Contents

Figures

Tables

1. Introduction

The Regional District of Nanaimo requested that an Integrated Stormwater Management Plan be completed for the Fairwinds' The Lakes District and Schooner Cove area. An ISMP is a process of investigating stormwater issues in a holistic approach at the watershed scale. The subject area is located on the east coast of Vancouver Island north of Nanaimo, as shown on Figure 1. There are two distinct study areas:

Fairwinds Lake District Neighbourhood - 286 ha with a proposed maximum of 1675 single dwelling and multi-dwelling units, and

Schooner Cove Neighbourhood – 11 ha with a proposed 360 multi-family units oriented around a commercial village with 2,325 m^2 of commercial space with a marina and neighbourhood support services.

Mention environmental values

1.1 Background

Brief description of history to get to ISMP

Background Information

The available background reports are summarized in the following table.

Table 1: Background Reports

	Date	Report Title/Author
Engineering	July 2012	The Lakes District & Schooner Cove Integrated Stormwater Management Plan – KWL
	July 2012	Fairwinds Lakes District & Schooner Cove Rainwater Management Standards – KWL, Rev A,
	Feb 2011	The Lakes District Neighbourhood Plan, Section 4.3.3 Master Rainwater Concept – Ekistics
	Feb 2011	Schooner Cove Neighbourhood Plan, Section 4.3.3. Master Stormwater Concept – Ekistics
	Jun 2008	Preliminary Geotechnical Terrain Assessment for Proposed Subdivision Fairwinds Neighbourhood 2, Nanoose Bay, B.C. – Trow
Land Use Planning	Jun 2013	The Lakes District Regional Park Masterplan & Development Guidelines, Ekistics
	July 2012	Fairwinds Resort Community Project Specific Street Standards – Ekistics,
	Feb 2011	The Lakes District Neighbourhood Plan, Ekistics
	Dec 2010	The Lakes District Neighbourhood Plan Background Summary, Ekistics
		The Lakes District Infrastructure Phasing & Land Use Phasing Plan – Ekistics, date unknown

	Date	Report Title/Author
		Schooner Cove Infrastructure Phasing & Land Use Phasing Plan – Ekistics, date unknown
Environmental	July 2013	Terms of Reference, Enos Lake Protection and Monitoring Program – Pottinger Gaherty Environmental
	Feb 2010	Environmental Impact Assessment – Pottinger Gaherty Environmental
	Feb 2009	Detailed Biophysical Assessment – Cascadia Biological Services,
	July 2007	Recovery Strategy for Paxton Lake, Enos Lake, and Varanda Creek Stickleback Species Pairs in Canada, DFO

1.2 ISMP Vision, Goals, and Objectives

The vision for *The Lakes District Neighbourhood Plan* is to sensitively integrate growth through principles of sustainability and community design. The plan provides for diverse housing forms structured around a network of regionally significant parks. It reconciles land use, environmental, servicing, transportation and economic considerations in a manner that respects the local community values. The character of the community is defined by the relationship between the built form and the surrounding landscape.

ISMP Goals, Objectives

The goal of the ISMP is to strive to maintain the existing ecological health of the aquatic resources (watercourses, wetlands, lakes and ocean) that is strongly valued.

The objectives of the study are:

- Safeguard human life and property from flood and erosion damage. Maintain public safety;
- Preserve watershed ecological health while allowing development to proceed;
- Employ green infrastructure by utilizing innovative best practices for rainwater and stormwater management, where applicable.
- Conserve ecological integrity by protecting both significant and sensitive aquatic species and habitats.
- Develop cost effective solutions (capital, operation, and maintenance) to facilitate orderly land development.

The ISMP must be approved by the Regional District of Nanaimo.

1.3 Stormwater, Drainage & Environmental Protection Criteria

Governing guidelines and criteria are based on the following:

- Stormwater Planning, A Guidebook for B.C., MOE, May 2002
- RDN criteria/guidelines
- MOTI

- Any environmental regulatory agencies involved?

Applicable criteria are summarized as follows:

Table 2: Summary of Stormwater Criteria

Application		Criteria/Methodology
Flood & Erosion Protection	Minor Drainage System	10-year return period design event. [1] Detention of 5-year post development flows to pre development levels. [2]
	Major Drainage System	100-year return period design event. [1]
Environmental Protection	**Volume Reduction** Source Controls	On-site rainfall capture (runoff volume reduction) for 6-month 24-hour storm (72% of the 2-year 24-hour storm). [3]
	Water Quality Treatment	Remove 80% of Total Suspended Solid based on 50 µm particle size from 6-month 24-hour storm (72% of the 2-year 24-hour storm). [3] Limit construction discharge water quality to the lesser of turbidity of 25 NTU or total suspended solids of 25 mg/L at all times expect in the 24 hour period following significant rainfall events (≥25 mm/day) at which time the turbidity can be up to 100 NTU. [4]
	Rate Control Detention / Diversion	Detain post-development flows in creeks to pre-development levels for 6-month, and 2-year 24-hour event. [3]
	Riparian	Establish riparian setbacks to comply with City requirements. [1]

1. City of Abbotsford Development Bylaw No. 1565, 2006 and Streamside Protection Bylaw No. 1465-2005.
2. MOTI
3. DFO Urban Stormwater Guidelines and BMPs for the Protection of Fish and Fish Habitat, 2001.
4. Land Development Guidelines for the Protection of Aquatic Habitat, Fisheries and Oceans Canada, September 1993.

WQ treatment b/c regulatory requirement to ocean, community values water bodies, environmental protection… *provincial water quality standards for the protection of aquatic life*

- If possible, maintain the existing peak flow rates in the existing watercourses;
- If existing peak flow rates cannot be maintained, the existing conveyance structures should be checked for hydraulic capacity;
- If the post development hydraulic capacity of the existing conveyance structures is exceeded, the downstream system should be upgraded;
- For the watercourse downstream of Enos Lake, if the post-development peak flow rates increase then the existing erosion sites should be protected and rehabilitated to prevent further erosion; and
- Rainfall intensities from the Victoria International Airport shall be used for sizing.

The above criteria was used to size and design the stormwater conveyance system.

1.4 Stakeholder Consultation Program

An extensive stakeholder consultation process is currently underway through the Neighbourhood Planning process starting in 2008 to present. Stakeholders include the following:

- Regional District of Nanaimo staff
- Community Advisory Group including:
  - Fairwinds Community Association;
  - Nanoose Naturalists;
  - Schooner Cove Yacht Club;
  - Fairwinds Golf Society;
  - Nanoose Property Owners & Residents Association;
  - North West Nanoose Residents Association;
  - Nanoose First Nation;
  - Nanaimo First Nation;
  - Regional District of Nanaimo Planning Department and Recreation & Parks Department; and,
  - Members at Large.
- First Nations – Snuneymuxw (Nanaimo) and Snaw-Naw-As (Nanoose);
- Technical Advisory Commitee including:
  - Regional District of Nanaimo - Planning, Recreation & Parks, Engineering,
  - British Columbia Ministry of Transportation and Infrastructure;
  - British Columbia Ministry of Environment; and,
  - Canadian Department of Fisheries and Oceans.

There have been three Public Open Houses, two Public Design Workshops, regular meetings with the Community Advisory Group, Technical Advisory Committee and RDN Staff, as well as ongoing consultation with the local community.

The community strongly values natural setting of the area and would like a high standard of environmental protection.

1.5 Project Team

This project was undertaken primarily by KWL with input from an inter-disciplinary team of professionals. The members and companies involved are outlined as follows:

Table 3: Project Team

Firm	Team Members
Bentall Kennedy	Russell Tibbles, VP, Development & Operations, Fairwinds
Kerr Wood Leidal Associates	Crystal Campbell, Project Manager David Zabil, Project Engineer Rob Warren, Client Manager Craig Sutherland, Water Resources Engineer Jack Lau, GIS Specialist

Firm	Team Members
Ekistics	Paul Fenske, Senior Planner Jeanette Elmore, Planner
Pottinger Gaherty Environmental Consultants Ltd.	Susan Wilkins, Senior Biologist Matt Hammond, Project Biologist
Trow	Jim O'Brien, P.Eng., Senior Geotechnical Engineer

Special thanks are also extended to Regional District of Nanaimo staff, _____.

2. Study Area Overview

The study area is defined in two distinct areas:

- Fairwinds Lake District Neighbourhood - 286 ha
- Schooner Cove Neighbourhood – 11 ha

2.1 Topography and Soils

The topography is varied with hillsides, benches, terraces, lakes and lowlands. Figure 2-1 shows areas of gentle terrain (0 – 20% slopes, hillsides (20 – 40% slopes) and steep slopes (>40%).

Soils

The surficial geology consists of upland soils compromised of glacial till soils, often with distinct lower layers that are a mixture of sand and crushed rock (from glaciation). Soil depth is generally thin veneers overlying bedrock with deeper deposits in the valleys, ravines and low lying areas (wetlands). Thick granular deposits were noted near the southwest shore of Enos Lake. Numerous bedrock outcrops were observed. Identified geotechnical hazards associated with potential slope stability and rockfall shall be mitigated at time of subdivision as per the recommendations of the *Preliminary Geotechnical Terrain Assessment.*[1]

2.2 Land Use

Existing land use within The Lakes District is mostly undeveloped and forested with some roads and institutional. Schooner Cove …

The Neighbourhood Plans propose the following land uses:

Table 4: Proposed Land Uses

Land Use	Area (ha)	% of Area
The Lakes District		
Regional Park	118.6	41.5%
Single Dwelling	68.2	23.9%
Single Dwelling & Duplex	46.4	16.2%
Road Right-of-Way	27.0	9.4%
Future Development Reserve	11.0	3.1%
Multiple Dwelling	7.7	2.7%
Community Park	2.7	0.6%
Community Mixed Use	1.9	0.3%

[1] Summarized from *The Lakes District Neighbourhood Plan Background Summary, 2010* prepared by Ekistics and *Preliminary Geotechnical Terrain Assessment for Proposed Subdivision, Fairwinds Neighbourhood 2, Nanoose Bay, B.C., 2008* prepared by Trow Associates.

Land Use	Area (ha)	% of Area
Civic Infrastructure	1.4	0.3%
Lakehouse Community Mixed Use	1.9	0.3%
Schooner Cove		

Refer to Figure 2-3.

2.3 Existing Drainage

The Lakes District

There are a number of existing water bodies within the study area or where the study area drains:

- Enos Lake and Dolphin Lake
- 10 watercourses
- Nine wetland/ponds

Refer to Figure 2-2. The coastal areas drain to Bluefin Bay and Schooner Cove within Georgia Strait.

Runoff from the proposed Lakes District development drains to three different watercourses. The majority of the development drains to the Enos Lake and downstream watercourse system. A smaller portion of the development drains to the Dolphin Lake and downstream watercourse system. Finally a small and steep ephemeral creek drains the NW portion of the Lakes District.

The Schooner Cove development is situated over three distinct watersheds. Two of the watersheds are situated directly on the shoreline and rainwater will drain directly to the marine environment. The most southern system will convey water southeast toward an existing storm drain system which then to the marine environment.

Enos Lake

The existing outlets for both Enos Lake and Dolphin Lake and the wetland north of Enos Lake have been modified through the installation of weir structures to control water levels. As a result of these weir structures, and the large size of storage area relative to their catchment areas, these lakes provide significant attenuation and reduction in downstream peak flow rates. There are existing water licences for storage and irrigation of the Fairwinds Golf Course from each of these lakes. Changes in water levels, as a result of the development are not expected to negatively impact either of these already modified facilities.

Enos Creek

Enos Creek drains a wetland with an existing beaver dam on the downstream end which in turn drains Enos Lake. The Watercourse downstream of the beaver dam shows signs of erosion and a waterfall

poses a barrier to fish passage. The erosion means that current flows are causing damage and increases in peak flows should be avoided.

Watercourse Downstream of Dolphin Lake

The watercourse downstream of Dolphin Lake is comprised of a highly modified creek with detention ponds through the Fairwinds Golf Course and a storm drain outfall to the marine environment.

Schooner Cove

The Schooner Cove area drains to Georgia Strait. The area is divided into three catchments (North, South, and East). The Northern and Eastern Catchments will drain directly to the ocean and the erosion impact, if any, is extremely limited and is not a concern. The Southern Catchment drains through an existing culvert and onto a beach and then the ocean. The culvert capacity will need to be checked for capacity during detailed design and if peak flows exceed its capacity then storage within the Southern Catchment will be required. Erosion is currently prevalent on the channel between the end of the culvert and the head of the beach and will be addressed during detailed design through a diffusion trench that limits current and future erosion.

As noted above two of the three catchments within Schooner Cove will discharge directly to the ocean and Erosion is not a concern and therefore no quantity modelling has been performed.

The existing stormwater system to the south of the proposed Schooner Cove development should be checked during detailed design for hydraulic capacity. If it does not have adequate capacity stormwater detention or upgrades to that system may be required. This will be addressed during detailed design. Existing erosion is present at the discharge point of the culvert exiting onto the beach at Dolphin Bay Road. A detailed design for erosion protection should be completed during the detailed design noted above.

Existing Drainage Problems

Existing Erosion Sites

E

2.4 Environmental Values

The Lakes District is home to a number of high-value environmental features including steep hillsides, environmentally sensitive forest areas and wetlands providing unique habitat for waterfowl, wildlife and other fauna. The key environmental findings are shown on Figure _.

Vegetation and Habitat Zones

The study areas lie within the Moist Maritime subzone of the Coastal Douglas Fir zone, which occurs along a small portion of south-eastern Vancouver Island, several islands in the Georgia Strait and a narrow strip of mainland British Columbia. It is characterized by warm, dry summers and mild, wet winters. Forests are dominated by Douglas-fir, and are accompanied frequently by western red cedar, grand fir, arbutus, Garry oak and red alder.

Understory species include salal, dull Oregon-grape, ocean-spray, bracken fern, sword fern, trailing blackberry, western trumpet honeysuckle and Oregon beaked moss.

The Neighbourhood Plan identifies seven Garry oak ecosystem polygons, with total extents of approximately 15 hectares (37 acres). Within the local context of Nanaimo/Nanoose, this area represents approximately 5% of the remaining coverage of this ecosystem type. The area lies within the northernmost tip of the native range of Garry oak, which extends from Vancouver Island to southern California. This sensitive habitat hosts a mix of vegetation consisting primarily of Garry oak and Arbutus, ocean-spray and common camas, along with a dense layer of rock moss and lichens. The Garry oak ecosystem provides habitat for a wide variety of wildflowers and grasses.[2]

Riparian Forest Cover

Riparian areas, surrounding watercourses, lakes and wetlands, are largely intact and consist of red alder, big-leaf maple, douglas fir, and many other riparian ecosystem plants. Figure _ shows 30 m setbacks.

Aquatic Resources

The waterbodies and watercourses within the study area include:

- Enos Lake and Dolphin Lake
- 9 watercourses labelled S1 to S9 on Figure _.
    - Two primary (>3rd order) watercourses – S1 Enos Creek and S9 Dolphin Creek
    - Seven smaller 1st order watercourses S2 to S8.

  All the watercourses have scour and mineral alluvium and the meet the minimum length of 100m continuous channel. [3]
- Nine wetlands.

Aquatic Species & Habitat

There are Stickleback in Enos Lake and Enos Creek. All the other watercourses are considered non-fish bearing as a result of the steep topography and numerous fish barriers. Although watercourses S3 to S8, draining into Enos Lake, are considered fish stream habitat. Dolphin Lake is much shallower and smaller than Enos Lake and has lower habitat values.

Stickleback in Enos Lake and Enos Creek

Enos Lake is habitat for a unique and at risk species of small fish, the Stickleback Species Pairs and or a hybridized version of the pairs which presumably require similar conditions to the original. The current situation and recovery strategy is described in the Species at Risk Act (SARA) report[4]. This report states that the Enos lake species pair has collapsed into a single hybrid swarm. Regardless, one of the

[2] The Lakes District Neighbourhood Plan Background Summary, Ekistics, December 2010.

[3] Detailed Biophysical Assessment, Cascadia Biological Services, February 2009

[4] Recovery Strategy for Paxton Lake, Enos Lake, and Varanda Creek Stickleback Species Pairs in Canada, Fisheries and Oceans Canada, July 2007.

long-term goals is to, "*establish or recover a viable population of the Enos Lake species pair, preferably in Enos Lake*".

Wildlife

Typical of the rural, forested landscapes of Nanoose Peninsula, terrestrial wildlife habitat in the Lakes District Neighbourhood Plan area is largely defined by second-growth forest, wetlands and lakes, and a variety of large mammals (including cougar and black-tailed deer), small mammals (including raccoon, beaver, river otter, grey and red squirrels), bird species (including bald eagle and red-tailed hawk), reptiles (including lizards and snakes) and amphibians (including frogs and newts).[5]

[5] The Lakes District Neighbourhood Plan Background Summary, Ekistics, December 2010.

3. Stormwater Management

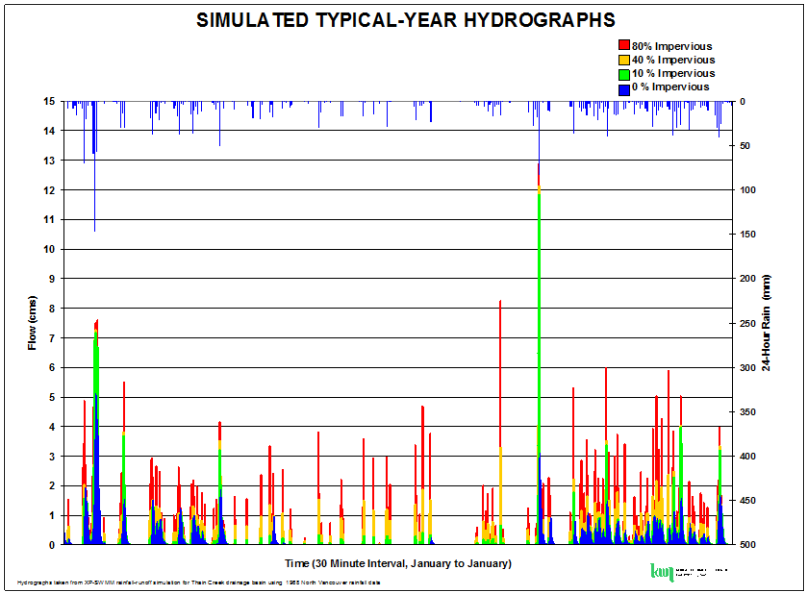
3.1 Impacts of Proposed Development

Typical Stormwater Impacts of Land Development

Land development typically involves replacing pervious forested area with impervious pavement, concrete and building structures. Redevelopment typically involves replacing developed areas with higher density land use with a further increase in total impervious area. Increasing impervious area results in two types of impacts:

- **Stormwater Quantity Impacts:** Increased and faster responding peak flow rates. During extreme rainfall-runoff events this can cause flooding and erosion, and during typical rainfall events this can cause watercourse erosion and instability and deteriorate aquatic habitat. There is less infiltration into the ground which can decrease baseflows during dry weather periods and therefore reduce the fish support capacity of a watercourse.
- **Stormwater Quality Impacts:** Land development and building construction activities result in sedimentation of watercourses. It has been found that urbanization over 30% TIA also results in non-point source (NPS) pollution of receiving waters and poor stream water quality. Together, sediment and contaminants can significantly degrade the fisheries value of a creek system.

Prior to land development, minor rainfall events do not yield surface runoff. However, because of increased impermeable area, surface runoff from these minor storms is produced after land development. This is clearly shown in the typical-year hydrograph for various levels of development.



Simulated Typical-Event Hydrograph for Levels of Imperviousness

Research has shown that urban development, which typically increases impervious area and decreases riparian corridor, significantly impacts the abundance and diversity of fish populations and benthic macroinvertebrate communities.

Potential Impacts with Fairwinds Development

The potential impacts associated with the Fairwinds Development are outlined as follows, together with the need for and suggested mitigation measures.

Table 5: Potential Stormwater Impacts with Fairwinds Development

Impact	Relevancy	Recommend Mitigation Measures
The Lakes District		
Increased runoff peak flows & volumes	➔ For extreme events. ➔ Need for safe flood conveyance system through proposed development area & downstream drainage areas	Site grading, Minor drainage system - storm sewers, culverts, ditches Major drainage system – overland flow on roadways, culverts,
	➔ For frequently occurring events. ➔ Mitigate impacts for area draining to erodible watercourses	Need volume reduction and detention measures – bioretention facilities, detention/diversion facilities.
	➔ Minimal impact to wetland water levels and erodibility	N/A
	➔ Minimal impact to lake water levels – see Sub-section 3.2	N/A
Decreased runoff water quality	➔ Need water quality treatment facilities prior to discharge to sensitive water bodies – Georgia Strait, Eno Lake, Dolphin Lake, wetlands	Roadside bioswales, regional biofiltration facilities or wetlands.
Decreased groundwater recharge & creek baseflows	➔ N/A because underlying bedrock and existing creeks are empheral.	N/A
Schooner Cove		
Increased runoff peak flows & volumes	➔ Need for safe flood conveyance system through proposed development area	Site grading, storm sewer /swales
	➔ Need to mitigate erosion	Storm outfall erosion protection
	➔ No impact to Georgia Strait water levels, no watercourses.	No detention required.
Decreased runoff water quality	➔ Need water quality treatment facilities prior to discharge to sensitive waterbodies – Georgia Strait	

Impact	Relevancy	Recommend Mitigation Measures
Decreased groundwater recharge & creek baseflows	➔ N/A because so close to shoreline.	N/A

3.2 Drainage System - Provide Safe Conveyance of Flood Flows

The proposed drainage system is shown in Figure _ consisting of:

- Site/Lot grading that drains lots toward road/municipal ROWs
- Storm Sewers/swales
- Outfalls

3.3 Impact to Lake & Wetlands

3.4 Impact to Downstream Drainage System

3.5 Stormwater Conservation Measures

Riparian Areas

Maintaining watershed health requires the preservation and conservation of riparian areas.

Land Use Recommendations

None of the hydrographs showed significant increases between pre and post development. The possible exception would be flows in Creek S2. This creek is very steep and ephemeral and does not provide any fish habitat. An erosion review at detail design stage is warranted but storage and or a change in land zoning does not appear to be warranted.

The Neighbourhood Plans propose over 40% of the Lakes District as parkland and the thin soils with underlying rock mean that the runoff regimes between pre and post development are very similar. Thus the land use proposed does not need to change in order to minimize impact. The proposed lot layout presents more compact development with larger green space than has been previously constructed at Fairwinds and this presents a better water quality regime for the water bodies concerned.

3.6 Stormwater Mitigation Measures to Maintain Watershed Health

Volume Reduction and Rate Control Measures to Minimize Creek Erosion

Water Quality Treatment Measures to Protect Wetland/Lake/Ocean Water Quality

Water Quality

Of the various stormwater receiving environments, Enos Lake is considered the most sensitive. The SARA report states that, "*As a group, sticklebacks are tolerant of a fairly large range of water quality conditions. The current provincial water quality standards for the protection of aquatic life are appropriate guidelines for basic parameters of water quality in lakes with stickleback species pairs. However, some aspects of water quality in species pair lakes need to be maintained in a much narrower range than that required for short-term individual survival, as described below.*" The report continues and identifies the following water quality aspects:

- Light Transmission – suspended solids, dissolved organic carbon, others affecting light transmission;
- Nutrients – nitrogen, phosphorus, total alkalinity;
- Extent of Littoral Habitat; and
- Extent of Macrophyte Beds.

Based on the above, the physical works associated with the proposed development from a water quality criteria will focus on the light transmission aspects. The criteria for stormwater quality shall be the removal of 80% of total suspended solids (TSS) with the secondary benefits such a system will provide. This is a widely used design criteria including in the LEED® *Stormwater Management: Treatment Credit and the King County Surface Water Design Manual*.

The other key water quality aspects will be handled though a regulatory and management perspective as follows:

- The nutrient levels in the Lake should be monitored and the use of fertilizers within the watershed may have to be controlled or eliminated.
- The littoral habitat and macrophyte beds shall be protected by limiting access points to the lake and protecting those areas which are the most productive for the Stickleback. There are reports that the current state of macrophyte beds have been adversely impacted by the presence of non native crayfish.

Schooner Cove

Schooner Cove will drain to the ocean which is a less sensitive receiving environment than Enos Lake. Due to the compact site the treatment standard chosen is 'equivalent to Total Suspended Solids (TSS) and Oil removal that would be expected from a Stormceptor or equivalent'. This standard is lower than what would be expected of a raingarden but will still remove 80% of TSS and a similar percentage of oils. The developer could choose to use a less expensive and more efficient raingarden should the land be available for this. The Stormceptor (or equivalent) is underground and is typically placed under a parking lot.

Other Creeks

There are watercourses entering the west side of Enos Lake which although non fish bearing do provide habitat to fish and should be protected. All creeks are depicted on Figure 1-1. The largest of these watercourses is referred to as S 6 (Refer to Figure 1). We have run the hydrologic model for the natural and post-development scenarios. This analysis indicates that the natural and post development 2-year flows (critical erosion event) are both 0.04 m^3/s. In other words there is no increase in peak flows from development. The proposed development accounts for less than 25% of the creek watershed and the attenuation provided by the existing wetland have attenuated flows. Another factor is the location of the creek in the watershed. Since it is very close to the outlet the peak runoff from this section does not coincide with the peak runoff from areas far upstream. This wetland is primarily created by the beaver dam across the outlet. Future protection for this creek will require stabilization of the beaver dam and will require water quality controls on stormwater for lands in the catchment due west of Fairwinds.

Creek S2 just west of Enos Creek is a very steep (average gradient 11%) ephemeral creek. It is rated as a 1st Order Stream which is the smallest classification used. This creek does not provide any habitat for fish. Peak flows in this creek are expected to increase and detention should be considered as an erosion mitigation measure should this be required. A study of the susceptibility toward erosion on this creek should be undertaken during detailed design. At that time the capacity of the culvert under Dolphin Drive will be considered as well.

There are beaver dams at several locations throughout the development site. These include downstream of the two wetlands above creeks S3 and S6, and above Enos Creek (S1). We understand that this latter beaver dam downstream has failed previously and it resulted in flooding of a property downstream on Cormorant Crescent. Construction of berms behind these dams is required to protect property in the case of Enos Creek and for habitat protection for all of them. A failure in the beaver dam could lead to serious erosive degradation of these creeks and property damage for Enos Creek.

WQ, modelling to size?

Figure 7: Proposed Drainage System

Figure 8: Impact to Downstream Drainage

Figure 9: Proposed Stormwater Management Environmental Protection Measures

4. Integrated Stormwater Management Plan

4.1 Introduction

4.2 The ISMP Plan

Safe Drainage

Stormwater Quantity

1. Modify the existing outlet structures from Enos Lake and Dolphin Lakes as described in Section 4. These structures and the storage in these lakes provide a significant peak flow attenuation benefit for controlling post development peak flow rates. With the modifications outlined, the post development flows are slightly reduced from the natural catchment scenario peak flows. Where feasible excess stormwater should be directed to these lakes to the extent possible.
2. A secondary berm structure be built downstream of the wetlands on Creeks S1 (Enos Creek) , S3, and S6 (Cedar Creek). (See Figure 1-1 for locations). These berm structures must be able to withhold water to approximately the current beaver dam water level and have a low flow outlet.
3. The existing erosion sites between Dolphin Drive and the ocean outfall will be rehabilitated. The existing culverts under Swallow Crescent and Dolphin Drive will be checked to confirm that they can safely convey the 200-year storm event.
4. The existing stormwater system south of Schooner Cove be checked for hydraulic capacity and if inadequate, stormwater detention be provided or that system will be upgraded.

Stormwater Quality Measures

5. The existing constructed wet ponds immediately south of Enos Lake will be utilized for treatment of adjacent areas as outlined on Figure 1-1.
6. New constructed wetlands sized to hold the six month events, as shown on Figure 1-1 will be constructed adjacent and connected to Dolphin Lake and also just upstream on its tributary wetland and the outlet wetland above Enos Creek.
7. New ‘rainwater creeks’ as shown on Figure 1-1, be constructed to convey and aerate water into waterbodies.
8. Post Construction nutrient levels in Enos Lake will be monitored as part of the existing water quality monitoring program and the use of fertilizers within the watershed may have to be controlled or eliminated.
9. The littoral habitat and macrophyte beds shall be protected by limiting access points to Enos Lake and protecting those areas which are the most productive for the Stickleback.
10. Construct Sediment Control Ponds or structures as part of a Sediment Control Plan during each phase of construction. These structures should be in place until 75% of construction in each catchment is complete.

Setbacks

Environmental Protection

These areas were protected through conservation areas within the Neighbourhood Plan Enhancements

4.3 Implementation Strategy

Erosion control plan

4.4 Adaptive Management Plan

Performance Monitoring Program

Figure 10: ISMP Plan

Figure 11: Environmental Enhancement Projects

5. Recommendations

Based on the foregoing, it is recommended that:

5.1 Report Submission

Prepared by:

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Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of Bental Kennedy (Canada) LP for the Fairwinds Lakes District Stormwater Management Plan. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

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Revision History

Revision #	Date	Status	Revision	Author
1	September, 2013	Draft		C. Campbell