloride (PVC), smooth-walled SDR-35 with rubber gasket-joints,
    d) Polyvinyl chloride (PVC), UltraRib™ (or approved equal) with rubber-gasket joints.

    For the materials above, the roughness coefficient (n) shall be assumed to be 0.013. Other materials may be approved on a case-by-case basis as required.

2. Pipes shall be designed with a continuous grade between manholes. In general, storm sewer pipes shall be designed with sufficient slope and size to discharge the full minor system design peak runoff without surcharging. Pipes shall be designed so that the full-flow velocity is not less than 0.9 m/s. The minimum slope permitted is 0.1%. Minimum slopes shall conform to Alberta Environment Design Guidelines.

3. If the velocity of flow predicted in a pipe exceeds 3.0 m/s, measures shall be taken to ensure:

    a) the pipe protected from excessive scour (which can cause spalling of concrete),
    b) that the pipe is suitably anchored so that it is not displaced by high flows and
    c) downstream manholes and structures are designed to withstand such high velocities.
    d) Pipes shall be designed with cover from the ground surface to the top of the pipe of not less than 1.2 m. Pipe materials and bedding shall be selected to resist live loads and dead loads.

E. DRY PONDS, WET PONDS AND CONSTRUCTED WETLANDS

1. Facility Approvals

These facilities require the approval of Alberta Environment and must conform to the design standards listed in the following documents:

a) Standards and Guidelines for Municipal Water, Wastewater and Storm Drainage Systems (Alberta Environment, December 1997),
b) Stormwater Management Guidelines for the Province of Alberta (Alberta Environment, January 1999),
c) Municipal Policies and Procedures Manual (Alberta Environment, April 2001).

Alberta Environment's should be consulted prior to initiating design for such facilities. Written documentation from AE detailing the design goals (release rate, water quality enhancement requirements) for a specific end-of-pipe Best Management Practices (BMP's) is required as a pre-requisite for design.

2. Stormwater Outfalls

Designs for these facilities require the specific review and approval of Alberta Environment. Design standards for outfalls listed in the following documents:

a) Standards and Guidelines for Municipal Water, Wastewater and Storm Drainage Systems (Alberta Environment, December 1997),
b) Stormwater Management Guidelines for the Province of Alberta (Alberta Environment, January 1999),
c) Municipal Policies and Procedures Manual (Alberta Environment, April 2001).

Alberta Environment should be consulted prior to initiating design for an outfall. Written documentation from AE detailing flood control requirements, preferred locations and other criteria is required as a pre-requisite for design.

F. BACKFILLING

1. Backfilling in Pipe Zone

Backfill material in the pipe zone shall be sand free from organic material and shall conform to the following gradation specification:

ASTM Sieve Size (mm)	% Passing
9.5	100
4.75	50 – 100
2.00	30 – 90
0.40	10 – 50
0.075	0 – 10

Backfilling shall be done uniformly on both sides of the pipe in 100 mm layers to a minimum of 97% STANDARD Proctor density.

2. Backfilling Above Pipe Zone

The backfill material above the pipe zone shall be free from organic material and shall be compacted in maximum 200 mm layers to the following standards:

a) Within carriageway, lane or walkway to minimum 98% of a STANDARD Proctor density.
b) Within landscaped areas to minimum 98% of a one-mold proctor density in maximum 300 mm layers.

Compaction testing will be based on a minimum of one density test per 150 lineal meters of trench for each 1.5 m of depth. If a density test indicates insufficient compaction at any depth, then two more densities, which are proportionally representative of the trench length will be taken at that depth. Then if the average of the three tests is below the required density, the area will be re-compacted to meet the specified density.

SECTION VI SERVICE CONNECTIONS

Service connections shall be placed as illustrated in Drawings SE-01, SE-02, SE-03 and SE-04.

The minimum size of Service for single family and duplex residences shall be as follows:

Water	20 mm
Sanitary	100 mm

A. GENERAL

1. Services larger than those indicated will be required when in the opinion of the Town of Raymond the length of service pipe or other conditions warrant.

2. The size and location of services to non-residential buildings shall be subject to the approval of the Town of Raymond.

3. Each residential dwelling unit must have a separate service.

   a) **Depth of Bury**
   Service lines shall be designed to a recommended minimum depth of bury from invert of service to finished grade of 2.6 m 3.0 m for lots grading from front to back.

   b) **Alignment**
   The sanitary and water services shall be laid in single trench to the alignments shown in Drawings SE-01 and SE-02.

B. WATER SERVICE CONNECTIONS

1. **General**

Wherever possible, tap main under pressure. Service connections shall be tapped into the upper portion of the water main at a minimum angle of 45 degrees from horizontal. Tappings shall have a minimum spacing of 600 mm. Use tapping machine to tap and thread corporation cock into the main. Use special care to prevent cuttings from falling into the main. Lay copper service on 75 mm of clean inorganic sand to the designated location of the curb stop. Attach curb stop and Epoxy set Epoxy coated service box to grade. Brace boxes securely to keep plumb during backfilling. Test for operation both before and after pressure test. Note that the Town shall be notified prior to the tapping of any main.

A 5.5 kg Zinc Anode shall be clamped to the service line and curb cock consistent with Detail SE-03.

Maximum size of tapping without utilizing service clamps shall be:

20 mm tap on a 150 mm Main
25 mm tap on a 200 mm Main

No water service between 50 mm and 150 mm shall be permitted.

2. Materials

a) **Copper Tubing**
   i) Wolverine type K, ASTM B88 or approved equal
   ii) PEX (cross linked polyethylene) tubing conforming to ASTM 876 or approved equal.

b) **Main Stops**
   i) Cambridge Brass 102-A1H1, 102-A3H3, 102-A4H4, 102-A5H5, 102-A7H7
   ii) Ford F1000-3 for 20 mm and 25 mm, F1000-4
   iii) Mueller H-15008

c) **Curb Stops (Boxes)**
   (to be epoxy coated with stainless steel rods)
   i) Cambridge Brass 203-H3H3, 203-H4H4, 203-H5H5, 203-H6H6, 203-H7H7
   ii) Ford B44-333SW from 20 mm, B44-444SW from 25 mm
   iii) Mueller, Oriseal Mark II B-25219F

d) **Service Saddles 40 mm AND 50 mm ONLY, Bronze Body with Stainless Steel Straps**
   i) Robar #2706
   ii) Romac #202BS

e) **Water Service Material For Services**
   150 mm and larger shall be PVC and in accordance with AWWA C-900.

f) **CC Chairs**
   To suit curb stop manufacturer 20mm – 50mm

C. SANITARY SERVICE CONNECTIONS

1. General

Connect services to mains with manufactured tee or wye fitting placed in mains or by cutting into mains and installing manufactured tee saddles. Take care to avoid cracking the main and remove all cuttings from main. Secure joint between saddle and main with mortar or other means acceptable to the Engineer. Install service line at a uniform gradient as specified on a minimum of 75 mm clean, inorganic sand. Support service lines adequately to prevent dislocation, buckling or settlement. Where water lines must be laid below sewer lines, ensure backfill over the water line is a minimum of 97% Standard Proctor density to prevent settlements. When a connection cannot be made directly into the house, plug the end of the sewer service to prevent entry of water and dirt.

Bends in the sewer service are permitted at these locations only:

a) 45 Degree bends with wyes or 22.5 Degree bends with tee connector at main
b) 45 Degree bends at top of riser
c) 22.5 Degree bends maximum at property line for house service connection

2. **Risers**

Where services are required to connect to mains in excess of 4.25 m deep, install risers and properly plug in accordance with Drawing SY-03, Appendix "C". Firmly support risers and anchor to the trench wall to minimize the possibility of damage to the riser during backfilling operations.

3. **Materials**

a) **Sewer Service Pipe**
PVC SDR 35 building sewer pipe conforming to CSA Specification B 182.1, latest revision thereof.

4. **Backfill**

See Section 3.G

ROADS AND STREETS
SECTION VII - ROADS AND LANES

A. CLASSIFICATION/DESIGN

Road classification and designation shall be in accordance with the classification system outlined in the Roads and Transportation Association of Canada (RTAC) manual - Geometric Design Standards for Canadian Roads and Streets. The following are minimum requirements to be used in the design of roads.

The following is a list summarizing Street Classifications:

STREET CLASSIFICATION	STANDARD DRAWING NO.	RIGHT-OF-WAY WIDTH
Local Residential	TN-01	18.0
Minor Collector - Residential	TN-02	20.0
Major Collector - Residential	TN-03	24.0
Industrial	TN-04	30.0
Lane	TN-05	6.0

B. DESIGN CRITERIA

All Roads shall be crowned or have cross-fall as shown on the applicable standard drawing. The minimum gutter grade shall be 0.60% and maximum gutter grade shall be 6.0%. These minimum and maximum grades shall be used only when necessary.

a) All vertical curves shall be designed to meet the following minimum requirements:

"K" VALUE		
Design Speed(km/hr)	**Crest** (m)	**Sag (m)**
50	7	6
60	15	10
70	22	15

K = L\A
L = Length of vertical curve in meters
A = Algebraic difference in grades (percent)
The minimum length of vertical curve shall be 45 m.

b) The following geometric standards shall be used:

CLASSIFICATION	DESIGN SPEED (km/hr)	MINIMUM RADIUS OF CURVE (m)	CURB RETURN RADIUS (m)
Local Residential	50	85	10
Minor/Major Collector	50	120	10
Arterial	50	450	15
Industrial	50	120	15

C. SIDEWALKS, CURB AND GUTTERS

Sidewalks, Curb and Gutters shall be installed according to the Standard Drawings and to approved grades and cross-sections.

1. Materials

The concrete for curb, gutter and sidewalk shall meet the following requirements:

Minimum Compressive Strength at 28 days	32.0 mpa
Maximum size of coarse aggregate	25 mm
Slump	25 - 75 mm
Entrained Air Content	6 - 8%

After September 15th, the concrete shall reach 27.5 mpa in 7 days.

All materials and admixtures used in the construction of the curb, gutters and sidewalks shall conform to applicable CSA and ASTM Standards and Specifications.

Curing Compound shall be placed on the concrete. It shall be a resin base impervious membrane and shall conform to ASTM C309 Type I. It shall be sufficiently free from permanent color to result in no profound change in color than that of natural concrete.

2. Placing of Concrete

The subgrade shall be compacted to a minimum of 100% Standard Proctor Density near optimum moisture content. The subgrade shall be free from any deflection under heavy loading. (See Section E-2 - "Proof Rolling of subgrade")

The concrete shall be vibrated into place according to the standard drawing cross-sections. Backfilling behind the curb, gutter and sidewalks shall be done soon after placement of the concrete. It shall be done carefully as not to damage the concrete. Heavy equipment used for road construction shall not be used near the concrete for a period of 7 days or until the concrete has reached a compressive strength of 70% of specified 28-day strength.

3. **Testing**

Compaction testing of subgrade shall be done a minimum of 1 field density test per 100 linear meters of subgrade. Additional testing may be required at the direction of the Engineer.

Concrete testing (including slump, air content, temperature, and compressive strength cylinders) shall be made for a minimum of 1 test per each 50 m^3 of concrete placed and a minimum of 1 complete test for each day of placing.

All testing shall conform to applicable CSA and ASTM Standards and Specifications.

D. ROADWAY CONSTRUCTION

1. **Common Excavation/Sub-grade Preparation**

All common excavation required under roadway, curb and gutter and sidewalks required to bring surface to sub-grade shall be compacted to a minimum of 97% Standard Proctor density placed in maximum 150 mm layers.

Sub-grade preparation shall consist of the scarification and mixing of the top 150 mm of sub-grade and shall be compacted to 100% Standard Proctor density near optimum moisture content.

2. **Proof Rolling of Sub-grade**

Proof rolling or load testing shall be performed on the sub-grade after compaction testing is completed and approved to help detect isolated unstable areas. The following procedures shall be followed:

a) Proof Roll the entire surface with as many passes as necessary, by slowly driving a fully loaded tandem truck or equivalent over the area.
b) Both the Engineer and the contractor shall closely observe this operation and mark out areas where weakness is indicated.
c) Weak areas shall receive additional compacting effort or be replaced with suitable material until satisfactory results are achieved.

NOTE: Proof rolling shall be done with a designated Town representative present.

3. **Pit Run Gravel Sub-grade**

When the native sub-grade material is unstable or in-situ material is too wet to provide a proper base for the pavement structure, pit run gravel shall be used. The pit run gravel shall be used to obtain a working platform for the Pavement Structure. The pit run gravel shall be placed and compacted uniformly to 97% Standard Proctor density.

The pit run gravel shall conform to the following gradation specification:

SIEVE SIZE (mm)	% PASSING
80	100
25	40 - 90
16	35 - 85
10	28 - 71
05	22 - 63
01.25	14 - 45
00.315	8 - 27
00.160	5 - 19
00.075	2 - 10

A geotechnical investigation shall be conducted on each project to identify site specific conditions. The report shall confirm or upgrade the previously listed minimum Pavement Structures.

4. **Pavement Structures**

The following are minimum requirements of pavement structure:

STREET CLASSIFICATION	MINIMUM PAVEMENT STRUCTURE
Local Residential	75 mm Asphaltic Concrete 200 mm Crushed Granular Base
Minor Industrial	100 mm Asphaltic Concrete 250 mm Crushed Granular Base
Major Industrial	125 mm Asphaltic Concrete 300 mm Crushed Granular Base
Residential Lane	75 mm Asphaltic Concrete 200 mm Crushed Granular Base

5. **Granular Base Course**

The granular base course shall be placed on the completed sub-grade in layers not exceeding 200 mm. It shall be compacted to a minimum of 100% Standard Proctor density.

The crushed gravel base course shall be free from clay, loam or other deleterious materials and shall conform to the following gradation specifications:

SIEVE SIZE (mm)	% PASSING
20	100
10	63 - 86
5	40 - 68
1.25	20 - 45
0.315	8 - 27
0.160	5 - 19
0.08	2 - 10

The gravel shall have at least 60% of material retained on the 5 mm sieve with at least 2 fractured faces. The gravel shall have a liquid limit of the

minus 0.4 mm sieve fraction not greater than 25% and a plasticity index not greater than 6%.

6. **Prime Coat/Tack Coat**

Prime Coats shall be the application of bituminous material to the sub-grade or previously prepared gravel base course prior to placing bituminous surfacing materials. The bituminous material for priming the base course shall be liquid asphalt. The asphalt types may vary from M.C. 30 to M.C. 250; from SS-1 to SS-1h or an emulsified asphalt primer to suit the conditions of the base. The rate of application may vary from 0.5 to 1.5 L/m^2.

Tack coats shall be the application of bituminous material to a previously constructed paving surface of any type in preparation of placing bituminous surfacing materials, against curb and gutter faces, manholes, valves and other appurtenances in the street to be paved. The asphalt for the tack coat may vary from SS-1 to SS-1H; from R.C.30 to R.C.250 depending on conditions to suit the base. The rate of application shall be 0.25 to 0.90 L/M^2.

Permit prime coat and tack coat to cure prior to placing asphaltic concrete paving mixtures.

7. **Asphaltic Concrete Pavement**

The contractor shall supply to the Town of Raymond an asphalt mix design. The asphaltic concrete pavement shall conform to the following list of properties:

a) **Gradation Specification**

SIEVE SIZE (mm)	**% PASSING**	
	Surface Course	**Base Course**
20	-	100
16	100	-
10	75 - 93	63 - 86
5	50 - 70	45 - 68
1.25	25 - 45	25 - 45
0.315	13 - 26	13 - 26
0.160	9 - 18	9 - 18
0.075	4 - 10	4 - 10

A minimum of 60% of the material retained on the 5 mm sieve shall have at least 2 fractured faces.

b) **Based on a 50 Blow Marshall**

i)	Stability	Min. 5000 N
ii)	Flow (0.25 mm)	2 - 4.5
iii)	% Air Voids - Total Mix	2 - 5%
iv)	Voids in Mineral Aggregate	15 min.

Hot plant mix asphaltic concrete shall be placed with time remaining so that the compaction shall be completed during daylight hours, when the temperature is a minimum 2^0 C and rising and the road surface is dry.

Asphalt cores shall be taken by an approved testing laboratory and shall be used in determining the following:

i) thickness
ii) % compaction
iii) in place air voids

The asphaltic concrete pavement shall be placed and compacted to a minimum of 98% laboratory design density. Should asphalt densities be less than specified, the Town of Raymond may require allowances for future maintenance costs.

8. **Testing**

Quality control testing shall be done during the road construction at the following minimum intervals:

a) sub-grade preparation - field density 1 test per 1000 sq. m.
b) sub-base construction - field density 1 test per 1000 sq. m.
c) asphaltic concrete placement:
    i) one sample of asphalt for complete Marshall testing including: oil content, stability flow, air voids and VMA for each 2000 m^2 or a minimum of 1 per day of placing.
    ii) In place asphalt core testing for thickness, density and air voids at 1 per 1000 $m^{2.}$

All testing shall be done in accordance with applicable CSA and ASTM Standards and Specifications.