SECTION “H”

STORMWATER DRAINAGE

H1 GENERAL

H1.1 Stormwater Management:

The specific requirements of the storm sewage system will depend on whether the **development** is defined as a rural or urban **development**. In either case, the intent of the stormwater management system is to prevent any negative downstream effects as a result of the **development**.

Detailed design of the stormwater system will be consistent with a stormwater management plan to be submitted by the **Developer** and approved by the **County**. Deviation from the intent of the stormwater management plan must be approved by the **County** and supported by engineering analysis.

For both rural and urban **development**, the stormwater system will either be designed based upon a “net-zero” impact (runoff rates for a 24 hour duration, 1:100 year post **development** design storm will not exceed rates for the same design storm under pre-**development** conditions) or on the available capacity of the receiving stream and appropriate area contributions.

If these standards and specifications do not cover an area of drainage concern, the onus will be upon the **Developer** to present alternative corrective measures and recommend proposed drainage standards to be used, based on sound economic, engineering, environmental, maintenance, and operational criteria for approval by the **County**. The system will meet the recommended standards of Alberta Environmental Protection and the Plumbing and Drainage Act of Alberta.

The **Developer** will provide rights-of-way or easements for drainage and have them registered in the name of the **County** so that future maintenance may be provided.

The **Developer** will be responsible not only for the drainage within the **development**, but also for drainage in the adjoining properties that would be affected by this **development**.

Any type of drainage diversion will be approved and licensed by Alberta Environment. Drainages works will include the constructions of ditches, berms, ditch checks, the installations of culverts, rip-raps, and other means of erosion control.

H1.2 Urban Systems:

The storm sewerage system will be designed as a separate system. Pipes and their appurtenances (manholes, catchbasins, outfall structures, etc.) will comprise the minor system. This system will convey runoff from snow melt and rainfall events without sustaining any surface ponding or excessive surface flows from a 1-in-5 year event. The road system, detention/retention facilities, parkland, and other land will comprise the major system. The major system will convey runoff from up to a 1-in-100 year storm event and will be sufficient to prevent any significant **property** damage (e.g. flooding of buildings).

H1.3 Rural Systems:

It is expected that a rural system will be comprised primarily of swales, ditches, culverts, and similar open flow components. The system will convey runoff from snowmelt and rainfall events consistent with the stormwater management plan. The system will be considered the major system, and will convey runoff for the design storm sufficient to prevent **property** damage.

H2 DESIGN CRITERIA

H2.1 System Design:

The Rational Method may be used for analysis of minor drainage systems up to a maximum catchment area of 50 hectares. Computer simulation methods must be used for analysis of major drainage systems (catchment areas greater than 50 ha) and is recommended for all final analysis and detailed designs.

The Rational formula is expressed as Q=CIA/360 where:

Q = runoff discharge in cubic meters per second;

C = dimensionless runoff coefficient;

I = rainfall intensity in millimeters per hour; and

A = catchment area in hectares.

i) The runoff coefficient, C, must be consistent with the following guidelines and based on sound engineering and best management practice:

Description	Storm Frequency	
	1:5	**1:100**
Undeveloped Farm Land	0.10	0.20
Lawns, Parks, Playgrounds	0.20	0.30
Residential (Urban)	0.35	0.60
Commercial (Urban)	0.60	0.80
Apartments (Urban)	0.70	0.80
Paved Surfaces	0.90	0.95
Gravel Surfaces	0.30	0.70

These values may be further modified based upon the specific **development** proposed. In rural **development**s or where a mixture of land uses or surface characteristics are proposed, the weighted average of pervious and impervious area runoff coefficients will be used.

ii) Rainfall intensity, I, will be determined using appropriate Intensity Duration Frequency (IDF) or rainfall data within the **County**. The maximum inlet time will be 15 minutes unless approved otherwise by the **County**.

iii) Effluent from sanitary sewers and any drainage from industrial, agricultural or commercial operations that may potentially be contaminated will not be discharged into the storm sewer system.

iv) Roof drainage from one-family and two-family dwellings will discharge to grassed or pervious areas. The point of discharge will be a sufficient distance to ensure the water flows away from the building. Roof drainage from apartment buildings, commercial areas and industrial areas will also be discharged to the surface drainage system.

v) Best management practices will be provided to minimize sediment discharge to the storm sewers. This will be in the form of properly graded and surfaced streets and lanes, landscaping, catchbasin sumps, sediment control structures at pond and lake inlets, or other means where appropriate.

H2.2 Pipe:

- Storm sewer pipe will be designed to convey the design flow when flowing full with the hydraulic gradeline at the pipe crown. All pipe crown elevations will match at manhole junctions.

- Storm sewer pipe hydraulics will be calculated using Manning's equation. The minimum Manning's "n" value will be 0.013 for smooth-walled pipes. For corrugated steel and open channels the values suggested in "Modern Sewer Design", latest edition, will be used but will not be less than 0.013.

- Storm sewer velocities will not be less than 0.60 m/s when flowing full. When the flow velocity exceeds 3.0 m/s, special consideration will be given to minor losses in the system and bedding requirements.

- Storm sewers 900 mm diameter and smaller will be PVC SDR 35 or Ultra Rib PVC storm sewer pipe, provided that manufacturer recommended pipe loadings are not exceeded. Storm sewers greater than 900 mm diameter will be of concrete pipe unless approved otherwise by the **County**. Concrete pipe will be of sulfate resistant concrete with a gasketed jointing system. On steep slopes, welded steel pipe or another rigid piping system will be constructed as approved by the **County**.

- The minimum inside diameter for storm sewers will be 300 mm. The minimum inside diameter for catchbasin leads will be 250 mm.

- The **Developer** is responsible for providing the engineering expertise relating to the structural design of storm sewers, providing all test results and the quality control of all materials proposed to be used. All storm sewers will be designed to prevent damage from superimposed loads. Notwithstanding information contained herein, all materials and loading calculation will be consistent with current **ASTM** and **CSA** standards.

    i) For rigid pipes a 0.025 cm crack will be determined as exceeding the working strength and the pipe rejected. For flexible pipe, when deflection greater than seven and one-half percent (7 ½%) of the original diameter is reached, then the pipe will be considered to have exceeded the limit of serviceability and will be rejected.

ii) Proper allowances will be made with regard to the class of bedding and the trench dimensions (width, depth) when determining the loadings on pipes. The recommended unit weight of soil is 2100 kg/m^3 metre.

iii) The minimum depth of cover to pipe crown will be 1.20 m, or 2.6 m to invert, whichever is greater.

iv) The Marston Theory is to be used in analyzing loadings in the single trench applications for rigid pipe. For flexible pipe, the modified IOWA formula will be used.

v) Concrete pipe specified under **ASTM** C655 may have combinations of circular and elliptical reinforcement with minimum steel requirements at all outer and inner points as specified under **ASTM** C76. The **Developer** will specify the horizontal and structural strength of all pipe.

- Changes in flow direction at a manhole will not exceed 90 degrees in pipes greater than 600 mm diameter.

- Curved sewers - It is recommended that sewers 600 mm inside diameter or less be installed with straight alignment between manholes, but curved sewers will be permitted providing that the following requirements are met:

  i) Permissible joint deflections will be in accordance with the manufacture's guidelines;

  ii) Manholes are to be located at the beginning and end of curve;

  iii) The curve will run parallel to the street centerline; and

  iv) The minimum grade for curved sewers will be fifty percent (50%) greater than the minimum grade required for straight runs.

H2.3 Manholes:

- The maximum spacing of manholes will be 150 m. Manholes will be located at the upstream end of each line, at changes in size or alignment and at all junctions. The downstream invert in a manhole at a change in direction will be a minimum of 30 mm lower than the lowest upstream invert.

- Manholes will be a minimum of 1200 mm in diameter. Precast (Type 50) reinforced concrete manhole barrels conforming to ASTM C478 will be used. The base will be constructed of 25 Mpa sulphate resistant (Type 50) concrete. Galvanized iron safety steps are required.

  Manhole frames and covers will be of cast iron. Grated or standard manhole covers will be used as required. A Norwood NF - 49 or approved equal frame and cover must be used on manholes. Located in carriageways and an appropriate locking manhole frame and cover must be used on manholes located in parkland areas.

H2.4 Catchbasins: (Refer to Drawing H-01 in Appendix C)

- For urban design, surface water will not be permitted to run a distance greater than 300 m along roadways without provision for interception by a catchbasin, except in lanes or walkways where 200 m in either direction may be permitted.

- Surface water will be intercepted with a number of catchbasins such that the combined inlet capacity is sufficient to receive the design stormwater flow.

- Minimum gutter grade will be 0.40% except in cul-de-sacs and around curb returns where minimum gutter grade will be 0.70%.

- All catchbasin bodies will be 900 mm pre-cast sulfate resistant concrete sections. The body will be constructed to provide a minimum 600 mm sump, unless otherwise approved.

- All catchbasin leads will discharge directly into storm sewer manholes. The minimum catchbasin lead size will be 250 mm with a minimum slope of 1% and a maximum length of 30 m. For leads of greater length or for those from a CBMH to a manhole the minimum lead size will be 300 mm.

  Catchbasin frames and covers will be combination precast iron inlet type. Norwood F41 & F51, Trojan K2 or approved equal will be used with 900 mm concrete sections.

H3 RIP RAP

When required by the plans, or as ordered by the Engineer, embankments, the ends of culverts, and ditch bottoms will be protected by rip-rap as directed. This item consists of supplying materials and constructing a protective covering of approved stone or sacked concrete on an earth bed,

granular filter blanket, or filter fabric in accordance with these specifications.

Rip-rap will be constructed at the locations and in conformity with the lines and grades shown on the plans or as designated by the Engineer.

The **developer** will supply all rip-rap materials including filter fabrics. The materials supplied will be subject to the approval of the **CAO**.

The **County** reserves the right to select an independent testing firm to conduct visual inspections and testing, and compile its own data during or after the construction period. Any costs associated with inspections and testing conducted by the **County** for areas that fail initial testing will be borne by the **developer** and taken from the security held by the **County**. These results will be made available to the **Developer** and Engineer. This quality assurance testing program does not relieve the **developer** of their responsibility to conduct their own quality control testing program.

H3.1 Type of Rip-Rap:

- Stone Rip-Rap - materials will consist of sound, hard and dense stones, boulders or quarry rocks resistant to the action of air and water and free from seams, cracks or other structural defects. The particles will be generally of equal dimensions in all directions, with a minimum of flat and/or elongated particles.

    i) Stone rip-rap used for corrugated steel pipe culverts, ditch checks and ditch blocks will meet the requirements of “normal stone rip-rap”. Normal stone rip-rap will consist of particles having dimensions of not less than one hundred and fifty (150) mm in any one direction.

    ii) Stone rip-rap materials used for corrugated structural plate pipe culverts, bridges, and major stream bank protection will meet the requirements for “heavy stone rip-rap” or “armour stone rip-rap”.

Heavy Stone Rip-Rap:

Weight of stones (Kg.)	**Percentage**
400 - 600	40 - 60
200 - 400	20 - 40
25 - 200	10 - 30
Under 25	0

Armour Stone Rip Rap:

Weight of stones (Kg.)	Percentage
600 - 900	60 - 70
300 - 600	20 - 30
100 - 200	10 - 20
Under 100	0

- Hand Laid Rip-Rap - Hand laid rip-rap will be sound, durable stones and in no case measure less than 150 mm. The stones will be placed with their beds at right angles to the slope, with larger stones used in the bottom courses, and the smaller stones at the top. They will be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not by the **adjacent** stones. The spaces between the larger stones will be filled with spalls, securely rammed into place. The finished work will present an even, tight, and reasonably plain surface, varying not more than 75 mm from the required contour.

- Random Rip-Rap - Random rip-rap, graded so that the smaller stone is uniformly distributed throughout the mass, will be dumped randomly over the areas until the required depth is attained. The occasional manual handling of rocks or stones will in no manner be construed to transform the classification of random rip-rap into that of hand laid rip-rap.

- Sacked Concrete Rip-Rap - granular material will be used for the concrete and consist of a well graded gravel with a maximum particle size of seventy-five (75) millimeters. Sacks will be manufactured from burlap and will have a capacity of approximately 0.03 cubic metres. The cement will be Portland cement conforming to the latest C.S.A. Specifications A5, type 1.

H3.2 Construction:

1. Preparation of foundation: Aprons and slopes to be rip-rapped will be excavated as shown on the Plans or as designated by the **CAO**. The foundation bed will be fine graded to form a uniform and even surface. Granular filter blankets or filter fabrics when required by the **CAO** will be placed as specified by the **CAO**. A thin lift of fine grained material will be placed over filter fabric to prevent damage to the fabric by the stones.

2. Application of rip-rap

i) Hand placed rip-rap: The stones, boulders or quarry rocks will be placed by hand to conform to the lines and grades as shown on the Plans or designated by the **CAO**. The stones will be firmly bedded into the bed and against adjoining stones and smaller stones used to fill in the voids. Hand placing will generally be designated for Normal Stone Rip-Rap.

Machine placed rip-rap: The stones, boulders or quarry rocks will be sorted and placed by machine to produce a uniform blanket or rip-rap conforming to the lines and grades shown on the Plans or designated by the **CAO**. The equipment used will be capable of handling and positioning individual rip-rap particles. Machine placing will generally be designated for Heavy Stone Rip-Rap and Armour Stone Rip-Rap.

ii) Random rip-rap: The stones, boulders or quarry rock will be dumped onto the surface to be rip-rapped and sufficient hand and/or machine work will be done to produce a uniform mat conforming with the lines and grades shown on the Plans or designated by the **CAO**. Random placing may be designated for all types of stone rip-rap.

iii) Sacked concrete rip-rap: The **CAO** will establish the mix design for the concrete to be used and it will be based on a minimum compressive strength of fourteen (14) MPa after 28 days. Each burlap sack will be filled with at least forty (40) kg of concrete and securely stapled or tied with wire ties. Within one half hour after mixing of the concrete, the filled sacks will be placed in their final position on the prepared base and packed into conformance with the base and the **adjacent** sacks already in place. The pattern to which the sacks are laid will be as required by the Plans or as designated by the **CAO**. Following placing, the sacked concrete rip-rap will be kept moist for 24 hours by sprinkling or by covering with at least one hundred (100) mm thickness of moistened earth.

H4 DITCHES

H4.1 Cross Section Elements for Ditches:

- Sideslope and backslope of channels or ditches will be 3:1 minimum.

- For a flat bottom ditch, the minimum width will be 1 m for local and collector roads and a minimum of 3 m for arterials, unless otherwise

approved by the **Municipal Engineer**.

- Minimum depth of ditch will be 1 m.
- All drainage channels will be topsoil and seeded. In channels, ditches and slopes that are highly susceptible to erosion, sodding will be provided, or other erosion treatments as recommended by the **Developer's Engineer** and approved by the **County**.

H4.2 Ditch Checks

Ditch checks are required for any ditch that has a 4% or greater grade. This ditch check will be considered as part of the design of the subdivision and addressed in the storm water management plan.

Ditch checks will be of a permanent nature and will be maintained by the **Developer** until final acceptance of the subdivision of the Municipality. The distance between ditch checks will be a minimum of 5 m from any culvert invert; and have a maximum spacing of 20 m.

Ditches with grades exceeding 3% must include erosion control design measures.

H5 GRADING

H5.1 General:

The intent is to achieve a proper balance between the street elevation, building grade elevation, surrounding **development** and existing topography. Basic to the **grading** design of lots is the selection of the proper building plan to meet and complement the land it is situated on.

Site **grading** will be done to ensure proper drainage of **private property** and to establish an adequate drainage system for the entire **development**.

The criteria recommended for the major system are:

- provide a level of protection for the 1-in-100 year frequency;
- no damage to structures due to flooding; and
- continuous road grades or overflow easements to open areas.

H5.2 Design:

Lot **Grading** (Urban Conditions)

i) The finished grade elevation at buildings are to be based upon CMHC guidelines found under "Finished Grade Elevation at the Building for Residential Lots".

ii) Back-to-front drainage must be the standard practice in laneless subdivisions. They must be graded to achieve a minimum slope of 2% or greater away from buildings and along the lot lines. Provisions must be made to keep the runoff at least 3 meters away from buildings where practical.

iii) Split drainage or front-to-back drainage may be allowed when a road, lane or public right-of-way exists at both the front and back of the lot, or as approved otherwise by the **County**.

iv) Reserves and public lands will be graded to drain towards developed roadway, lanes and/or the storm drainage system according to a specific landscape or site plan submitted by the **Developer** and approved by the **County**.

v) The construction of all overland drainage control will be completed to the satisfaction of the **County**, in accordance with approved plans, prior to the issuance of the **construction completion certificate** for storm sewer mains.

H6 PLANS

H6.1 General:

All construction plans will conform to the standards outlined in Section B of this Manual.

H6.2 Plan Submission:

A description of existing and proposed storm sewer facilities and areas served must be submitted, including the following information as required:

- Soils reports.
- Stormwater Management Design Report.

- Storm flow computations (including catchment areas) using the Rational Method and/or computer modeling analysis.
- Approved drawings for all crossings.

Prior to the issuance of the **Final Acceptance Certificate**, the following will be submitted:

- Recent plans.
- Maintenance & operations manuals.
- Video inspection reports.
- Registered easements and caveats.

H6.3 Detail Plans:

At least four (4) copies of the Plans as amended will be supplied to the **County** after final approval, before any construction work will be authorized. Plans and profiles will show:

- Location of streets and storm sewers within same.
- Details of all storm sewer appurtenances (special manholes or junctions, inspection chambers, inverted siphons, sampling devices, weirs, etc.)
- Details of special protection for pipe where high velocities are encountered.
- Drawings for crossing **permits** for any oil, power, gas, or other transmission lines or railways.