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DESIGN BRIEF – STORMWATER MANAGEMENT PLAN

RE: Revision 1 - Storm Water Management Plan
Coal Valley Estates
Remainder, D.L. 24, Nelson District, Cumberland, BC

MCSL FILE: 2211-46871-5

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REVIEWED BY: Bob Hudson, P.Eng.

DATE: November 24, 2014

1.0 INTRODUCTION

The following Stormwater Management Plan (SWMP) has been prepared on behalf of Coal Valley Estates Ltd., in support of ongoing development permit applications for the above noted parcel. The intent of this plan is to set a base line for pre-development (2007) site runoff, develop per hectare performance targets for post-development (based on the BCSWGB and Village Guidelines), and provide preliminary sizing for the proposed mitigation techniques or Best Management Practices (BMPs) required to achieve the performance targets.

2.0 SITE DESCRIPTION

The 46 hectare subject property legally identified as the Remainder of District Lot 24, Nelson District, is located adjacent the western edge of existing development within the Village of Cumberland. The subject property, zoned CDMU-6, is bordered to the east by existing residential developments, to the south by parkland, to the west by a working forest zoned UR-1 and to the north by forested lands zoned RU-1. The CDMU-6 zoning allows for mixed residential and multifamily use.

The rolling topography of the site ranges from 170 – 213 metres above sea level and is bisected east to west by a wetland which drains to the south east. A review of existing flora and fauna, conducted by *Ursus Environmental* in October 2006 shows that the property is located in the Coastal Western Hemlock Biogeoclimatic Zone. The upland areas contain regenerating forest with underbrush consisting of salal, vanilla leaf, blackberry, swordfern, salmonberry and Oregon grape. Vegetation in the moister, low lying area consists of juvenile western red cedar, red alder and salmonberry.

Soil stratigraphy was examined by *Lewkowich Geotechnical Engineering Ltd.* who logged 34 test pits within the subject property during their October 2006 field investigation. Lewkowich's February 2007 Preliminary Geotechnical Assessment states:

> *The soil conditions consisted generally of a layer of organics, overlying silty sand with some gravel, over dense silty sand glacial till. Bedrock was encountered in most test pits at depths varying from ground surface (TP06- 32) to 2.0m (TP06-12). Several test pits were terminated in very dense glacial till.*
>
> *The upper sand material (overburden) was generally found to be silty, compact to dense, with some gravel. This material should be suitable for infiltration of storm water infiltration. Further permeability testing would be necessary to determine the permeability characteristics of this material.*
>
> *Ground water seepage was not encountered during the testpits.*

3.0 EXISTING RUNOFF

Most of the site is located within the Maple Creek Watershed, with a small portion of the south west corner located within the Perseverance Creek Watershed. The northern half of the property drains to the Maple Lake wetlands, and the southern portion of the site to the Maple Creek Watershed. A small remaining area within the south west quadrant of the site drains to Perseverance Creek.

A hydraulic model was developed using SWMM software, enabling analysis of existing site response to a variety of design rainfall events. Simulations were completed for the MAR (Mean Annual Rainfall), and synthetic, 24-hour SCS Type 1A distribution, for 2, 5, and 10 Year rainfall events (derived from 32 years of data from Environment Canada's Puntledge rain gauge (1021990)). For simplicity, a single 1.0 hectare catchment has been modeled to set a base line for existing site runoff, define post-development performance targets, and provide preliminary sizing for the proposed mitigation techniques, all on a per unit area basis. This method allows runoff for each phase of the development to be analyzed on a volumetric discharge of *cubic metres per hectare* (m^3/ha) and a peak discharge of *litres per second per hectare* (lps/ha).

Model input parameters, based on existing soils information (provided by *Lewkowich Geotechnical Engineering Ltd.* in their February 2007 Preliminary Geotechnical Assessment), are summarized in **Table 1** overleaf. Results of the modeled, pre-disturbed (2007) site response are indicated in **Figure 1** overleaf, and summarized in **Table 2** double overleaf.

Table 1: Existing Site-Specific Storm Water Modeling Parameters for a 1 hectare sample area

Parameter	Existing
Area (ha)	1.0
Width (m)	50
Slope (%)	12
% Impervious	15
N Imperv	0.013
N Perv	0.2
Dstore Imperv (mm)	2
Dstore Perv (mm)	7
Zero % imperv	25
Curve #	70
Drying time (days)	7
Subarea routing	PERV

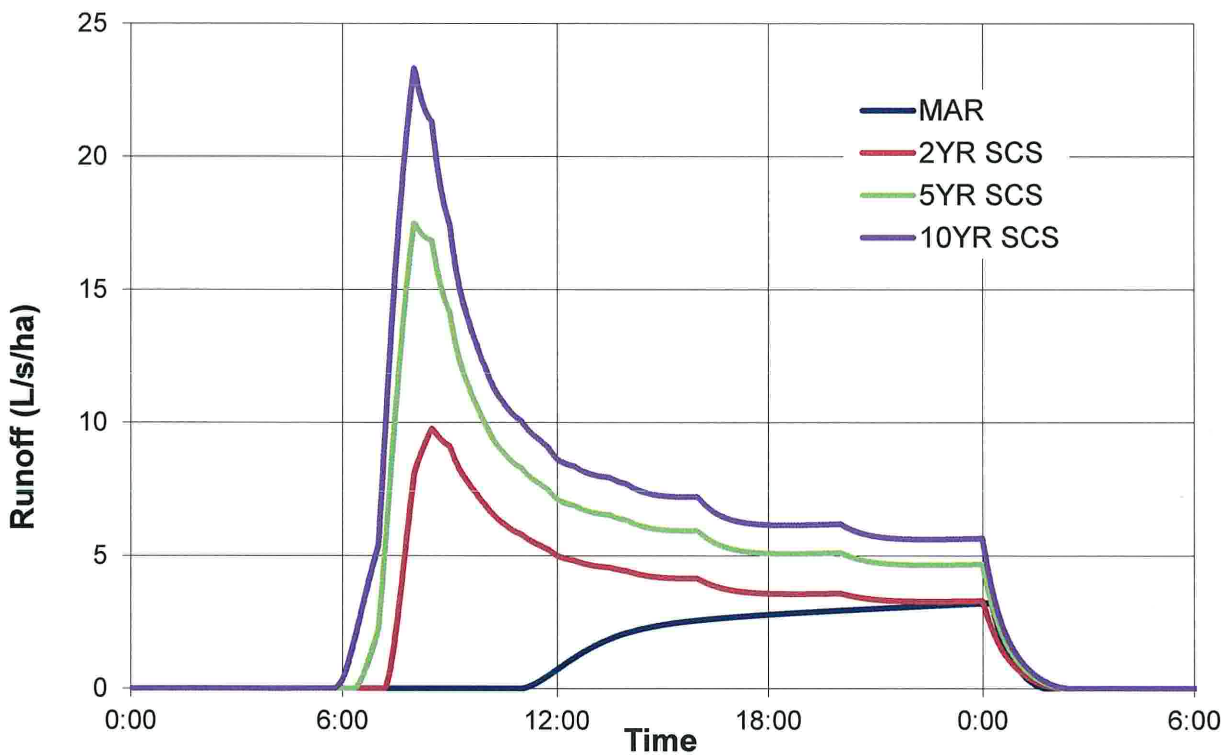

Figure 1: Hydrographs for the MAR, 2, 5, and 10 Year Rainfall Event under Present Day Site Conditions

Table 2: Existing Runoff Quantities for a 1 hectare sample area

24-hour Distribution	Total Precipitation (mm)	Existing Runoff	
		Total (m^3/ha)	Peak (lps/ha)
MAR	48	120	3.2
2-Year	73	285	9.8
5-Year	95	445	17.5
10-Year	110	560	23.3

Peak discharge (runoff) from the site is high when compared to other sites within the Valley. Higher than normal discharge rates can be attributed to steep slopes, minimal soil cover atop bedrock and the intense rainfall patterns unique to the Cumberland area.

4.0 PERFORMANCE TARGETS

Performance targets have been developed based on the Village of Cumberland Bylaw No. 990, Section 10.1.5.17) which requires rainwater management in accordance with the Water Balance Model. The British Columbia Stormwater Planning Guidebook (BCSWPG), and Beyond the Guidebook, a 2007 revised publication which builds on the BCSWPG are the baseline for the Water Balance Model.

The BCSWPG suggests that the complete spectrum of rainfall events should be evaluated with the goal that post development flow rates should mimic pre-development rates. The BCSWPG also recognizes that the rainfall capture targets will depend on the site and watershed-specific conditions. Beyond the Guidebook introduces the following three performance targets to facilitate implementation of the integrated strategy for managing the complete rainfall spectrum:

Rainfall Capture – "Rainfall capture" measures include infiltration, evapotranspiration, or re-use.

Runoff Control – delay overflow runoff by means of detention storage with 'runoff control' and release into a receiving body at a rate that mimics pre-development flow rates.

Flood Mitigation – reduce flooding by providing sufficient hydraulic capacity to "contain and convey' ensuring that large storm events are safely conveyed by the storm drainage system.

The BCSWPG targets have been developed based on the statistical distribution of rainfall intensities in British Columbia. The datum used to measure hydrological impact is the so-called "Mean Annual Rainfall" (MAR). The MAR is defined as the rainfall event which is exceeded, on average, once per year. Rainfall events up to and including the MAR, equate to approximately 95% of annual rainfall volume. Conversely, extreme storms in excess of the MAR typically account for less than 0.4% of all rainfall events.

Based on the results of the SWMM analysis and the design objectives outlined above, the Performance Targets for the remainder of the Coal Valley development are as follows:

Table 3 – Performance Targets

	Small Storm Goal	Medium Storm Goal		Large Storm Goal
	MAR 24hr rainfall event	2 year, 24hr rainfall event	5 year, 24hr rainfall event	10 year, 24hr rainfall event
Target peak runoff rate (l/s/ha)	3.2	9.8	17.5	23.3
Target peak volume rate (m^3/ha)	120	285	445	560

5.0 DESIGN ELEMENTS

The proposed Low Impact Development (LID) strategies to be implemented for this project have been developed to promote onsite capture of runoff and groundwater recharge. Properly employed, this approach will mitigate peak runoff rates, and provide qualitative treatment of runoff, prior to discharge. The following LIDs are proposed for the site:

5.1. Amended Soil

The use of amended soils will be fundamental to achieving a water balance for this site. Properly functioning amended soil can significantly increase the amount of initial abstractions of the pervious area of the site. Initial abstractions reflect the depth of rainfall lost to depression storage and evapotranspiration. A minimum of 300 mm of topsoil which meets the revised MMCD Specification outlined below should be placed on all pervious areas of the site. This soil can either be stripped from the site and re-used (if available) or imported.

To account for compaction and clogging over time, the post-development mitigated model has assumed 12 mm of initial abstractions, for all pervious surfaces. This reflects the long term performance of 300 mm of amended soil inclusive of a FOS of 2. All amended soils should conform to the MMCD specification for growing medium, with the following amendments:

- Lawn Areas: topsoil should meet or exceed the MMCD specification for growing medium with the organic content amended to be 8%; and,
- Planters, Shrub and Groundcover Areas: topsoil should meet the MMCD specification for growing medium with organic content of 8 to 15%.

Refer to MMCD and *Green Infrastructure Partnership, "Topsoil: Just How Do You Obtain a Performing Topsoil Layer, to Advance Rainwater Management & Water Conservation"* for more information on amended soils.

5.2. Retention of Native Vegetation

Wherever possible, the native vegetation should be retained and/or re-established post development. Vegetation reduces runoff by retaining, evapotranspirating and aiding in infiltration.

5.3. Infiltration Galleries

Runoff from buildings and streets will be directed to infiltration galleries where existing topography and soil stratigraphy allow. **Figure 2** overleaf, shows a typical lot level infiltration gallery to collect and infiltrate runoff from buildings. Lot level infiltration galleries will be sized dependant on the building footprint and the soil stratigraphy of the lot. Each lot level gallery will be equipped with a grit sump upstream of the gallery and an overflow connected directly to the municipal sewer. Catchbasins will also be connected to infiltration galleries via underflow piping. The catchbasin will serve as a grit sump, adding longevity to the infiltration gallery and the overflow will be connected to the municipal sewer. **Figure 3** overleaf, shows a typical catchbasin infiltration gallery. Lot level and catchbasin infiltration galleries will filter sediment and hydrocarbons from runoff, introduce additional infiltration and provide additional storage volume for larger, less frequent events.

Infiltration galleries have been modeled with an estimated saturated hydraulic conductivity for the site of 40 mm/hr, an average base area of 30 m^2 per hectare and an average effective storage area of 10 m^3/hectare. The galleries will be filled with drain rock (porosity approximately equal to 0.4) and lined with filter fabric. A longevity factor of 0.75 was used in this analysis to account for plugging of pore spaces and degradation over time. To ensure long term function, each gallery will be situated downstream of a grit sump manhole or catchbasin.

5.4. Wetland Attenuation

Per the Village's Stormwater Drainage Master Plan, wetlands within the subject property, as well as the larger Maple Creek and Perseverance Creek water sheds will form an integral part of managing runoff from this site. Minimal overburden atop shallow bedrock, characteristic of the upland areas of this site make for limited storage potential, or onsite capture/retention of runoff. Wetland storage, as was used for previous phases of development, will continue to be used to attenuate peak volume and discharge in excess of that which can be retained onsite through the implementation of the above noted LIDs. Wetland attenuation has not been modeled at this time. The vast capacity of the downstream wetlands is estimated to be immensely greater than the slight increase in runoff due to the proposed Low Impact Development strategies to be implemented for this development.

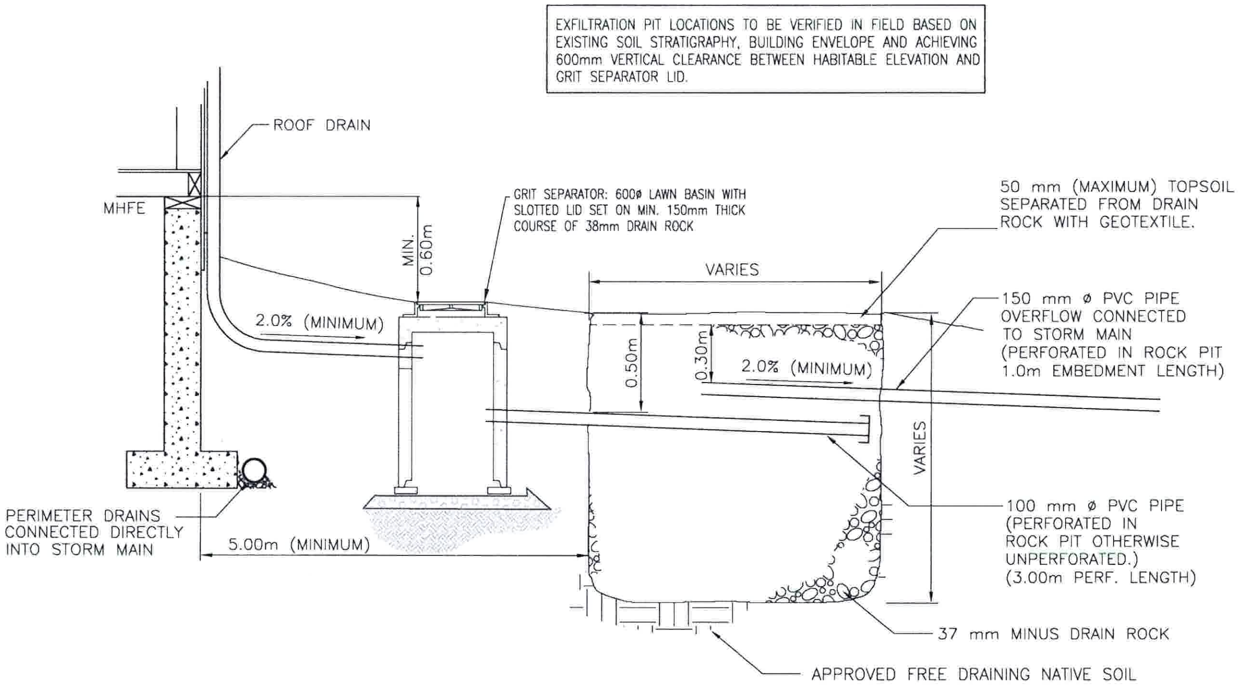

Figure 2: Typical Lot Level Infiltration Gallery

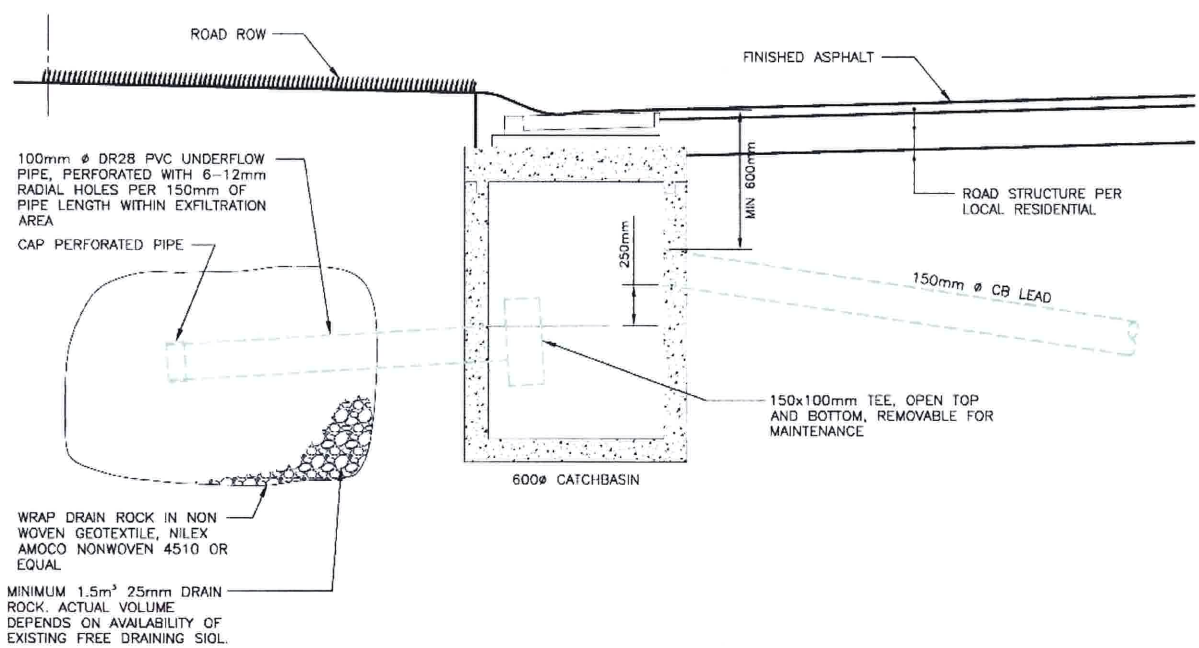

Figure 3: Typical Catchbasin Infiltration Gallery

6.0 QUALITY

Removal of Total Suspended Solids (TSS) will be achieved by catchbasin sumps and grit sumps upstream of all infiltration galleries. Groundwater recharge through infiltration galleries will serve to further improve/polish this surface runoff prior to release into the Village's downstream stormwater infrastructure and wetlands.

7.0 POST-DEVELOPMENT RUNOFF

A 1.0 hectare post-development sample site was modeled using SWMM software. Simulations for both mitigated and non-mitigated site response were completed for the MAR and synthetic, 24-hour SCS Type 1A distribution 2, 5, and 10 Year rainfall events (derived from 32 years of data from Environment Canada's Puntledge rain gauge (1021990)). Model input parameters derived are summarized in **Table 4** overleaf. The post development mitigated model includes the LIDs design elements described above. Results of the modeled site response are indicated in **Figures 4 to 7** double overleaf.

Table 4: Site-Specific Storm Water Management Parameters for a 1 hectare sample area

Parameter	Existing	Post-Development	Post-Development Mitigated
Area (ha)	1.0	1.0	1.0
Width (m)	50	280	280
Slope (%)	12	5	5
% Impervious	15	60	60
N Imperv	0.013	0.013	0.013
N Perv	0.2	0.15	0.15
Dstore Imperv (mm)	2	2	2
Dstore Perv (mm)	7	5	12
Zero % imperv	25	25	25
Curve #	70	90	80
Drying time (days)	7	7	7
Subarea routing	PERV	OUTLET	IMPERVIOUS

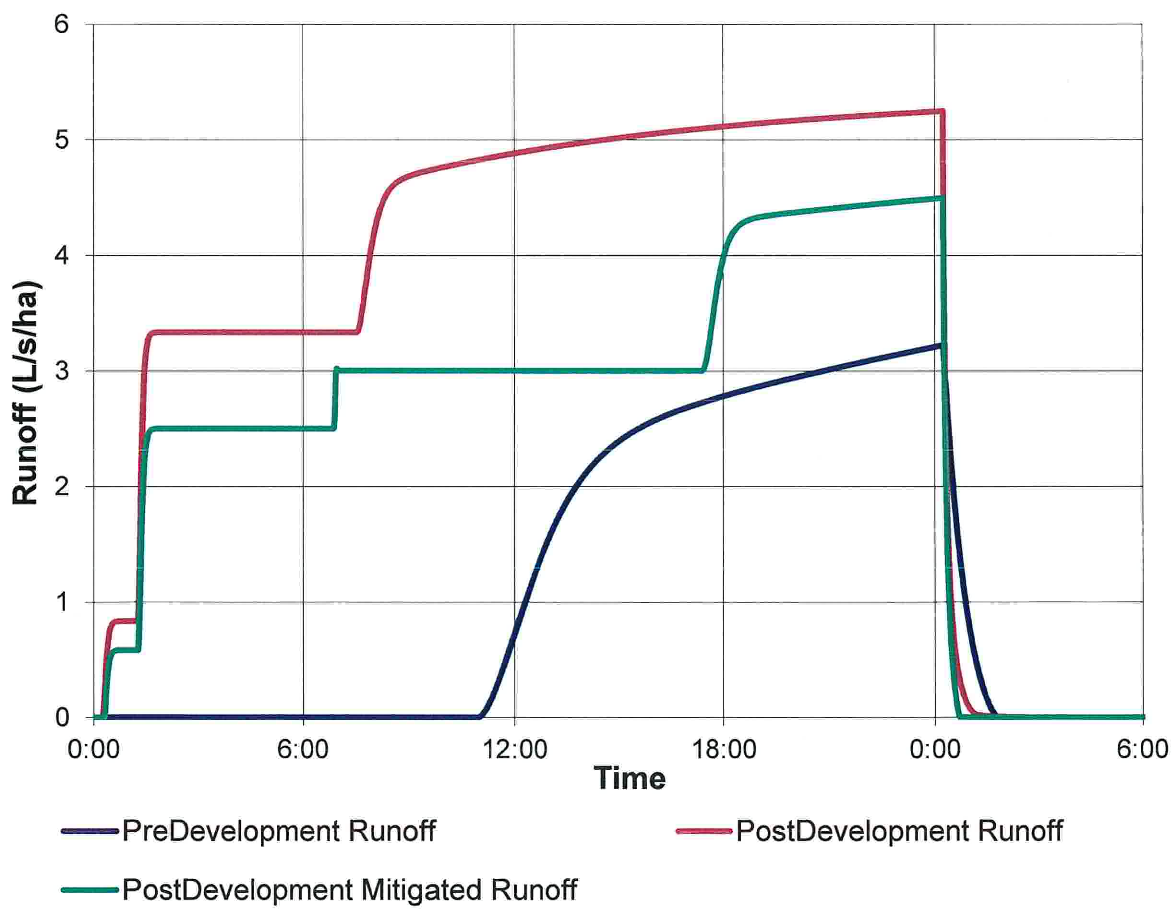

Figure 4 – LID Performance: MAR Event

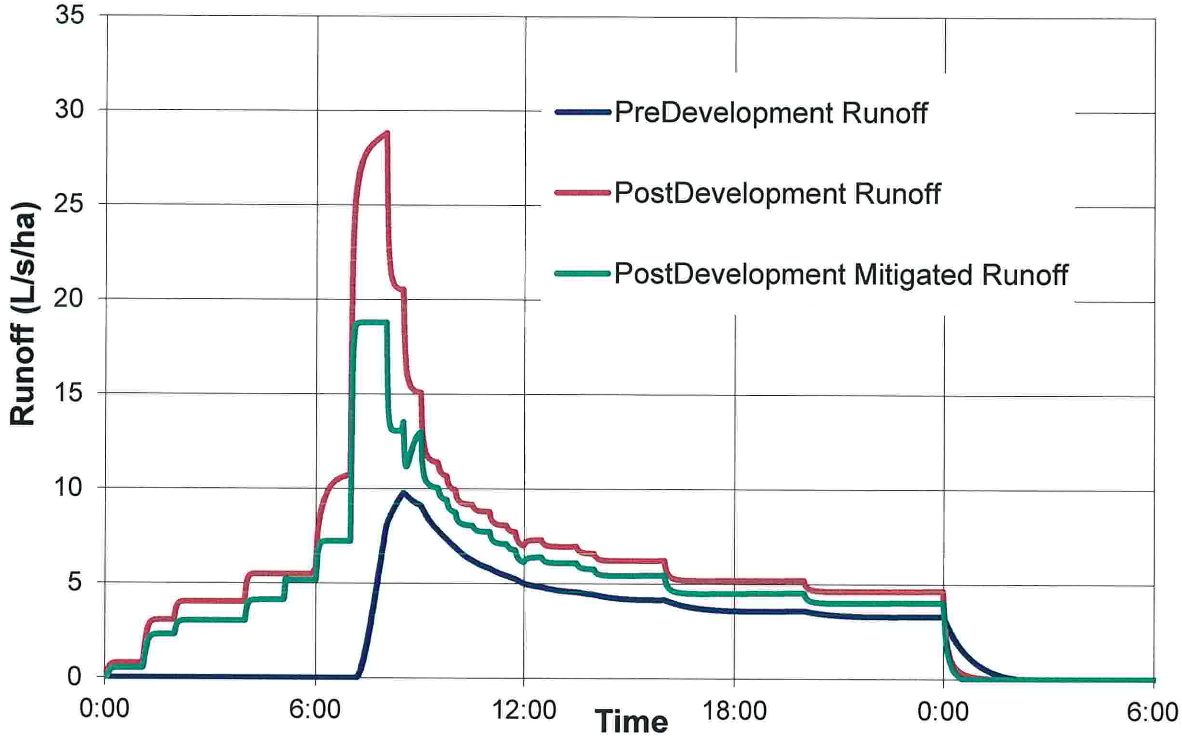

Figure 5 – LID Performance: 2YR Event

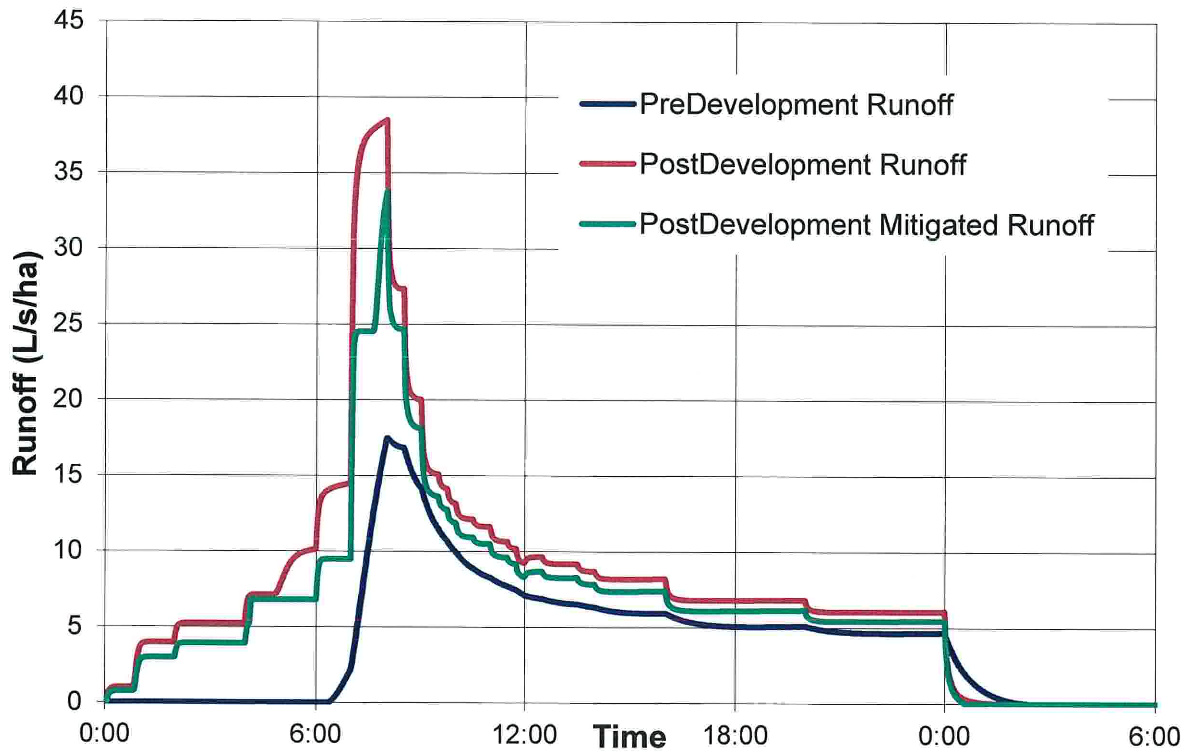

Figure 6 – LID Performance: 5YR Event

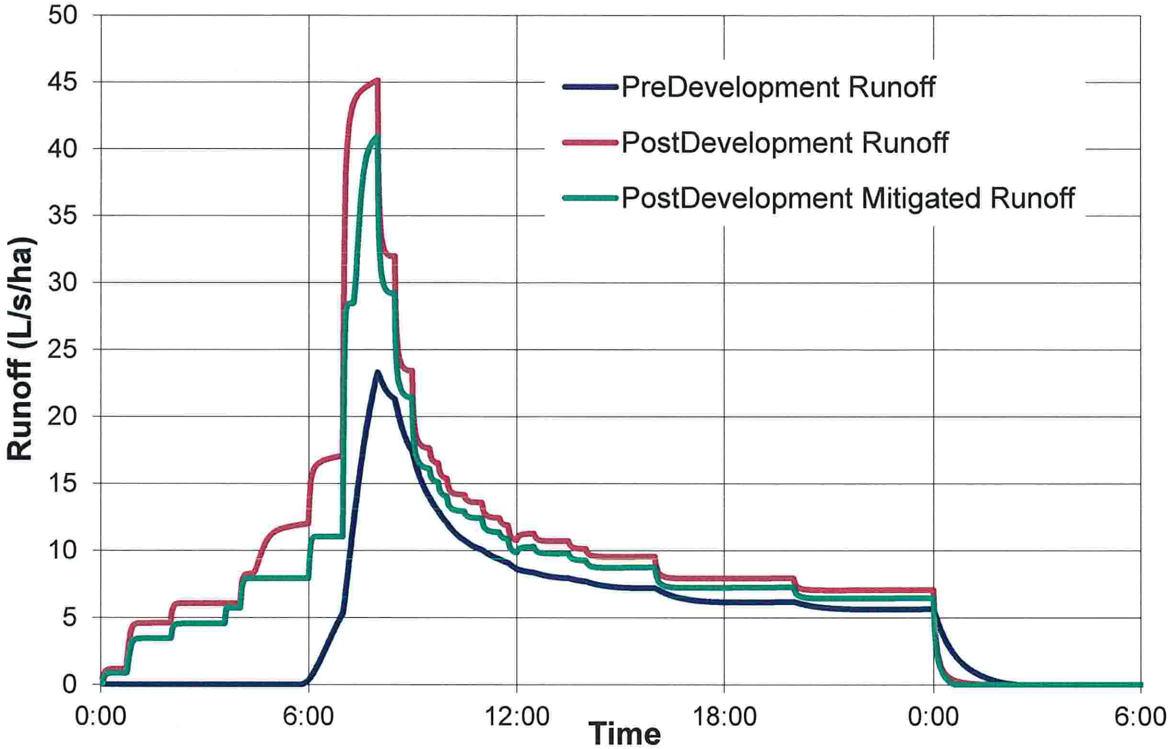

Figure 7 – LID Performance: 10YR Event

Table 5 below, compares pre- and post-development simulated runoff quantities for the site on a per hectare basis. The analyses show that with the use of LIDs as proposed herein, post-development runoff can be infiltrated, evapotranspirated, detained and released at a reduced rate. Peak runoff in excess of pre-developed rates as well as increased post development runoff volume, will be attenuated by the downstream wetlands.

Runoff upto and including the 10 year peak flow will be conveyed by the minor system to the existing downstream Village infrastructure. Flows in excess of the 10 year peak will be conveyed via existing and proposed overland flood routing.

Table 5: Pre- and Post-Development Runoff Quantities per Hectare of Land

24-Hour Distribution	**Total Precipitation (mm)**	**Existing**		**Post-Development (No LID)**		**Post-Development (With LID)**	
		Total (m^3/ha)	Peak (lps/ha)	Total (m^3/ha)	Peak (lps/ha)	Total (m^3/ha)	Peak (lps/ha)
MAR	48	120	3.2	380	5.3	270	4.5
2-Year	73	285	9.8	620	28.8	500	18.8
5-Year	95	445	17.5	830	38.5	700	33.8
10-Year	110	560	23.3	980	45.1	840	41.0

8.0 MAINTENANCE

The LID system will require regular maintenance. It is recommended that runoff is directed around infiltration galleries during civil and residential construction to avoid being clogged with silt laden runoff. Additionally, all private and municipal catchbasin sumps should be checked every six months for sediment/debris build-up and cleaned accordingly. This maintenance should be schedule just before and just after the rainy season (September and April).

9.0 CONCLUSION

The proposed stormwater management system for Coal Valley Estates utilizes site specific Low Impact Development (LID) strategies including amended soil in all landscaped areas to reduce runoff, sumps to reduce Total Suspended Solids (TSS) and pollutant loading, and subsurface infiltration galleries to control peak runoff rates and runoff volumes. Performance targets have been set based on the water balance model and site constraints. Low Impact Development techniques have been sized on a per hectare basis. This will allow for a phased development approach of the 40 hectare parcel allowing the LIDs for each phase to be sized based on the recommendations of this report.

We conclude that all stormwater management goals for the site can be met through the use of the LIDs described in this document.

We trust this document is as required at this time. Should you wish to discuss the contents, please do not hesitate to contact the undersigned.

We certify this to be a report prepared by:

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Enclosures

CD/njg