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Rainwater Management Plan: Ella Stream, Nott Brook, Throup Stream, and Wright Road Creek Watersheds

Final Report
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Prepared for:

District of Sooke

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Revision History

Revision #	Date	Status	Revision	Author
1	June 2011	Final Draft		CS
2	January 2012	Final	Incorporated final revisions and edits from District of Sooke	CS

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Executive Summary

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Executive Summary

The District of Sooke is located about 35 minutes west of Victoria on the rugged west coast of Vancouver Island, BC. The District of Sooke has prepared and adopted a Liquid Waste Management Plan (LWMP) which outlines overall sanitary and rainwater objectives to protect public safety and property, improve water quality, and protect aquatic and riparian habitat in the District. One of the primary rainwater recommendations of the LWMP is development of watershed scale Rainwater Management Plans (RWMP) to guide "on-the-ground" solutions to rainwater management issues at a watershed scale. All 18 watersheds in the District were reviewed as part of the LWMP study to identify priority streams for RWMP review. The highest priority watersheds identified for RWMP development were the Ella Stream, Nott Brook, Throup Stream and Wright Road Creek.

The three primary objectives of this RWMP are to:

1. Protect public safety and private property from flood damage;
2. Protect and enhance ecological health and function of the watersheds, riparian areas and watercourses; and
3. Improve water quality in watercourses and receiving waters.

The development of the RWMP was guided by the vision and goals of other District of Sooke plans including the *Official Community Plan* (OCP), the *Sooke Master Transportation Plan*, the District *Parks and Trails Master Plan*, the *Sooke Town Centre Plan*, and the LWMP. The RWMP provides a vehicle to manage the rainwater and watersheds off all these plans.

The primary tasks in the study included:

1. Review of past plans and studies and selection of relevant rainwater standards and criteria to use as targets to meet the RWMP goals;
2. Field reviews to collect both hydrotechnical and ecological data to develop a watershed inventory;
3. Development and calibration of a hydrologic/hydraulic computer model of the watersheds to estimate peak flows and impacts of future land use changes;
4. Review of current ecological health of the watershed using the Watershed Health Tracking System (WHTS) and detailed review of stream health using the Proper Functioning Condition (PFC);
5. Development and testing of hydrotechnical upgrades;
6. Development and review of rainwater Best Management Practices (BMP) examples to reduce effective impervious area and increase rainwater capture for frequent smaller events;
7. Identification of aquatic and riparian habitat enhancement opportunities and linkages with greenways and trails;
8. Preparation of RWMP strategy to meet the objectives and targets selected to meet the RWMP goals; and
9. Identification of select projects and preparation of implementation plan including linkages with other projects identified in District planning documents, budgetary costs, and funding opportunities.

The field reviews and development of hydrotechnical and ecological watershed inventories identified known flooding and erosion locations as well as aquatic and riparian habitat enhancement opportunities such as removal of invasive species, planting native riparian vegetation, improving channel complexity and improving fish passage through culverts. The results of the PFC indicate that several reaches of the watercourses in the study area are properly functioning. However, some of the reaches namely the lower reaches of Throup Road below Charters Road and Nott Brook between Maple Avenue South and West Coast Road are showing significant signs of erosion and degradation of the stream channels. Improved implementation and enforcement of rainwater BMPs and restoration of these reaches is needed to improve and protect the ecological health of the watercourses.

The results of the hydrotechnical investigation indicate that peak flows during the modelled storm design events do not increase significantly from current land use conditions to full OCP build out. Modelled flows increase up to 7.5%, 3.4%, and 1.9% for the 10-year, 25-year and 100-year return period design storms, respectively. This is due to the increase in impervious area of about 12% across the entire study area. Under both current and future land use, the major storm drains located at Guardian Village in the Nott Brook watershed and Francis Gardens in the Throup Stream watershed are adequately sized to meet the design criteria. However, the majority of the road crossing culverts modelled are undersized and do not meet the design criteria.

Three hydrotechnical upgrade scenarios for rare large storm events (1:10-year and greater) were tested including full upgrade of all culverts, detention and diversion. Based on the results of these model results, it appears that the full culvert upgrade option is the most feasible. Detaining the large storm events requires large detention areas and the cost of land acquisitions would be limiting and diversion of large storm events could have negative impacts in other watersheds. Therefore, it is recommended that road crossing culverts be upgraded as part of on-going road improvements outlined in the *Transportation Master Plan*. No detailed modelling of the foreshore area was completed as part of the project. However, drainage in this area will need to be assessed and potentially upgraded as part of the re-development outlined in the *Town Centre Plan*.

Although peak of larger events are not likely to change significantly, a review of smaller more frequent storm events (less than 1:10-year) indicates that both total volume and peak discharges would increase under proposed future land-use. Increases to smaller more frequent storm events can have a detrimental impact on stream health through increases in channel erosion. The modelling indicates that both detention and diversion may be suitable for protecting watercourses from erosion and habitat degradation as a result of increased flows during more frequent events. The primary recommendations are to upgrade the John Phillip Memorial Park pond to detain 6-month, 1:2-year and 1:5-year storm events, and construction of a diversion along Throup Road to by-pass flows around the lower section of Throup Stream. The diversion could be constructed as part of the proposed Throup Road upgrades identified in the *Transportation Master Plan*. In addition to these capital projects, implementation of rainwater source controls on new development used to capture and maintain lower intensity rainfall on-site will help mitigate impacts of development on stream health.

The WHTS was used to review the impacts of development on ecological health of the watershed. This system uses two key watershed parameters, total impervious area (TIA) and riparian forest integrity (RFI) as indices of the health of the watercourses in the watershed. The RFI is a measure of the health of the riparian corridor and is the percentage of forest cover in the riparian area based on air photo interpretation. Comparing current watershed health with future unmitigated watershed health indicates the potential impact of development on the watercourse. The WHTS shows the importance of maximizing riparian vegetation and minimizing total impervious area. In order to maintain or improve the watershed health index, the riparian areas need to be protected and enhanced through implementation and enforcement of the *Riparian Areas Regulation* (RAR) and impervious area need to be reduced through use of rainwater BMPs as part of new development or re-development. Example BMPs using known soil conditions in the watersheds and District of Sooke development standards are included in this plan to help guide future implementation of rainwater BMPs. New development should capture and retain up to the 72% of 2-year storm event equivalent to 51 mm of rainfall in 24 hours.

A number of specific capital projects including hydrotechnical upgrades as well as riparian and aquatic habitat restoration have been identified through development of this RWMP plan. The projects were selected based on goals and targets in the RWMP as well as integration with other projects identified in District of Sooke plans. Implementation of the projects has been outlined in an implementation plan which outlines the projects, linkages with other planned infrastructure projects and estimated costs. It is estimated that the total cost to implement the projects is approximately $4.3 million over the next 20 years. A monitoring plan, including annual "state of the watersheds" reports is recommended to record implementation and success of the plan as well as allow for future refinement and adjustment to incorporate future technological improvements, changes in relevant targets or other findings.

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Section 1

Introduction

1. INTRODUCTION

1.1 Background

The District of Sooke provides a gateway to the rugged west coast of Vancouver Island while only 35 minutes from the capital city of Victoria. The current population consists of approximately 10,000 people throughout the 66.65 square kilometres of the District of Sooke.

Twenty-eight significant watersheds drain into Sooke Bay, Inlet, Harbour and Basin with 16 of these watersheds within the District of Sooke boundaries. These watersheds are presently subject to a range of development pressures. Some of these watersheds are in the midst of significant urban or industrial development, while others are in relatively undisturbed rural or natural settings. However, all of these watersheds are likely to be subject to increasing urban development pressure in the near future.

Development of a Liquid Waste Management Plan (LWMP) was a condition of the provincial funding to assist with construction of the sewage collection and treatment facility. The LWMP provides a framework for managing both wastewater and rainwater. The rainwater component was prepared in three stages with Stage 1 used to introduce rainwater management concepts to the community, gather community input and develop overall rainwater goals considered appropriate for detailed investigation and discussion in Stages 2 and 3.

To provide focus and assistance in selection of watersheds for preparation of RWMPs, the LWMP recommended that watersheds be prioritized. As part of Stage 2 of the LWMP, all of the watersheds in the District of Sooke were classified and prioritized based on fish presence, existing development and future development pressure. Based on this assessment Ella Stream, Nott Brook, Throup Stream and Wright Road Creek watersheds were ranked as the first priority and are the subject of this report. The District of Sooke initiated this study in November 2008.

Liquid Waste Management Plan – Rainwater Management Goals

The primary rainwater management goals of the LWMP are to ensure that:

- Municipal rainwater infrastructure is developed in a manner that will result in healthy watercourses and healthy marine near shore environments;
- Watershed based management approaches be implemented to protect Sooke's watersheds;
- Low-impact development techniques are employed to maintain and where possible restore the pre-development hydrologic regime of urbanized watersheds and developing watersheds;
- Biological and chemical contaminants do not enter rainwater flows in the first place (source controls);
- A green infrastructure approach to rainwater management is taken to provide cleaner water and air through well treed riparian zones and streetscapes;
- Education and training activities are undertaken and community involvement is supported;
- Rainwater, on-site sewage treatment and groundwater recharge are not viewed in isolation;
- Spills are prevented and response and reporting protocols are in place;
- Annual monitoring and reporting of rainwater flows is undertaken;

- Methods to fund rainwater activities are investigated; and
- Regulatory policies, guidelines and options are discussed.

These goals were developed in consultation with the public and local stakeholders. They were adopted by District of Sooke Council to provide guidance in rainwater management planning.

Watershed Rainwater Management Plans

The LWMP recommended watershed scale rainwater management plans be prepared which use watershed specific information to develop on-the-ground solutions to manage rainwater, integrate relevant municipal infrastructure improvements with ecological assessments and relevant municipal planning processes and bylaws. The primary goals of a Rainwater Management Plan (RWMP) are to:

- Ensure protection of property and human life from flooding;
- Enhance the ecological health of the watershed by minimizing total and effective impervious area and restoring riparian forest integrity;
- Restore the ecological component of hydrological functions of the watercourse (reduce the peak flows and volumes of post-development frequently occurring rainfall-runoff events), including maintenance or enhancement of baseflow;
- Restore/rehabilitate channel form and function, and aquatic habitat; and
- Restore habitat connectivity, provide public green space, and investigate opportunities to provide a multi-use greenway corridor.
- Maintain or enhance water quality through implementation of rainwater source controls and best management practices.

These goals provided the framework for this study.

Official Community Plan – Rainwater Management Goals

Many of the goals, objectives and policies in the recently updated *District of Sooke Official Community Plan 2010* (OCP) also support rainwater management planning, including:

Sooke Smart Growth Goals/Actions

- Require all new buildings and structures under development permit areas meet or exceed a minimum LEED^{TM} Certified Standard;
- Support of LEED^{TM}, energy efficiency and green building practices into construction; and
- Promote and implement green infrastructure and alternative development standards.

Economic Development

- Require LEED^{TM} standard for all new development and re-development or equivalent standard.

Sustainable Land Use Policy - Agriculture and Food Security

- Protect and enhance natural landforms and ecosystems; and
- Eliminate contamination of Sooke Harbour in order to re-establish local shellfish industry.

Health and Quality of Life

- Ensure ongoing health of the natural environment.

Housing

- Develop housing that has minimal environmental footprint.

Infrastructure

- Environmentally sensitive infrastructure servicing is encouraged and practiced where feasible with sensitivity balancing the capacity of the natural environment with demands of growth;
- Encourage rainwater collection and storage for non-potable and landscaping purposes;
- Adopt integrated rainwater management strategy that is technically sound;
- Encourage green roof design as a method to help reduce rainwater runoff, while providing natural filtration; and
- Provide incentives for rainwater collection and other water saving features, as well as for green roofs and efficient sustainable alternate wastewater treatment and/or disposal.

Environment

- Take responsibility for a sustainable, positive community future by ensuring the ongoing health of the natural environment, both within and surrounding Sooke;
- Identify, protect, enhance, and create environmental resources for the long term benefit of wildlife, natural ecosystems and the enjoyment of the present and future population as well as visitors to the District of Sooke;
- Preserve and protect Sooke's natural resources, rural identity, and scenic beauty;
- Promote leading edge best management practices in new development and District-owned parks;
- Protect Sooke's marine environment;
- Support educational programs that create public awareness regarding Sooke's collective environmental responsibility;
- Eliminate contamination of Sooke Basin and Harbour area to protect and ensure a healthy and vibrant Sooke Basin and Harbour for future generations to come;
- Aim for the enhanced health and safety of the residents and visitors, and minimize the risk of damage to property and life resulting from hazardous natural conditions; and
- Harmonize existing development and the natural environment.

1.2 Scope of Assignment and Major Tasks

In January 2009, Kerr Wood Leidal Associates (KWL) was retained by the District of Sooke to prepare a RWMP for the Ella Stream, Nott Brook, Throup Stream and Wright Road watersheds. The scope of the project included:

- Document the current ecological, hydraulic and hydrological condition of the watershed, including mapping and photos;

- Create and calibrate a hydraulic/hydrologic model of the watershed for existing and future conditions;
- Identify and prioritize the hydrotechnical drainage problems in the watershed;
- Identify and prioritize the aquatic and riparian ecological concerns in the watershed;
- Evaluate the likely impacts of further development and re-development;
- Identify and evaluate potential improvement solutions that are consistent with the goals, and objectives of the District of Sooke OCP;
- Recommend solutions that will address the hydrotechnical problems, while working towards improving the ecological aspects of the watershed;
- Develop an implementation plan including prioritization, funding opportunities and scheduling;
- Identify the benefits associated with the proposed solutions; and
- Provide cost estimates for the recommended solutions.

Table 1-1 summarizes the major tasks involved in undertaking this study.

Table 1-1: Project Work Program

Major Tasks					
Phase 1 Reconnaissance	1.	Project Initiation		11.	Develop & Evaluate Alternatives
	2.	Drainage Inventory			
	3.	Environmental Inventory			
	4.	Hydrogeology Inventory		12.	Phase 3 Draft Report & Meetings
	5.	Hydrologic & Hydraulic Modelling			
	6.	Phase 1 Draft Report & Meetings			
Phase 2 Assessment	7.	RWMP Framework		13.	RWMP
	8.	Environmental Assessment		14.	Implementation & Maintenance Strategy
	9.	Hydrotechnical Assessment		15.	Phase 4 Draft Report & Meetings
	10.	Phase 2 Draft Report & Meetings		16.	Final Report & Meetings

1.3 Rainwater Management Criteria

For the purposes of this report, rainwater is defined as the rainfall associated with all rainfall events large and small. Rainwater replaces the word stormwater. ‘Storm sewers’ are also referred to as ‘storm drains’.

The criteria applicable to this study were derived from:

- the District of Sooke Bylaw No. 65, Subdivision and Development Standards Bylaw*, 2003*;
- Stormwater Planning: A Guidebook for British Columbia, 2002; and
- Beyond the Guidebook – Context for Rainwater Management and Green Infrastructure in British Columbia, 2007

The rainwater criteria required to meet the goals of the Ella Stream, Nott Brook, Throup Stream and Wright Road Creek watersheds are set out in Table 1-2.

Table 1-2: Summary of Rainwater Criteria

Application		Criteria/Methodology
Flood Protection	Minor Drainage System	• 10-year return period design event for pipes less than 900 mm. 1 ▪ 25-year return period design event for pipes greater than 900 mm.1
	Major Drainage System	• 100-year return period design event. 1 • 100-year return period design event for major watercourse culverts crossing Highway 14.2
Environmental & Erosion Protection	Volume Reduction (Source Controls)	• On-site rainfall capture (runoff volume reduction) for Tier 72% of 2-year 24-hour storm).3
	Water Quality Treatment	• 6-month 24-hour storm (72% of the 2-year 24-hour storm)
	Rate Control (Detention / Diversion)	• Control post-development flows to pre-development levels for 6-month, 2-year 24-hour events.2
	Riparian	• Establish riparian setbacks.4

1 District of Sooke – Bylaw No. 65, Subdivision and Development Standards Bylaw, 2003 – Rainwater Management – Schedule F, Sept 2009.
2 BC Ministry of Transportation Supplement to Transportation Assoc. of Canada Geometric Design Guide, 2007.
3 Stormwater Planning: A Guidebook for British Columbia, 2002; Beyond the Guidebook - June 2007
4 British Columbia *Riparian Areas Regulation*, 2006.

1.4 Previous Studies and Background Information

Several previous studies and plans provided guidance and background to the development of the RWMP, they are summarized as follows:

Table 1-3: Summary of Background Material

Date	Title
May 2010	District of Sooke Bylaw No. 270, Sooke Zoning, Consolidated
May 2010	District of Sooke Official Community Plan - ADOPTED
Mar. 2010	Liquid Waste Management Plan (Rainwater) – Phase 2 & 3 - FINAL
June 2009	Sooke Town Centre Plan - ADOPTED
Mar. 2009	District of Sooke Transportation Master Plan - FINAL
Feb. 2009	District of Sooke Parks and Trails Master Plan - FINAL
Sept. 2008	District of Sooke Bylaw No. 65 Subdivision and Development Standards, Consolidated
2006	John Phillips Memorial Conceptual Park Plan
Mar. 2005	Inventory and assessment of watercourse mapping, stormwater quality and watershed information
Nov. 2004	Sooke Highway 14 Drainage Report - DRAFT
Jan. 2000	An evaluation of the coastline sensitivity associated with stormwater discharges in the District of Sooke

1.5 Project Team

The study was led and directed by the following District of Sooke staff:

- Elisabeth Nelson, P. Eng, Municipal Engineer;
- Al Fontes, AScT, Manager of Operations;
- Laura Byrne, A.Ag, Parks and Environmental Services Coordinator;
- Katherine Lesyshen, MCIP, Planner; and
- Kevin Smitten, Engineering Technologist.

The consulting project team consists of inter-disciplinary professionals, as outlined:

Table 1-4: Project Team

Company	Team Members
Kerr Wood Leidal Associates Ltd.[1]	Crystal Campbell, P.Eng., Project Manager Craig Sutherland, P.Eng., Project Engineer Jeff Howard, P.Eng., Modeller Jennifer Young, E.I.T., Drainage Inventory/Modeller Jack Lau, AScT, GIS/Mapping
SWELL Environmental[2]	Lehna Malmkvist, R.P.Bio., Ecologist Cori Barraclough, R.P.Bio. Ecological Inventory Assitance Brian LaCas P.Eng. Ecological Inventory Assitance Sarah Buchanan, Field Assistant
HB Lanarc Consultants Ltd.	David Reid, FCSLA, Planner/Landscape Architect Jana Zelenski, BCSLA, Landscape Architect
Lowen Hydrogeology	Denis Lowen, P.Geo., Hydrogeology
Notes: 1. Site survey/mapping assistance from Bazzett Land Surveying Inc. 2. Aqua-tex Scientific Consulting Ltd. and LaCas Consultants Inc. acting as subconsultants	

No external stakeholder or public consultation were conducted during this study, however, the main guiding principles were based on those established during the LWMP and OCP processes that had stakeholder and public input.

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Section 2

Overview of the Rainwater Management Plan Watersheds

2. OVERVIEW OF THE RWMP WATERSHEDS

2.1 Introduction

This section describes the watersheds, including:

- description of the creek and drainage patterns;
- existing and future land uses;
- known flooding and erosion sites; and
- drainage and hydrogeology inventory.

2.2 Watershed Characteristics

The RWMP includes the Throup Stream, Nott Brook, and Wright Road Creek watersheds. Additionally the RWMP includes an environmental assessment of Ella Stream and the foreshore between Wright Road Creek and Throup Stream. The watersheds cover the Sooke Town Centre and the majority of the surrounding residential development in the District of Sooke, as shown in Figure 2-1. The following tables summarize watershed/creek characteristics.

Table 2-1: Ella Stream Characteristics

Description	Ella Stream Watershed
Drainage Area	• 134.0 ha
Stream Structure	• One 2.1 km main-stem (mainly open channel with a few culverts).
Topography	• Topography ranges from El. 275 m at the headwaters to sea level at the discharge to Juan de Fuca Strait. • Slopes of the watershed are as steep as 20% at the headwaters to 12% adjacent to the lower reaches.
Land Use	Existing: • 19% impervious, mostly undeveloped area and single family residential development. Future (Estimated from OCP): • 37% impervious, mostly single family residential development.
Drainage	• Ella Stream drains in a south-westerly direction discharging to Sooke Bay in the Juan de Fuca Strait approximately 1.0 km north of the northern boundary of the T'Sou-ke First Nation Reservation.
Soils	• 2% loamy sand (90 mm/hr saturated hydraulic conductivity) • 14% sandy loam (20 mm/hr saturated hydraulic conductivity) • 84% loamy sand (66 mm/hr saturated hydraulic conductivity)
Channel Characteristics	• Nine erosion sites along creek.

Table 2-2: Nott Brook Characteristics

Description	Nott Brook Watershed
Drainage Area	• 377 ha.
Stream Structure	• One 3.9 km main-stem (mainly open channel with a number of culverts). • One 1.5 km main tributary (mainly open channel with a few culverts).
Topography	• Topography ranges from El. 160 m at the headwaters to sea level at the discharge to Juan de Fuca Strait. • Slopes of the watershed are as steep as 15% at the headwaters to 2% adjacent to the lower reaches.
Land Use	Existing: • 27% impervious, mostly single family residential development and agriculture. Future (Estimated from OCP): • 37% impervious, mostly single family residential development.
Drainage	• Nott Brook drains in a south-westerly direction discharging to Juan de Fuca Strait near the northern boundary of the T'Sou-ke First Nation Reservation.
Soils	• 23% loamy sand (66 mm/hr saturated hydraulic conductivity) • 63% sandy loam (20 mm/hr saturated hydraulic conductivity) • 10% sandy loam (23 mm/hr saturated hydraulic conductivity) • 4% silt loam (10 mm/hr saturated hydraulic conductivity)
Channel Characteristics	• Mostly disturbed channelized creek. • Detention upstream of Grant Road at Winfield Drive. • Detention upstream of Otter Point Road. • 43 culverts, ranging in size from 250 mm to 2,000 mm. • 3 erosion sites along creek and 3 flooding sites.

Table 2-3: Throup Stream Characteristics

Description	Throup Stream Watershed
Drainage Area	• 89 ha.
Stream Structure	• One 1.5 km main-stem (mainly open channel with a number of culverts).
Topography	• Topography ranges from El. 70 m at the headwaters to sea level at the discharge to Sooke Harbour. • Slopes of the watershed are typically in the 5% to 10% range.
Land Use	Existing: • 32% impervious, mostly single family residential development. Future (Estimated from OCP): • 41% impervious, mostly single-family residential development.
Drainage	• Throup Stream drains in an easterly direction discharging to Sooke Harbour approximately 0.5 km west of Sooke River.
Soils	• 20% sand (100 mm/hr saturated hydraulic conductivity) • 70% sandy loam (20 mm/hr saturated hydraulic conductivity) • 10% loamy sand (66 mm/hr saturated hydraulic conductivity)
Channel Characteristics	• Mostly disturbed channelized creek. • Wetland area upstream of Sooke Road. • Main-stem channel has an average slope of 3%. • 12 culverts, ranging in size from 600 mm to 900 mm. • 1 erosion site along creek and 1 flooding site.

Table 2-4: Wright Road Creek Characteristics

Description	Wright Road Creek Watershed
Drainage Area	• 23.9 ha.
Stream Structure	• One 1.0 km main-stem (mainly open channel with a number of culverts). • One 0.2 km tributary (open channel).
Topography	• Topography ranges from El. 28 m at the headwaters to sea level at the discharge to Sooke Harbour. • Slopes of the watershed are as steep as 10% adjacent to the lower reaches to 2% in the upper sections.
Land Use	Existing: • 29% impervious, mostly single family residential development. Future (Estimated from OCP): • 40% impervious, mostly single family residential development.
Drainage	• Wright Road Creek drains in a south-easterly direction discharging to Sooke Harbour approximately 1.0 km northwest of Sooke Whiffin Spit.
Soils	• 49% sandy loam (20 mm/hr saturated hydraulic conductivity) • 27% sandy loam (23 mm/hr saturated hydraulic conductivity) • 24% silt loam (10 mm/hr saturated hydraulic conductivity)
Channel Characteristics	• Mostly disturbed channelized creek. • 43 culverts, ranging in size from 500 mm to 1100 mm. • One flooding site along creek

2.3 Existing and Proposed Future Land Use

Existing (2007) Land Use

The existing land use for the subject area is based on current zoning outlined in District of Sooke Bylaw 270, Sooke Zoning Bylaw, 2007 shown in Figure 2-2 and updated with aerial photography from 2007.

The majority of the watersheds have been at least partially developed, primarily consisting of single family properties. Treed areas of the watersheds include Ella watershed, the part of T'Sou-ke First Nation land to the north, the headwaters of Nott Brook north of Maple Park Terrace, and the area around Throup Road Park.

The watersheds also include land uses consisting of a golf course, recreational properties, and several mobile home developments.

The residential and commercial developments along Sooke Road between Maple Avenue South and Church Road are located within the foreshore watershed and drain directly to the Sooke Harbour.

Proposed Land Use

Proposed land use in the watersheds is defined by the recently adopted OCP. In general, land use in the watersheds will not change significantly. The only major exceptions are re-development of the downtown core area, in-fill and re-development of parts of existing agricultural land in Nott Brook and Throup Stream Watersheds and development of light industrial area near the outlet of Ella Stream watershed. Figure 2-3 shows the proposed future OCP land use in the watersheds.

2.4 Reported Flooding and Erosion Sites

Based on discussions with District of Sooke staff and informal discussions with property owners during field visits, known flooding and erosion sites have been identified and shown in Figure 2-4 and summarized below.

Table 2-5: Summary of Known Flooding and Erosion Sites

Map ID[1]	Location	Description
Ella Stream Watershed		
A-1	Downstream of West Coast Road	Gully is showing signs of excessive erosion - down cutting, failing banks
Nott Brook Watershed		
B-1	Upstream of Townsend Road (2191 Townsend Road)	Low-lying private property that floods.
B-2	North side of Grant Road West between Maple Avenue South and Guardian Road (6956 to 6692 Grant Road)	Undersized driveway culverts leading to overtopping of Grant Road West and flooding along Guardian Road.
B-3	Agricultural Property (1980 Maple Avenue South)	Bank erosion and down cutting of channelized stream.
B-4	Upstream of West Coast Road Culvert (7096 West Coast Road)	Flooding of private property as a result of undersized culvert

Map ID[1]	Location	Description
B-5	Downstream of Grant Road West culvert on Nott Brook tributary (7081 Grant Road West)	Erosion of channelized stream section - down cutting, headcuts and failing banks.
B-6	Upstream of West Coast Road culvert on Nott Brook tributary (7120 West Coast Road)	Erosion of channelized stream section- down cutting, headcuts and failing bank.
Throup Stream Watershed		
C-1	Downstream of Church Road (2171 Church Road)	Flooding of private property as a result of constricted opening into storm drain.
C-2	Downstream of Charters Road (2113 Charters Road)	Erosion and down cutting of channel located at bottom of steep gully.
Wright Road Creek Watershed		
D-1	East end of Wright Road	Flooding of private properties as a result of water flowing down roadside ditch on north side of Wright Road from creek.
Foreshore Area		
E-1	Ed Macgregor Park	Minor erosion of foreshore from pedestrian traffic near boardwalk
Note: Locations shown in Figure 2-4		

2.5 Drainage Inventory

Field visits were conducted in March and April 2009 to verify watershed and creek characteristics for a comprehensive inventory of the drainage system. A detailed survey was conducted to collect cross-section information along Throup Stream and Nott Brook for the purposes of performing the hydraulic analysis.

The major drainage paths were traversed with the following information noted:

- culvert sizes and bridge openings;
- typical channel cross sections, bank confinement/stability;
- erosion sites;
- detention facilities and any other hydraulic structures; and
- photographs of key watershed features.

Figure 2-5 depicts the drainage patterns, culverts, bridges and surveyed cross-section locations.

Hydraulic Structure Inventory

Hydraulic structures were investigated during the drainage inventory including culverts and bridges located on the main drainage paths. Detention ponds were found in the Nott Brook and Throup Stream watersheds. The information obtained including culvert and bridge size, type and condition is summarized in Appendix A.

Channel Sections

Detailed topographic surveys were carried out at all major road crossings, allowing measurement of invert elevations, hydraulic capacity, and total length for all culverts and bridge crossings.

2.6 Hydrogeology Inventory and Assessment

A soil assessment of the Ella Stream, Nott Brook, Throup Stream, and Wright Road Creek watersheds was carried out as part of the RWMP by Lowen Hydrogeology Consulting Ltd. to determine soil characteristics and evaluate potential for infiltration source controls. The assessment involved a desk-top study and literature review; therefore, it is assumed that the local soil assemblages are comparable to those in reference materials and latest soil mapping available from the Province of British Columbia (see Figure 2-6). The results also assume that natural soils have not been disturbed (compacted, excavated, filled or moved). Disturbed soils can have markedly different hydraulic conductivity than native soils. A detailed field investigation to determine hydraulic conductivity of disturbed soils was beyond the scope of this assessment.

The results of the soil assessment are summarized in a technical memorandum included in Appendix B and are summarized below:

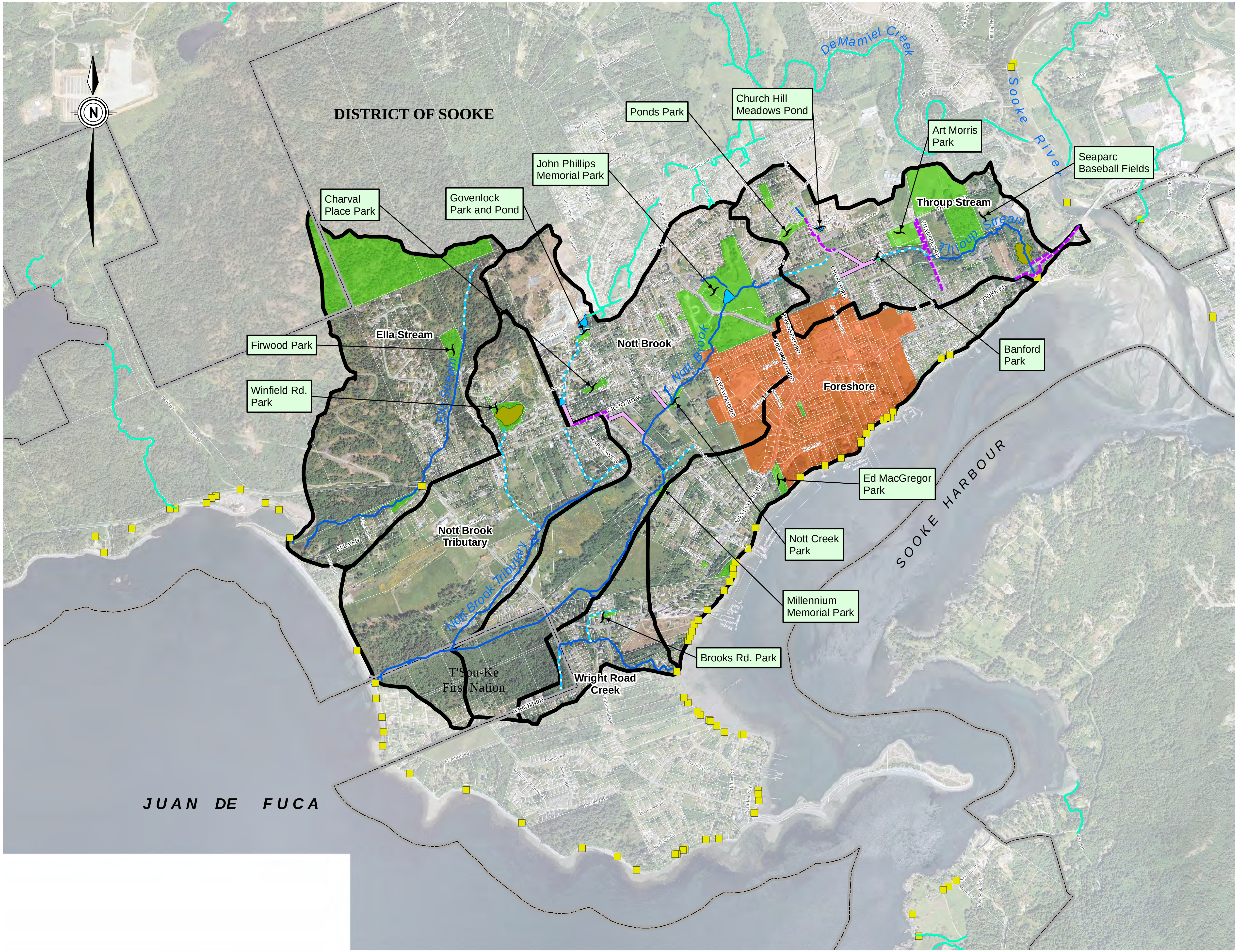
- Soils in the watershed are highly variable with diverse origins; including glacial, marine, fluvial, and weathering products. Most soils are well drained but depth of soil is limited;
- It is estimated that infiltration rates for soils in the watershed range from 10 to 200 mm/hour;
- Only a small proportion (< 15%) of the area of the watersheds is considered to have good disposal potential for rainwater flows with very well draining soils with sufficient depth; and
- The remainder of the area is considered to be marginal to unsuitable for large stormwater flow disposal. These areas have either poor draining soils or insufficient soil depth for adequate infiltration of large quantities of storm flows. However, the infiltration rates are more than sufficient for volumetric reduction and retention of day-to-day rainfall events.

Figure 2-7 shows the rainwater infiltration potential for areas in the watersheds.

Those areas identified as having fair or good potential for rainfall infiltration potential should be studied further with test pitting and soil logging, field conductivity testing and water level monitoring. For site selection, water injection testing should be carried out for a minimum of one week in the wet season. These tests should be carried out as part of future development and should be a requirement of future subdivision development bylaw updates.

The following are suggested principles and measures that could be implemented during the future development of the Ella Stream, Nott Brook, Throup Stream, and Wright Road Creek watersheds:

- Minimize the removal of vegetation and/or disturbance of native soils. Avoid stripping native soils from the land prior to development where possible;
- Natural creek ravines and areas overlain by coarse textured materials should be conserved to maintain infiltration potential; and
- Further channelizing streams within the watershed should be avoided and the channel fill deposits should be left intact to assist in reducing the magnitude of peak flow events.



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

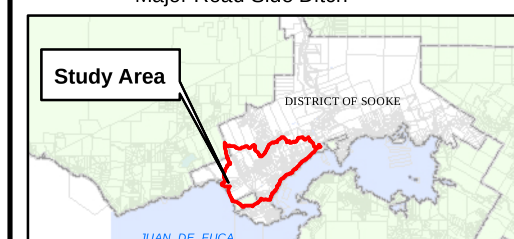
- Municipal Boundary
- Watershed Boundary
- Town Centre Plan Area
- Parks and Green Spaces
- Stormwater Outfall
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch



REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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consulting engineers

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Project No.	Date
2609-001	January 2012

Location Map

Figure 2-1

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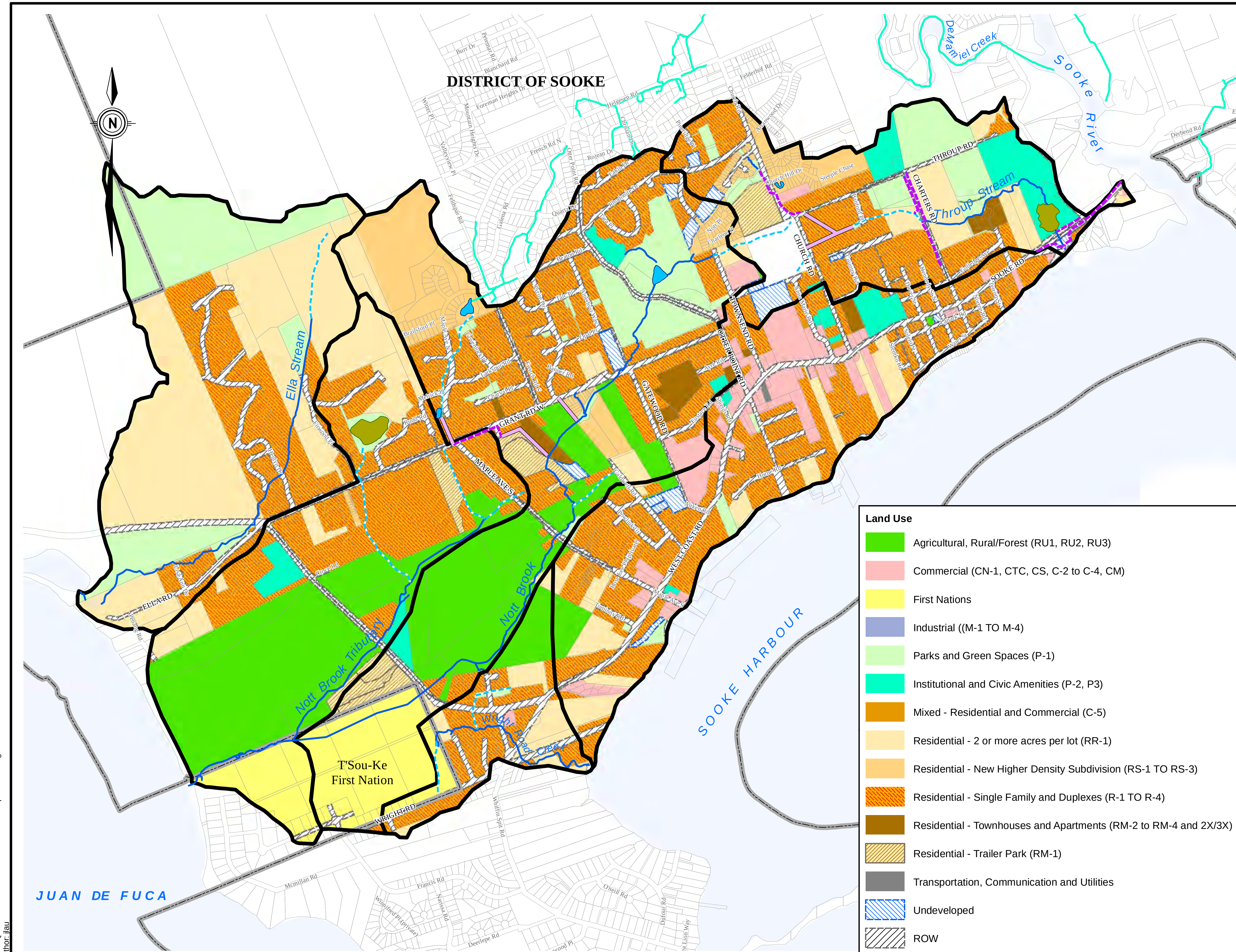
Author: jlau



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainmwater Drain
- Major Road Side Ditch

REFERENCE

Cadastral and Zoning data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83
Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

2007
Existing Land Use

Figure 2-2

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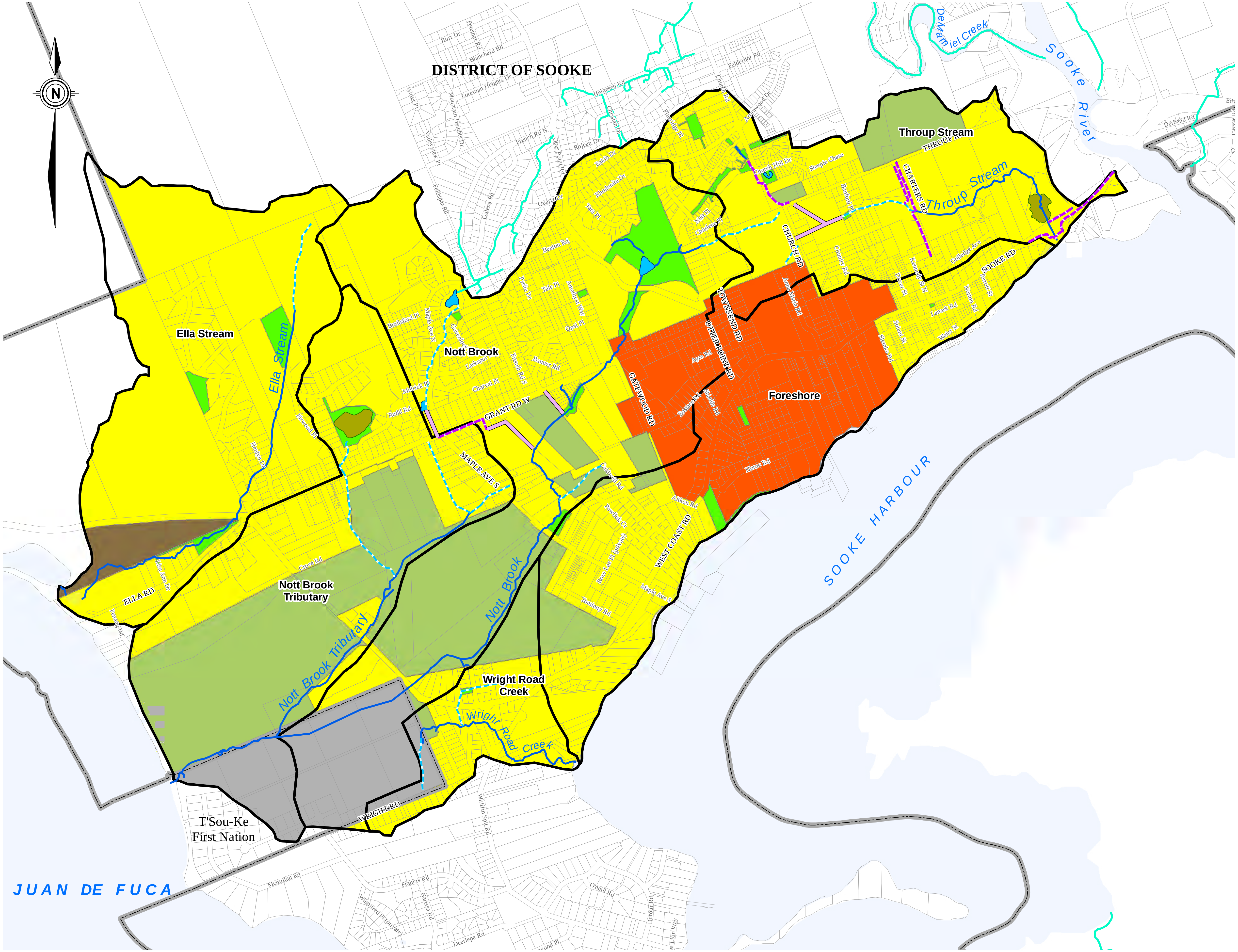
Author: jlau



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

OCP Land Use Designation

- Agricultural
- Community Residential
- Industrial
- Park
- Town Centre
- First Nations

REFERENCE

Cadastral data and Land Use from Provided by the District of Sooke
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

OCP (2010)

Figure 2-3

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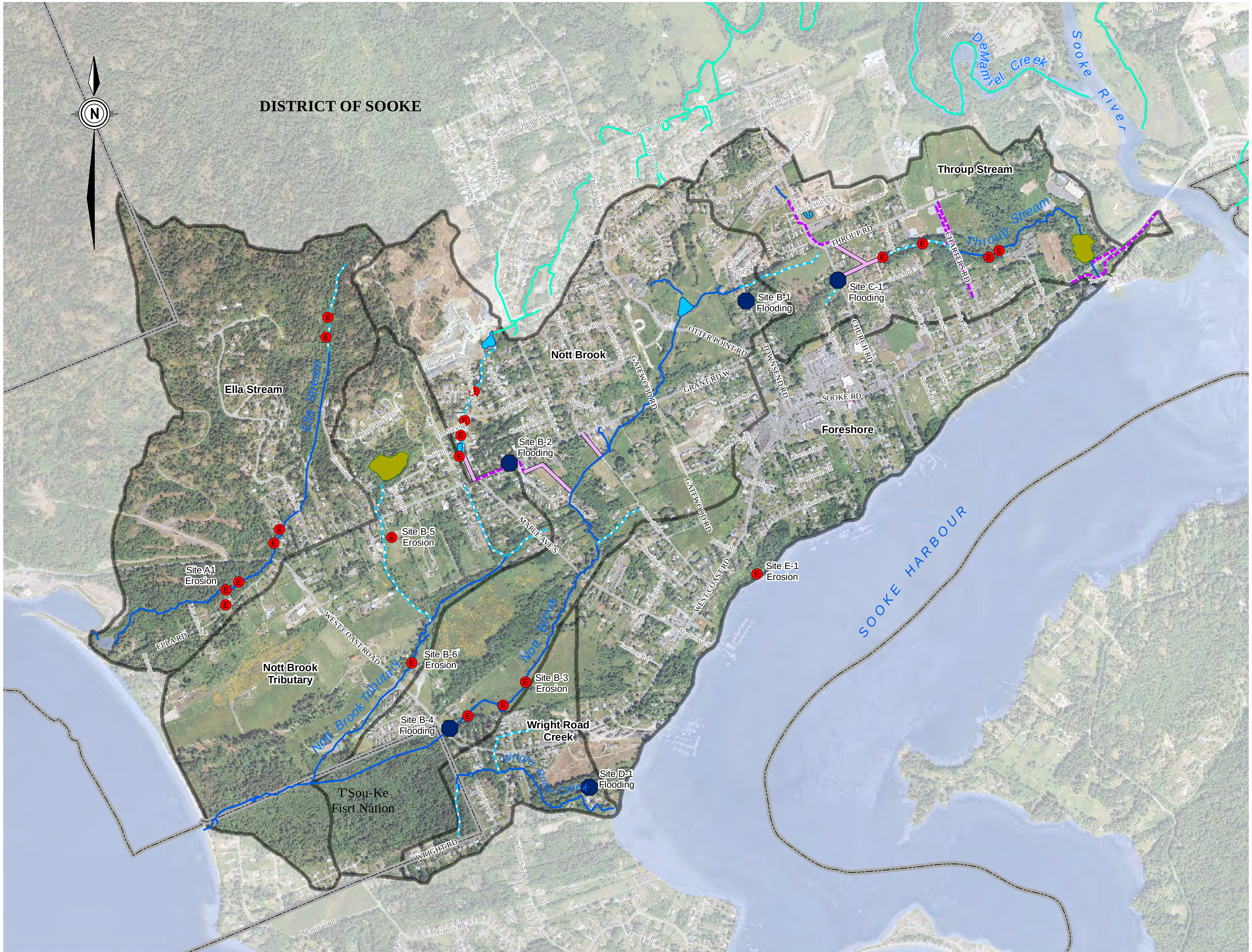
Author: jlau

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds Rainwater Management Plan



Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Known Sites

- Erosion Site
- Flooding Site

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Known Flooding and Erosion Sites

Figure 2-4

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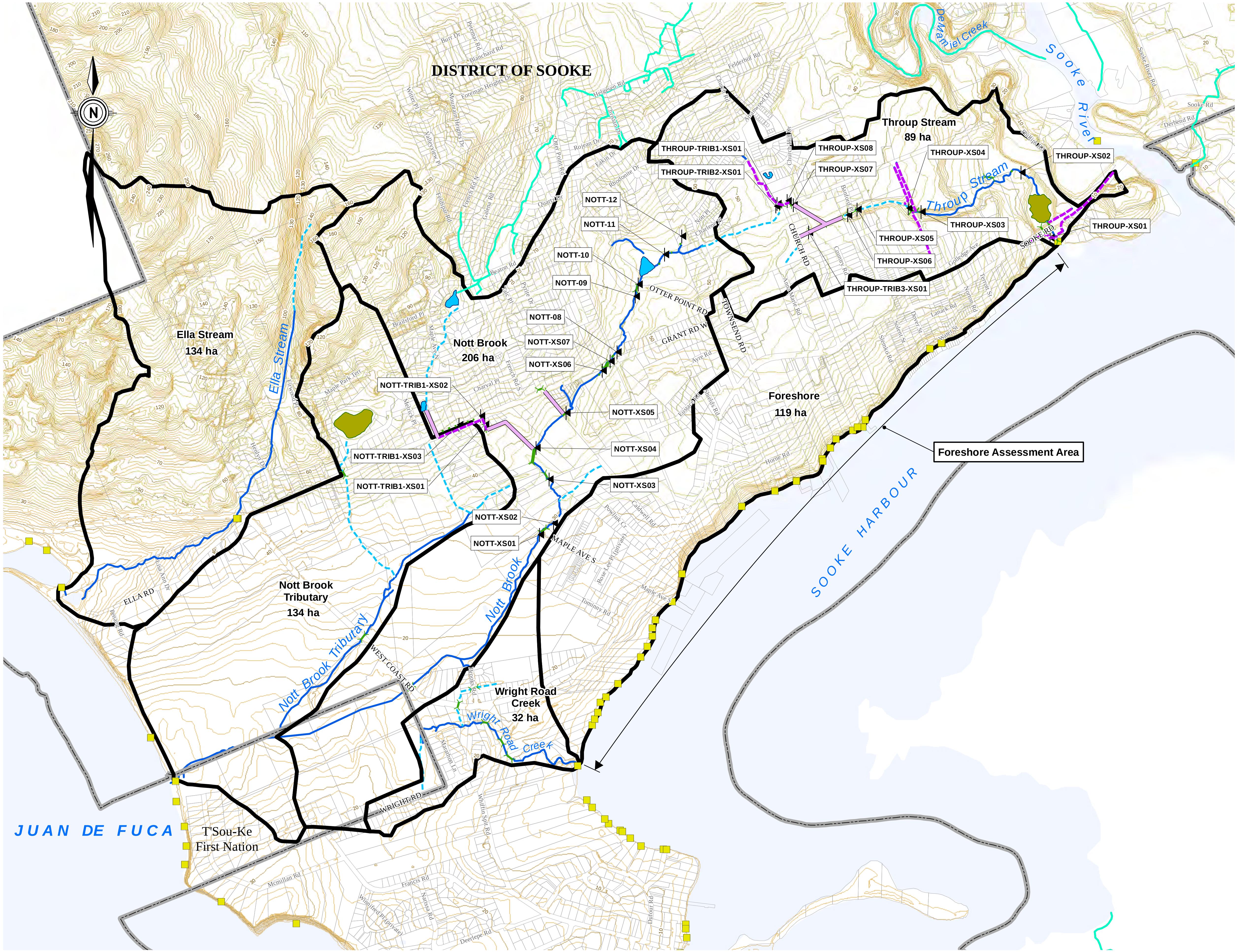
Author: jlau



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Stormwater Outfall
- Contour (2 m Interval)
- Surveyed Culvert/Drain
- Surveyed Channel Sections
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic and Cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Drainage Inventory

Figure 2-5

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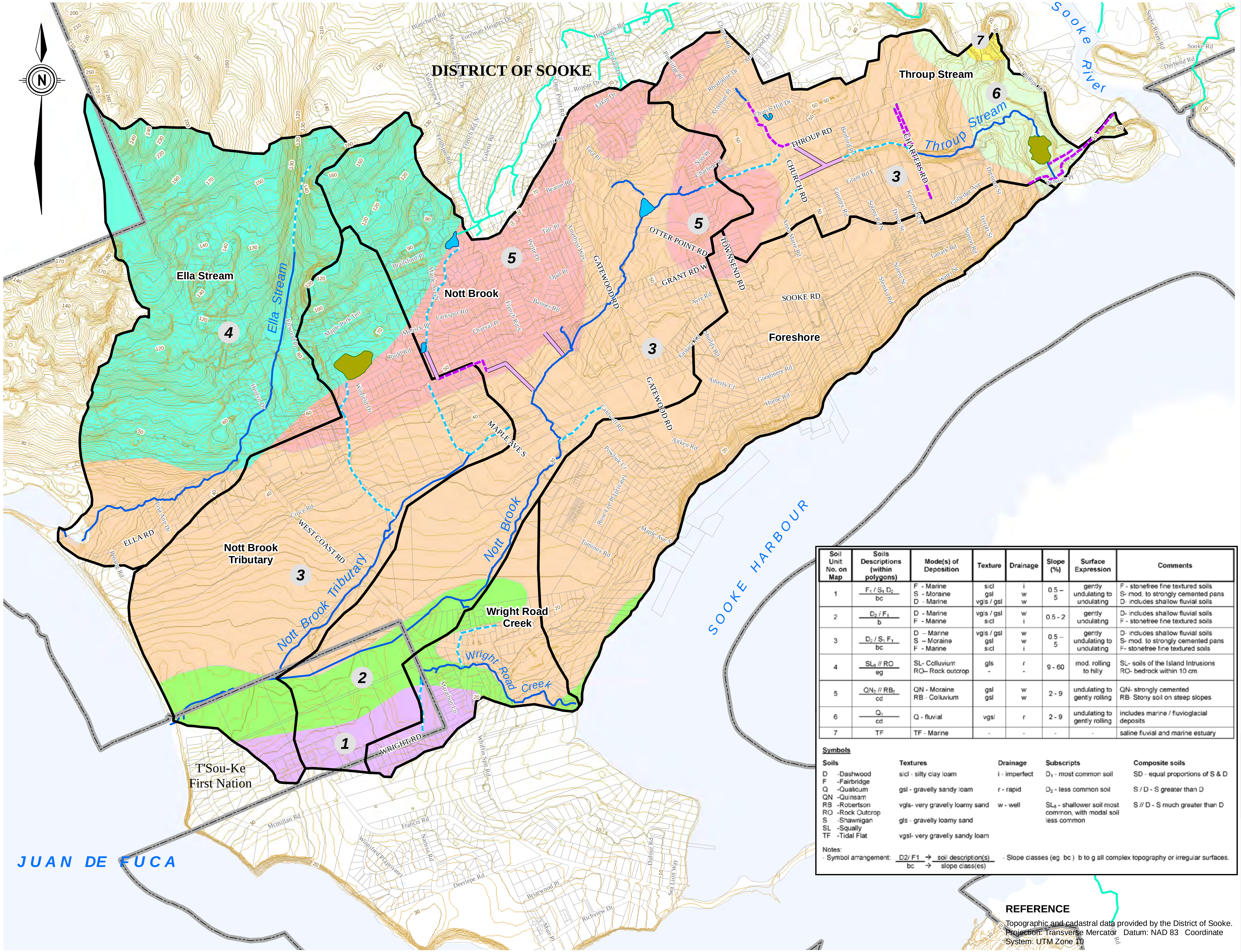
Author: jlau



Soil Unit No. on Map	Soils Descriptions (within polygons)	Mode(s) of Deposition	Texture	Drainage	Slope (%)	Surface Expression	Comments
1	$\frac{F_1 / S_1 D_2}{bc}$	F - Marine S - Moraine D - Marine	sicl gsl vgls / gsl	i w w	0.5 – 5	gently undulating to undulating	F - stonefree fine textured soils S- mod. to strongly cemented pans D- includes shallow fluvial soils
2	$\frac{D_2 / F_1}{b}$	D - Marine F - Marine	vgls / gsl sicl	w i	0.5 - 2	gently undulating	D- includes shallow fluvial soils F - stonefree fine textured soils
3	$\frac{D_2 / S_1 F_1}{bc}$	D – Marine S – Moraine F - Marine	vgls / gsl gsl sicl	w w i	0.5 – 5	gently undulating to undulating	D- includes shallow fluvial soils S- mod. to strongly cemented pans F- stonefree fine textured soils
4	$\frac{SL_6 // RO}{eg}$	SL- Colluvium RO– Rock outcrop	gls -	r -	9 - 60	mod. rolling to hilly	SL- soils of the Island Intrusions RO- bedrock within 10 cm
5	$\frac{QN_2 // RB_2}{cd}$	QN - Moraine RB - Colluvium	gsl gsl	w w	2 - 9	undulating to gently rolling	QN- strongly cemented RB- Stony soil on steep slopes
6	$\frac{Q_1}{cd}$	Q - fluvial	vgsl	r	2 - 9	undulating to gently rolling	includes marine / fluvioglacial deposits
7	TF	TF - Marine	-	-	-	-	saline fluvial and marine estuary

Symbols

Soils
D -Dashwood
F -Fairbridge
Q -Qualicum
QN -Quinsam
RB -Robertson
RO -Rock Outcrop
S -Shawnigan
SL -Squally
TF -Tidal Flat

Textures
sicl - silty clay loam
gsl - gravelly sandy loam
vgls- very gravelly loamy sand
gls - gravelly loamy sand
vgsl- very gravelly sandy loam

Drainage
i - imperfect
r - rapid
w - well

Subscripts
D_1 - most common soil
D_2 - less common soil
SL_6 - shallower soil most common, with modal soil less common

Composite soils
SD - equal proportions of S & D
S / D - S greater than D
S // D - S much greater than D

Notes:
- Symbol arrangement: $\frac{D2/F1}{bc} \rightarrow \frac{\text{soil description(s)}}{\text{slope class(es)}}$
- Slope classes (eg. bc) b to g all complex topography or irregular surfaces.

REFERENCE
Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

Municipal Boundary
Watershed Boundary
Contour (2 m Interval)
Major Pond
Wetland

Watercourse
Permanent
Ephemeral
Watercourse Outside of Study Area

Major Road Side Ditch
Major Road Side Ditch
Major Stormwater Drain

Surficial Geology 1 Soil Unit No. (Refer to Table)
1 - Silt Loam
2 - Sandy Loam
3 - Sandy Loam
4 - Loamy Sand
5 - Loamy Sand
6 - Sand
7 - Marine

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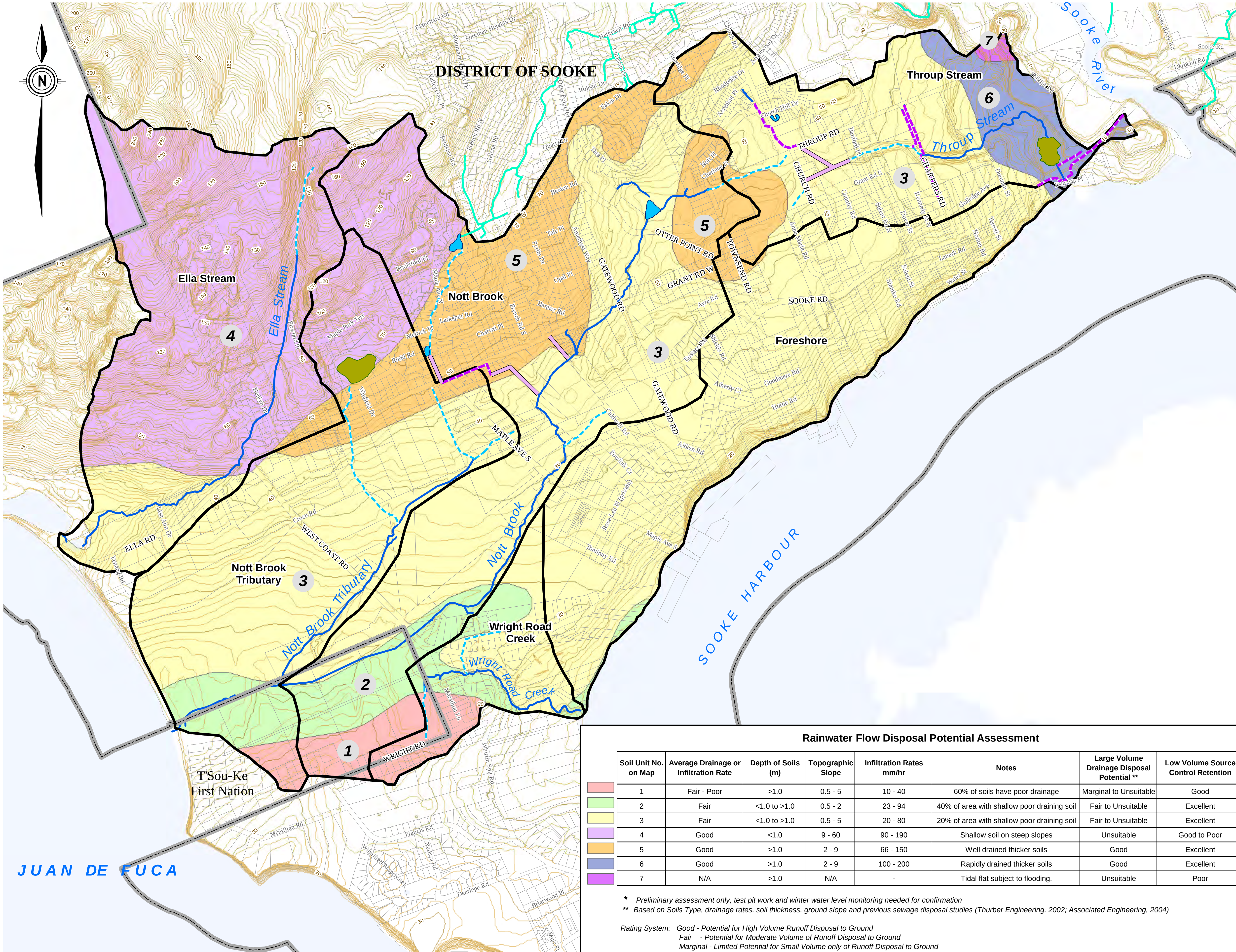
Project No. 2609-001
Date January 2012

Surficial Geology

Figure 2-6

Path: Q:\2600-2699\2609-001\430-GIS\MXD-Rp\2609001Fig2-6.mxd Date Saved: 1/9/2012 2:21:00 PM
Author: jlau



Rainwater Flow Disposal Potential Assessment

	Soil Unit No. on Map	Average Drainage or Infiltration Rate	Depth of Soils (m)	Topographic Slope	Infiltration Rates mm/hr	Notes	Large Volume Drainage Disposal Potential **	Low Volume Source Control Retention
	1	Fair - Poor	>1.0	0.5 - 5	10 - 40	60% of soils have poor drainage	Marginal to Unsuitable	Good
	2	Fair	<1.0 to >1.0	0.5 - 2	23 - 94	40% of area with shallow poor draining soil	Fair to Unsuitable	Excellent
	3	Fair	<1.0 to >1.0	0.5 - 5	20 - 80	20% of area with shallow poor draining soil	Fair to Unsuitable	Excellent
	4	Good	<1.0	9 - 60	90 - 190	Shallow soil on steep slopes	Unsuitable	Good to Poor
	5	Good	>1.0	2 - 9	66 - 150	Well drained thicker soils	Good	Excellent
	6	Good	>1.0	2 - 9	100 - 200	Rapidly drained thicker soils	Good	Excellent
	7	N/A	>1.0	N/A	-	Tidal flat subject to flooding.	Unsuitable	Poor

* Preliminary assessment only, test pit work and winter water level monitoring needed for confirmation

** Based on Soils Type, drainage rates, soil thickness, ground slope and previous sewage disposal studies (Thurber Engineering, 2002; Associated Engineering, 2004)

Rating System: *Good - Potential for High Volume Runoff Disposal to Ground*
Fair - Potential for Moderate Volume of Runoff Disposal to Ground
Marginal - Limited Potential for Small Volume only of Runoff Disposal to Ground
Unsuitable - No Potential for Runoff Disposal to Ground

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Contour (2 m Interval)
- Major Pond
- Wetland

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area
- 1 Soil Unit No. (Refer to Table)

REFERENCE

Topographic and cadastral data provided by the District of Sooke. Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Rainwater Infiltration Potential

Figure 2-7

Path: Q:\2600-2699\2609-001\430-Gis\MXD-Rp\2609001Fig2-7.mxd Date Saved: 1/9/2012 2:23:16 PM
Author: jlau

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Section 3

Environmental Assessments

3. Environmental Assessments

3.1 Introduction

This section summarizes the following:

- PFC methodology and results; and
- WHTS.

These assessments indicate the existing environmental values and resources in the watersheds and show potential impacts of the future land development.

3.2 Proper Functioning Condition (PFC) Environmental Assessment

PFC is a qualitative method for assessing the condition of riparian-wetland areas. The term PFC is used to describe both the assessment process and the condition of a riparian wetland area. The method was developed by a national interagency team and documented in a series of Technical References (TR 9 through 16) (Prichard, 1993 through 1999 et al.)[1]. See the PFC user's guides for more details on the PFC process http://www.blm.gov/nstc/library/techref.htm .

The PFC assessment involves using a standard checklist to consistently assess the hydrology, soils and vegetation of riparian areas. The checklist and its summarization are used to classify the health or state of physical processes of the riparian-wetland area. The PFC assessment method was chosen because it could provide an efficient, proven, scientifically defensible method for assessing riparian and stream channel condition. A PFC assessment method is also available for wetland ecosystems. Further explanation of the PFC assessment methods can be found in Appendix C.

Appropriate use of this assessment requires an interdisciplinary team (ID Team) of individuals with journey-level skills in hydrology, vegetation, soils/geology, and ecology in order to adequately perform a field assessment using the Riparian-Wetland Functional Checklist. For assessment purposes, the team divided the stream into a series of finite segments (reaches), each having common attributes and processes. Results of the assessments provide land management agencies and citizen groups with a mutual understanding of the current health of the stream and watershed. Managers, landowners, and concerned citizens have used PFC assessments for development of management strategies designed to bring about outcomes that are realistic and achievable. PFC assessment findings for stream and riparian zones provide indicators of the limits of the watershed's capacity to produce certain values. An accurate portrayal of the physical processes and their present condition is essential in designing plans to manage the watershed for values important to the community.

---

[1] Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado
Prichard, D. 1998. (Work group leader) Riparian Area Management – A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. TR 1737-15. US Department of Interior, Bureau of Land Management and US Department of Agriculture, Forest Service.
Prichard, D. 2003. (Work group leader) Riparian Area Management - AUser Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas. (Technical Reference 1737-16). US Department of Interior, Bureau of Land Management and US Department of Agriculture, Forest Service.
A User Guide to Assessing Proper Function Condition and Supporting Science for Lentic Areas, US Dept. of the Interior, Bureau of Land Management; US Dept. of Agriculture, Forest Service TR 1737-16, 2003
Buchanan, S., C.L Barraclough, L. Townsend, D. Hegg, L. Malmkvist, and W.P. Lucey. 2009. Colquitz River Watershed Proper Functioning Condition Watershed Assessment. Aqua-Tex Scientific Consulting Ltd. 129 pp + appendices.

The Sooke watersheds assessment area was divided into six catchment areas (watersheds and subwatersheds) stratified by defined segments (reaches) of a stream that share common processes and attributes. A total of 42 reaches were defined and assessed. The assessment covered the main channel and large tributaries for Nott Brook, Ella Stream, Throup Stream and Wright Road Creek, smaller tributaries were not assessed within this scope of work, however they were mapped where observed. All reaches, for each creek, were numbered sequentially from downstream to upstream and tied to a global positioning system (GPS) waypoint or prominent landmark for map reference.

3.3 Findings and Recommendations from the PFC Assessment

The following section outlines the results of the environmental field investigation and PFC assessment. Both the specific sites identified during the investigation shown in Figure 3-1 and the PFC classifications for each stream reach are shown in Figures 3-2 and 3-3, respectively. Appendix C contains the details of the assessment. The classifications and recommendations for each reach are summarized in the following subsections:

Nott Brook (Channel A)

Nott Brook is a medium-sized watershed (342 ha), which drains into Sooke Bay, where the marine receiving waters are rated high sensitivity. This watershed has been extensively developed (residential and agricultural) and further development is expected. Water quality is a concern and significant rainwater management measures need to be considered for this watershed. The watercourse is currently inhabited by cutthroat trout.

The current ecological condition of this creek is varied; there are several PFC reaches, and some portions that are non-functional or functional-at-risk. The reaches in poor condition exhibit excessive erosion (bank instability and downcutting) and invasive and non-native species in the riparian zone. The causes of degradation are partly historical, primarily past logging and land clearing, and due in part to increased runoff and peak flows due to development activities and corresponding increases to impervious surfaces in the watershed. Improvements to the ecological health of the Nott Brook watershed will require rainwater management throughout the watershed to control runoff and channel restoration activities, such as instream energy dissipation and sediment detention structures (e.g., weirs), bank stabilization (e.g. bioengineering), invasive species control, and riparian planting. A summary of the results is shown in Table 3-1.

Table 3-1: PFC Ratings in Nott Brook

Reach	PFC Rating	Proposed Restoration Measures
1	Proper Functioning	RWM
2	Proper Functioning	RWM, all terrain vehicle management
3	Non-functional	Erosion rehabilitation, instream energy dissipation, Invasive species management, riparian plantings, exclusionary fencing, RWM
4	Functional-at-Risk (No apparent trend)	Erosion rehabilitation, instream energy dissipation, Invasive species management, stop mowing of riparian zone within Millenium Memorial Park, plant native riparian species, RWM
5	Proper Functioning	Riparian plantings, RWM
6	Functional-at-Risk (Downward trend)	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, exclusionary fencing, education, RWM

7	Proper Functioning	Invasive species management, riparian plantings, RWM
8	Functional-at-Risk (No apparent trend)	Invasive species management, riparian plantings, daylighting, RWM
9	Proper Functioning	Invasive species management, riparian plantings, daylighting, instream habitat, RWM
10	Proper Functioning	Invasive species management, riparian plantings, stop mowing within riparian area, daylighting
11	Proper Functioning	Riparian plantings, channel complexing, RWM
12	Non-functional	Riparian plantings, instream energy dissipation, RWM
13	Proper Functioning	Invasive species management, RWM
RWM = rainwater management Refer to Figure 3-2 for reach locations	Green text = proper functioning Red text = non functional	Orange = Functional-at-Risk (Downward) Yellow = Functional-at-Risk (No apparent)

Nott Brook Tributary (Channel B)

Nott Brook tributary (Channel B) is part of the 342 ha watershed that drains into Sooke Bay. The current ecological condition of this creek is mixed. The upper reaches are PFC and should be protected and maintained, with some restoration activities (invasive species management and riparian plantings). The lower reaches are non-functional (ditches) and exhibit excessive erosion (bank instability and downcutting) and invasive, non-native species in the riparian zone. The causes of degradation are partly historical, land clearing and agriculture, and due in part to increased runoff and peak flows due to development activities and corresponding increases to impervious surfaces in the watershed. Improvements to the ecological health of the Nott Brook Tributary will require rainwater management throughout the watershed to control runoff and channel restoration activities, such as bioengineering, weirs, riparian plantings and invasive species control. A summary is shown in Table 3-2.

Table 3-2: PFC Ratings for Nott Brook Tributary (Channel B)

Reach	PFC Rating	Proposed Restoration Measures
1	Non-functional	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
2	Non-functional	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
3	Proper Functioning	Invasive species management, riparian plantings, exclusionary fencing
4	Proper Functioning	Invasive species management, RWM
5	Proper Functioning	Riparian plantings, RWM
RWM = rainwater management Refer to Figure 3-2 for reach locations	Green text = proper functioning Red text = non functional	Orange = Functional-at-Risk (Downward) Yellow = Functional-at-Risk (No apparent)

Nott Brook Tributary (Channel C) – Maple Avenue North

Maple Avenue North (Channel C) is a tributary to Nott Brook. This channel has been heavily modified by residential development, it shows evidence of erosion from high flows, has been armoured, and has sparse riparian vegetation. The causes of degradation are increased runoff from upstream development, as well as activities of landowners adjacent to the channel. Restoration opportunities include rainwater management, landowner education, and instream restoration such as planting native riparian vegetation. A summary of the PFC assessment is shown in Table 3-3.

Table 3-3: PFC Ratings for Nott Brook Tributary (Channel C)

Reach	PFC Rating	Proposed Restoration Measures
Detention Pond	N/A	Riparian and aquatic plantings; safety of outlet structure
1	Non-functional	Replace existing armouring with bio-engineering or other living/soft erosion protection treatments, instream energy dissipation, riparian plantings, RWM, education
2	Functional-at-Risk (Downward Trend)	Instream energy dissipation, erosion, riparian plantings, RWM, education
Detention Pond	N/A	Riparian and aquatic plantings
RWM = rainwater management Refer to Figure 3-2 for reach locations	Green text = proper functioning Red text = non functional	Orange = Functional-at-Risk (Downward) Yellow = Functional-at-Risk (No apparent)

Throup Stream

Throup Stream is small watershed (98 ha) that drains into Sooke Harbour, where the marine receiving waters are rated "high" sensitivity. This watershed has been extensively developed and further development is expected. Water quality is a concern and significant rainwater management measures need to be considered for this watershed. The watercourse is habitat for coho and chum salmon.

The current ecological condition is mixed, there are several reaches in PFC and several that are Functional-at-Risk with a downward trend and one non-functional reach. The reaches in poor condition exhibit excessive erosion (bank instability and down cutting) and invasive, non-native species in the riparian zone. The causes of degradation are partly historical, primarily past logging and land clearing, and due in part to increased runoff and peak flows due to development activities and corresponding increases to impervious surfaces in the watershed. Improvements to the ecological health of the Throup Stream will require rainwater management throughout the watershed to control runoff and channel restoration activities, such as instream energy dissipation and sediment detention structures (e.g. weirs), bank stabilization (e.g. bioengineering), invasive species control, and riparian planting. A summary of the PFC assessment is shown in Table 3-4.

Table 3-4: PFC Ratings for Throup Stream

Reach	PFC Rating	Proposed Restoration Measures
1	Proper Functioning	Riparian plantings, large wood, outfall erosion repair
2	Proper Functioning	No restoration needed, protect as is
3	Proper Functioning	Invasive species management
4	Functional-at-Risk (Downward Trend)	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
5	Non-functional	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
6	Functional-at-Risk (Downward Trend)	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
RWM = rainwater management Refer to Figure 3-2 for reach locations	Green text = proper functioning Red text = non functional	Orange = Functional-at-Risk (Downward) Yellow = Functional-at-Risk (No apparent)

Ella Stream

Ella Stream is small watershed (119 ha) that drains into Sooke Bay. The watershed contains forestry and industrial land use, and is currently undergoing extensive residential development. This watercourse provides habitat for cutthroat trout. The current ecological condition of this creek is mixed, there are several reaches in PFC and several that are Functional-at-Risk with a downward trend and three Non-functional reaches. The reaches in poor condition exhibits excessive erosion (bank instability and downcutting) and invasive, non-native species in the riparian zone. The causes of degradation are partly historical, primarily past logging and land clearing, and due in part to increased runoff and peak flows due to development activities and corresponding increases to impervious surfaces in the watershed. Improvements to the ecological health of the Ella Stream will require rainwater management throughout the watershed to control runoff and channel restoration activities, such as bioengineering, weirs, riparian plantings, and invasive species control. A summary of the PFC assessment is shown in Table 3-5.

Table 3-5: PFC Ratings for Ella Stream

Reach	PFC Rating	Proposed Restoration Measures
1	Proper Functioning	Invasive species management, Add large wood
2	Functional-at-Risk (Downward Trend)	Erosion rehabilitation, RWM
3	Functional-at-Risk (Downward Trend)	Invasive species management, erosion rehabilitation, instream energy dissipation, RWM
Trib. 3a	Proper Functioning	Invasive species management
4	Non-functional	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
5	Non-functional	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
6	Functional-at-Risk (Downward Trend)	Invasive species management, erosion rehabilitation, instream energy dissipation, riparian plantings, RWM
7	Proper Functioning	Invasive species management
8	Non-functional	Instream energy dissipation, riparian plantings
9	Proper Functioning	No restoration needed

RWM = rainwater management
Refer to Figure 3-2 for reach locations
Green text = proper functioning
Red text = non functional
Orange = Functional-at-Risk (Downward)
Yellow = Functional-at-Risk (No apparent)

Wright Road Creek

Wright Road Creek is a small watershed (27 ha) which drains into Sooke Harbour, where the marine receiving waters are rated high sensitivity. This watershed has been extensively developed and further development is expected. Water quality is a concern and significant rainwater management measures need to be considered for this watershed. The watercourse is currently used by stickleback, but has the potential to provide habitat for cutthroat trout and chum salmon, which were found here in the past.

The current ecological condition of this creek is quite high, there are several reaches in PFC, however; the lower part of the watershed is Functional-at-Risk with a downward trend. The reach in poor condition exhibits excessive erosion (bank instability and downcutting) and invasive, non-native species in the riparian zone. The causes of degradation are partly historical, primarily past logging and land clearing, and due in part to increased runoff and peak flows due to development activities and corresponding increases to impervious surfaces in the watershed. Improvements to the ecological health of the Wright Road Creek will require rainwater management throughout the watershed to control runoff and channel restoration activities, such as instream energy dissipation and sediment detention structures (e.g. weirs), bank stabilization (e.g., bioengineering), invasive species control and riparian planting. A summary of the PFC assessment is shown in Table 3-6.

Table 3-6: PFC Ratings for Wright Road Creek

Reach	PFC Rating	Restoration
1	Proper Functioning	Invasive species management, riparian plantings, instream energy dissipation
2	Functional-at-Risk (Downward Trend)	Instream energy dissipation, invasive species management, riparian plantings
3	Proper Functioning	Invasive species management, riparian plantings
4	Proper Functioning	Riparian plantings
5	Proper Functioning	Riparian plantings
6	Proper Functioning	No restoration required, protect as is
RWM = rainwater management Refer to Figure 3-2 for reach locations		Green text = proper functioning Red text = non functional Orange = Functional-at-Risk (Downward) Yellow = Functional-at-Risk (No apparent)

3.4 Watershed Health Tracking System

The WHTS is simple tool to estimate and track overall stream health and show the potential impacts of future development and benefits of proposed best management practices (BMPs). It includes watershed health indicators such as impervious area, riparian forest integrity, and Benthic Index of Biotic Integrity (B-IBI) scores, to represent the cumulative impacts of upstream development on aquatic ecosystems (e.g. changes in flow regime, water quality, instream habitat). These indicators can be tracked over time as the watersheds develop and as mitigation measures are implemented. Currently the watersheds are considered in good and fair condition as depicted on Figure 3-4. Appendix D provides additional explanation on the WHTS. The total impervious area for existing and future conditions is summarized as follows:

Table 3-7: Existing and Future Impervious Areas and RFI

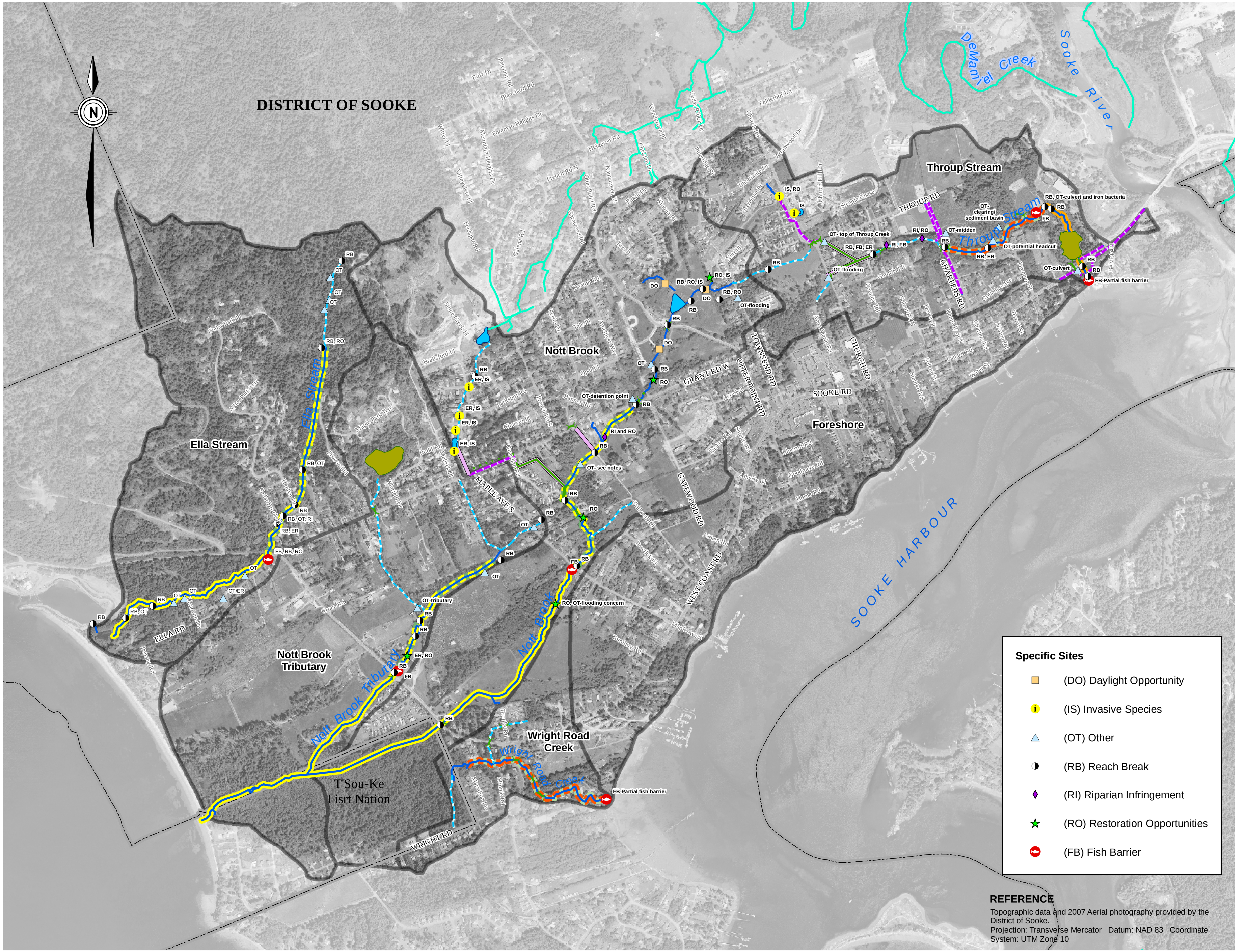
Watershed	Total Impervious Area		Riparian Forest Integrity	
	Existing	Future Unmitigated	Existing	Future (w/ RAR protection)
Nott Brook	27%	37%	51%	29%
Throup Stream	32%	41%	50%	29%
Wright Road Creek	29%	40%	51%	32%
Ella Stream	19%	37%	86%	39%

Figure 3-3 shows the existing riparian vegetation within 30 m setback assessment area. Figure 3-4 shows the WHTS with predicted Benthic Index of Biotic Integrity (B-IBI) scores based on impervious area and riparian forest integrity for Ella Stream, Throup Stream, Wright Road Creek, Nott Brook, and Nott Brook Tributary. Both existing and future scores are predicted. The future predicted B-IBI scores assume the impacts of the proposed development without mitigation measures to reduce effective impervious area and degradation of riparian forest integrity based on applying the RAR setbacks (assumed 15 m on average). Assumptions for WHTS included:

- Existing Total Impervious Area (TIA) was measured from 2007 aerial photography; and
- Unmitigated future TIA was taken from hydrologic model (assumed full OCP build out) and that RFI would be decreased to 15 m RAR buffers.

Potential Impacts of Future Development

Figure 3-4 shows the potential impacts associated with future development. All the watersheds decline in ecological health, especially Ella Stream. The goal of a RWMP is not allow watershed health for each watershed as a whole, to get worse and recommend measures to mitigate the impacts of development. To this end, riparian corridors should be protected and restored, and impervious area minimized through Low Impact Development techniques and stormwater source controls.



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland
- Surveyed Culvert/Drain

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Fish Presence

Coho and Chum Salmon

- Current Extent
- Potential Extent

Cutthroat Trout

- Current Extent
- Potential Extent

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

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Project No.	Date
2609-001	January 2012

Environmental Inventory

Figure 3-1

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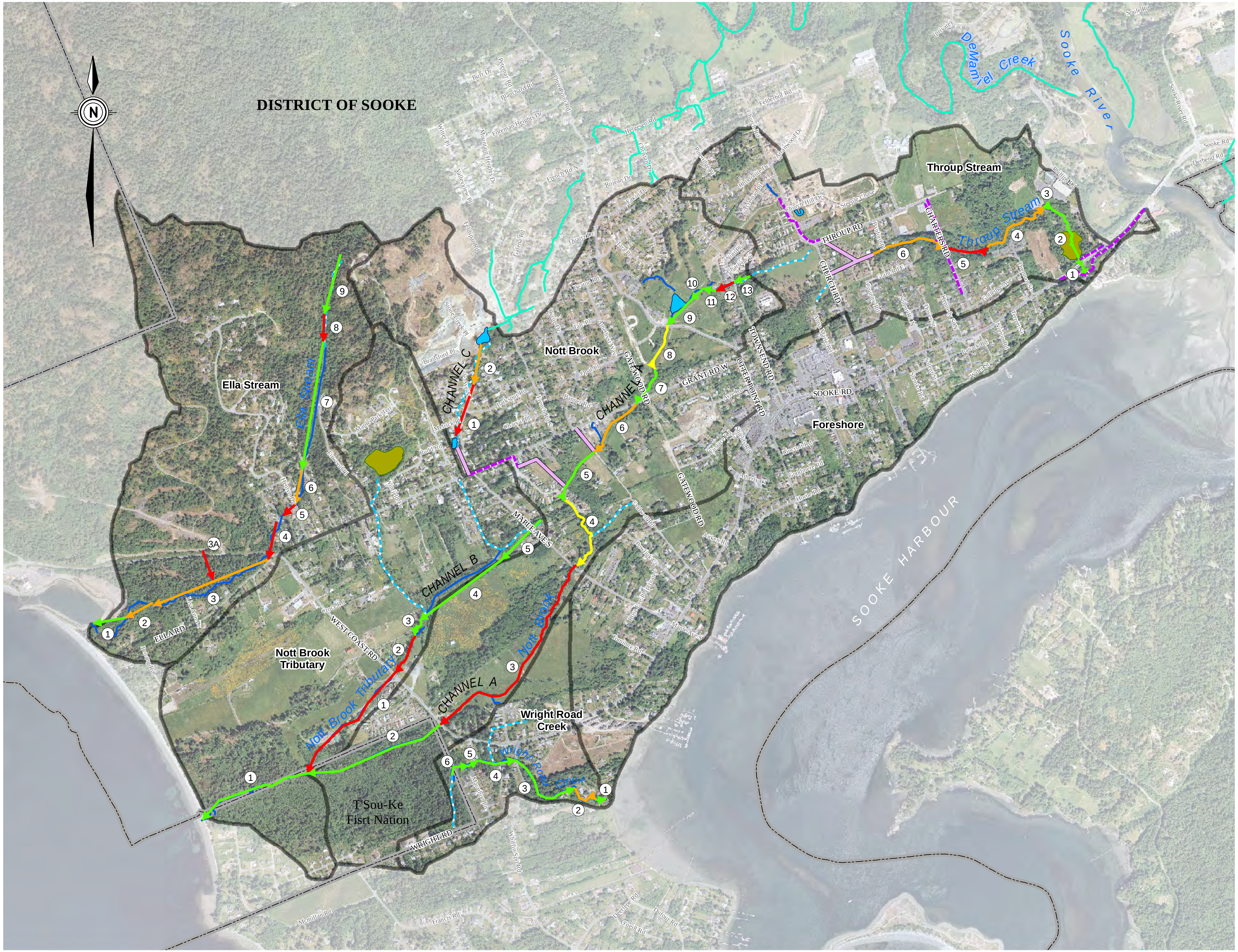
Author: jlau

District of Sooke
Nott, Throup, Wright Road and
Ella Watersheds
Rainwater Management Plan



Legend

Municipal Boundary
Watershed Boundary
Major Pond
Wetland

Watercourse

Permanent
Ephemeral
Watercourse Outside of Study Area

Major Rainwater System

Major Rainwater Drain
Major Road Side Ditch

Reach Data (PFC Rating)

Proper Functioning
Functional at Risk (Not Apparent)
Functional at Risk (Downward Trend)
Not Functional
6 Channel Reach

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Proper Functioning Condition Assessment

Figure 3-2

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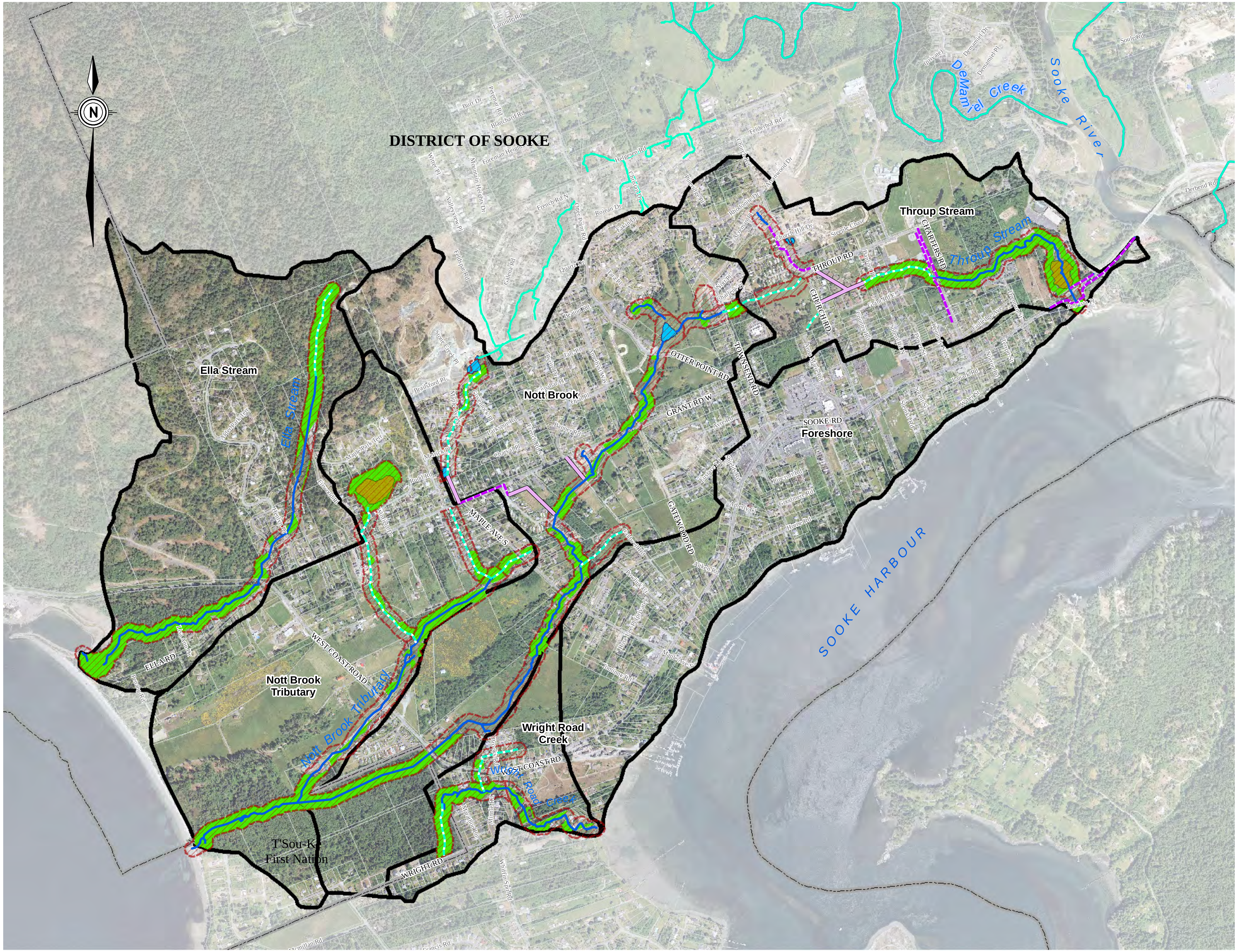
Author: jlau



District of Sooke
Nott, Throup,Wright Road and Ella Watershed
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Vegetated Riparian Area
- Riparian Assessment Area (30 m)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

30 m RFI Riparian Assessment

Figure 3-3

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Author: jlau

Figure 3-4: Watershed Health Tracking System – Sooke Watersheds

Section 4

Hydrologic and Hydraulic Modelling

4. Hydrologic and Hydraulic Modelling

4.1 Introduction

This section summarizes the hydrologic and hydraulic modelling analysis. The purpose of the analysis was to:

- Create, calibrate and validate the hydrologic model to ensure accurate predictions of watershed rainfall-runoff response;
- Determine peak design flows at strategic locations under existing land-use (2007) and future land-use (OCP) conditions; and
- Develop strategies to upgrade drainage and size conveyance systems to meet design criteria.

4.2 Flow Monitoring Data

The hydrologic models were calibrated to the flows recorded at the hydrometric monitoring station installed as part of this project on Nott Brook immediately upstream of the Maple Avenue South cross culvert (see Figure 4-1). This gauge was installed in April of 2009 and continues to operate. The gauge records water levels and is converted to streamflow estimates using a rating curve.

KWL measured the flow rate at this location for five different water depths to establish a stage/discharge relationship. This relationship allows the recorded water level to be converted to flow. The graph generated for discharge (flow) versus stage (relative depth) is illustrated on Figure 4-2.

Ideally flows and depths would be measured in the field for larger storms in order to determine a more accurate flow versus depth relationship for greater depths and flows. Unfortunately, it was not possible to collect this data. However, as the gauge site is located upstream from a culvert, standard culvert hydraulics calculations were used to extrapolate the flow rate for events greater than the largest measured flow of 0.35 m^3/s.

Historical Rainfall Data

For the development of design storms, rainfall data was obtained from Environment Canada for the *Sooke Marine Climate Station* which was in operation from 1967 to 1992. For calibration of recent events, the rainfall data from the Sooke Municipal Hall climate station was used. The locations of the climate stations are shown on Figure 4-1. This climate station was installed for this project and has been in operation since April of 2009.

4.3 XP-SWMM Modelling

The software XP-SWMM (RUNOFF and HYDRAULICS blocks) was selected for hydrologic and hydraulic analysis. The model consists of representative watersheds with associated hydrologic runoff parameters and a network of representative channels, drains and culverts. The layout of the model is shown on Figure 4-3.

XP-SWMM Hydrologic Model Catchments

Catchments

The Nott Brook, Throup Stream and Wright Creek watersheds were discretized into large catchments using contours, field watercourse information and existing drainage information. The major model catchments are shown in Figure 4-3.

In total, 16 catchments were created and imported into the XP-SWMM model. Catchments were assigned the following attributes:

- slopes, using available contour information;
- existing impervious area, using 2007 aerial photographs and the CRD 2004 Land use database to determine land use
- typical land use impervious percentage information; and
- groundwater parameters based on typical values for soils.

Impervious Percentage and Land Use

The existing land use conditions model was based on the 2007 aerial photography Figure 2-2, the CRD's 2004 land use database and typical land use impervious percentages from the table below. The aerial photograph was used to estimate the actual land use in areas that have changed since the CRD database was created. The commercial and institutional and civic amenities properties were evaluated individually by looking at the aerial photography. A unique impervious percentage was assigned to each lot depending on the lot coverage (see Table 4-1).

Table 4-1: Typical Impervious Percentages by Existing Land Use

Land Use	Existing Total Impervious Percentage
Agricultural, Nurseries and Greenhouses	5%
Commercial	Mixed
First Nations	10%
Institutional and Civic Amenities	Mixed
Parks and Green Spaces	5%
Road Right of Ways (ROW)	70%
Residential – 2 or more acres per lot	10%
Residential – New Higher Density Subdivision	70%
Residential – Single Family and Duplexes	40%
Residential – Townhouses and Apartments	60%
Residential – Trailer Parks	50%
Undeveloped	0%

Future land use impervious percentages were estimated based on the OCP Figure 3-2 and the typical land use impervious percentages (see Table 4-2).

Table 4-2: Impervious Percentages by Future Land Use

Land Use	Existing Total Impervious Percentage
Agricultural	5%
Town Centre	75%
First Nations	40%
Community Residential	40%

Groundwater and Soil Parameters

The groundwater portion of XP-SWMM – RUNOFF was used to better estimate the groundwater and interflow portions of the runoff hydrograph.

The soils mapping and hydraulic conductivity values were obtained from Lowen Hydrogeology. The lower end of the hydraulic conductivity value range for each soil was compared to typical hydraulic conductivity numbers in *Infiltration Hydrology* (Ferguson, 1994). The soils were labelled with a soil texture matching the hydraulic conductivity, ranging from sand to silt loam.

The soil parameters required by SWMM were then selected from the KWL parameter database using the assigned soil textures and the hydraulic conductivities from Lowen. The groundwater outflow was selected to be a conservative.

XP-SWMM Hydraulic Model

Culverts and Weirs

The hydraulic network includes culverts within the study reaches. Figure 4-3 shows the culvert locations and the extent of the modelled channel reaches. Channel cross-sections and culvert sizes were input from the 2008 field survey. Entrance and exit losses were added to the culverts based on the type of inlet and outlet present.

Overflows were added to several culverts located on Nott Brook, upstream of Otter Point Road. These culverts are located in a low lying area used for storage and overtop in smaller events. Weirs were added to the model to simulate this overtopping.

Boundary Conditions

The downstream boundary condition for each outfall was set to a fixed backwater condition. The elevation for the boundary was determined by selecting a high tide elevation using the 2009 Canadian Tide and Current Tables (Volume 5) for Sooke (station 7020). The TWL Regional Station Benchmark Database was then checked to determine the chart datum for the Sooke station. The downstream boundary was set to El. 1.557 m (geodetic) to reflect a high tide.

Model Verification

The model was developed for existing conditions, and calibrated and validated based on the data available. A comparison of the modelled flows and those recorded by the flow monitoring station on Nott Brook at Maple Avenue South is illustrated on Figure 4-4.

A review of this figure shows that the model flows are generally higher than the measured flows during storm events, and the measured flows are higher than the model flows during periods of little or no precipitation. This calibration was deemed adequate for the following reasons:

The stage/discharge relationship has not been confirmed for higher flows and therefore the measured flows are based on an extrapolation of the data. It is unwise to calibrate the model to approximate values when it would mean a significant reduction in flow peaks resulting in non-conservative design flows for sizing purposes.

The calibrated model unit flow rates compare well with the flows from other models that have been calibrated with significant storm events.

The model includes redirection of all impervious surfaces to pervious surfaces and a 25% reduction in the impervious areas. The soil infiltration rates were taken from the hydrogeological assessment. Further reduction in impervious areas or an increase in the infiltration rates would not be justified.

4.4 Design Storms

The design storms were developed using the intensity duration frequency curves and precipitation data obtained from Environment Canada for the Sooke Marine Climate Station.

The rainfall distribution for the design storms was determined by reviewing 25 significant storm events from 1968 to 1992. This distribution was used to establish a design storm with duration of 24-hours. Design storms were established for the 10-year, 25-year, and 100-year return periods.

Table 4-3 shows precipitation amounts for various durations for these storm events.

Table 4-3: Total Precipitation Amounts for Design Storms

Duration	Total Rainfall (mm)		
	10-year	25-year	100-year
6-hour	49.9	57.9	69.7
12-hour	73.4	85.2	102.8
24-hour	115.0	137.7	171.3

4.5 Antecedent Condition Assumptions

In order to ensure that the model was providing accurate results, precipitation was added ahead of the design storms to account for antecedent conditions. On January 6, 2009 a storm with a return period of approximately five years occurred in the Greater Victoria area. The precipitation on the days leading up to this event was fairly typical of winter conditions.

For all modelling scenarios the precipitation which occurred from January 1, 2009 to January 5, 2009 was added ahead of the design storms. The climate station installed for this project was not in operation at this time. Therefore, the antecedent precipitation data was developed based on the University of Victoria School-Based Weather Station Network climate stations at Edward Milne Community, Journey Middle, and John Muir Elementary schools. The precipitation from these three schools were averaged and used as the antecedent precipitation.

The design storms, including the antecedent precipitation, are illustrated on Figure 4-5.

4.6 Peak Flow Estimates

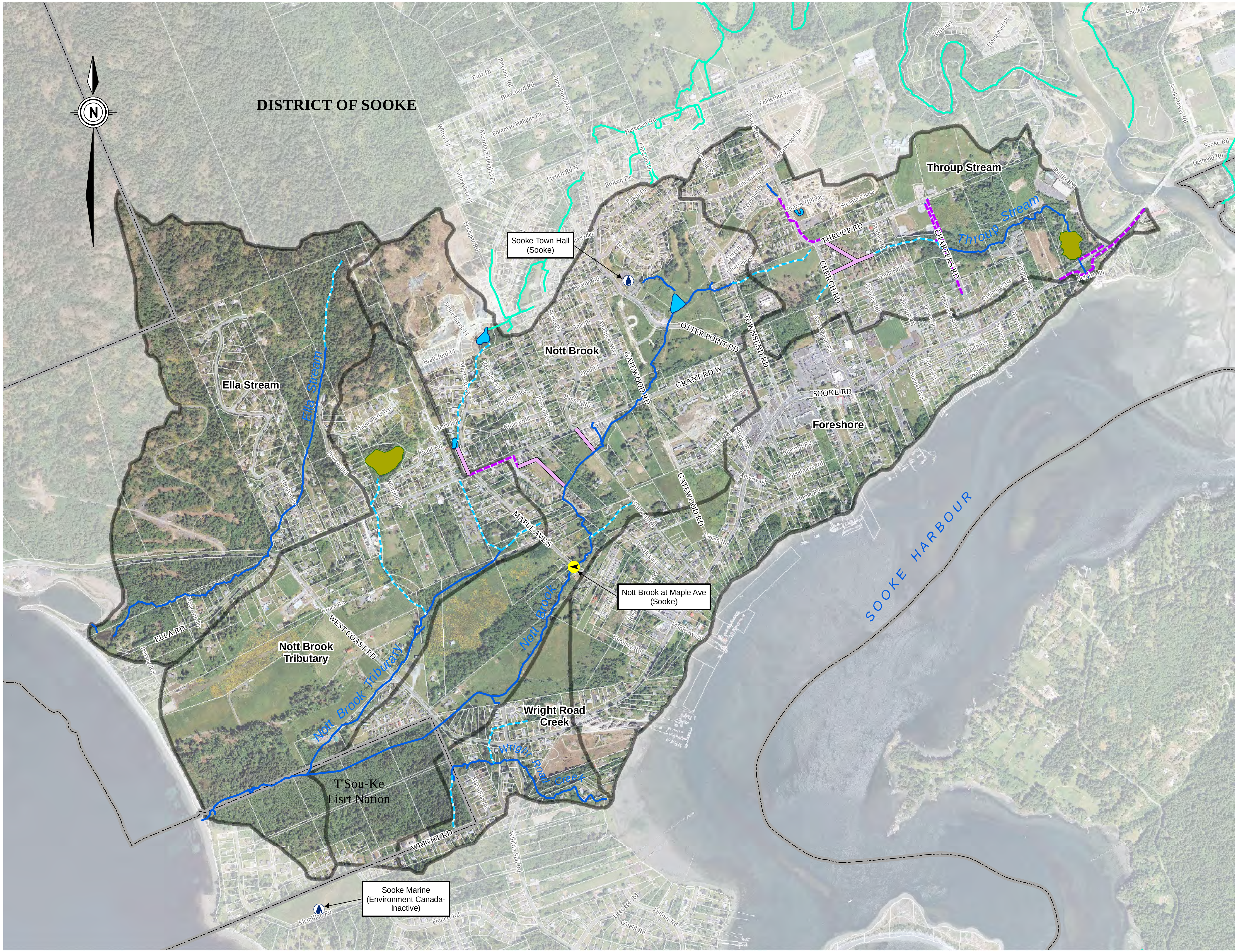
The models for existing and unmitigated future land use conditions with saturated soil conditions typical of winter conditions yielded the following peak flows estimates (See Table 4-4).

Table 4-4: Peak Flow Estimates for Existing and Future Land Uses

Location	Description	Peak Flow Estimate (m^3/s)						
		Area (ha)	Existing Land Use			Unmitigated Future		
			10-year	25-year	100-year	10-year	25-year	100-year
B-1	**Nott Brook Main-stem** at Grant Road	48.0	1.18	1.35	1.54	1.23	1.38	1.57
B-2	**Nott Brook North Tributary** at Confluence	44.2	0.78	0.78	0.78	0.78	0.78	0.78
B-3	**Nott Brook Main-stem** at West Coast Road	171.4	3.48	3.82	4.20	3.58	3.90	4.26
B-4	**Nott Brook South Tributary** at Confluence	133.8	3.71	4.67	5.77	3.99	4.83	5.85
B-5	**Nott Brook** at Outlet	331.2	7.78	9.23	10.94	8.19	9.48	11.10
C-1	**Throup Stream** at Charters Road	53.1	1.40	1.61	1.87	1.41	1.62	1.88
C-2	**Throup Stream** at Outlet	93.3	1.30	1.40	1.54	1.32	1.43	1.56
D-1	**Wright Road Creek** at Outlet	32.4	1.16	1.36	1.36	1.18	1.36	1.36
Refer to Figure 4-6 for Flow Estimate Locations Note: Flows not modelled for Ella Stream Watershed								

Impacts of Development

Comparing the existing and unmitigated peak flow estimates indicates that the future land use has only small increases in peak flows rates for the 10-year, 25-year and 100-year return periods. Typically the impacts of development are more evident in the frequently occurring flow events such as the 72% of 2-year and 2-year runoff events.



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

Municipal Boundary
Watershed Boundary
Major Pond
Wetland

Climate/Hydrometric Stations

Stream Flow Gauge
Rainfall Gauge

Watercourse

Permanent
Ephemeral
Watercourse Outside of Study Area

Major Rainwater System

Major Rainwater Drain
Major Road Side Ditch

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No. 2609-001
Date January 2012

Hydrometric and Climate Stations

Figure 4-1

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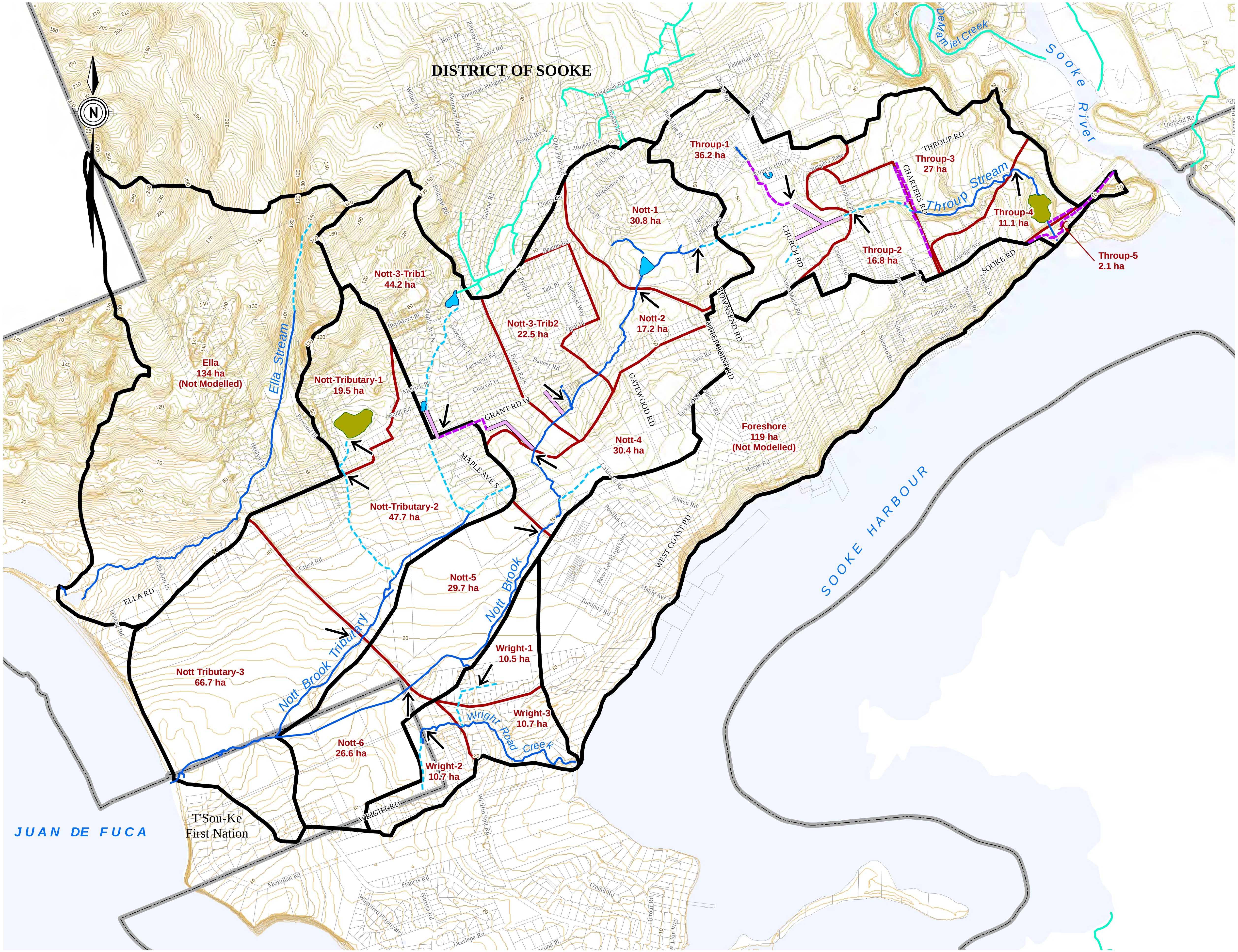
Author: jlau

Figure 4-2: Nott Brook at Maple Avenue Hydrometric Gauge – Rating Curve

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan



Legend

- Municipal Boundary
- Watershed Boundary
- ID Area — Model Catchment
- Limit of Modeled Channel
- Contour (2 m Interval)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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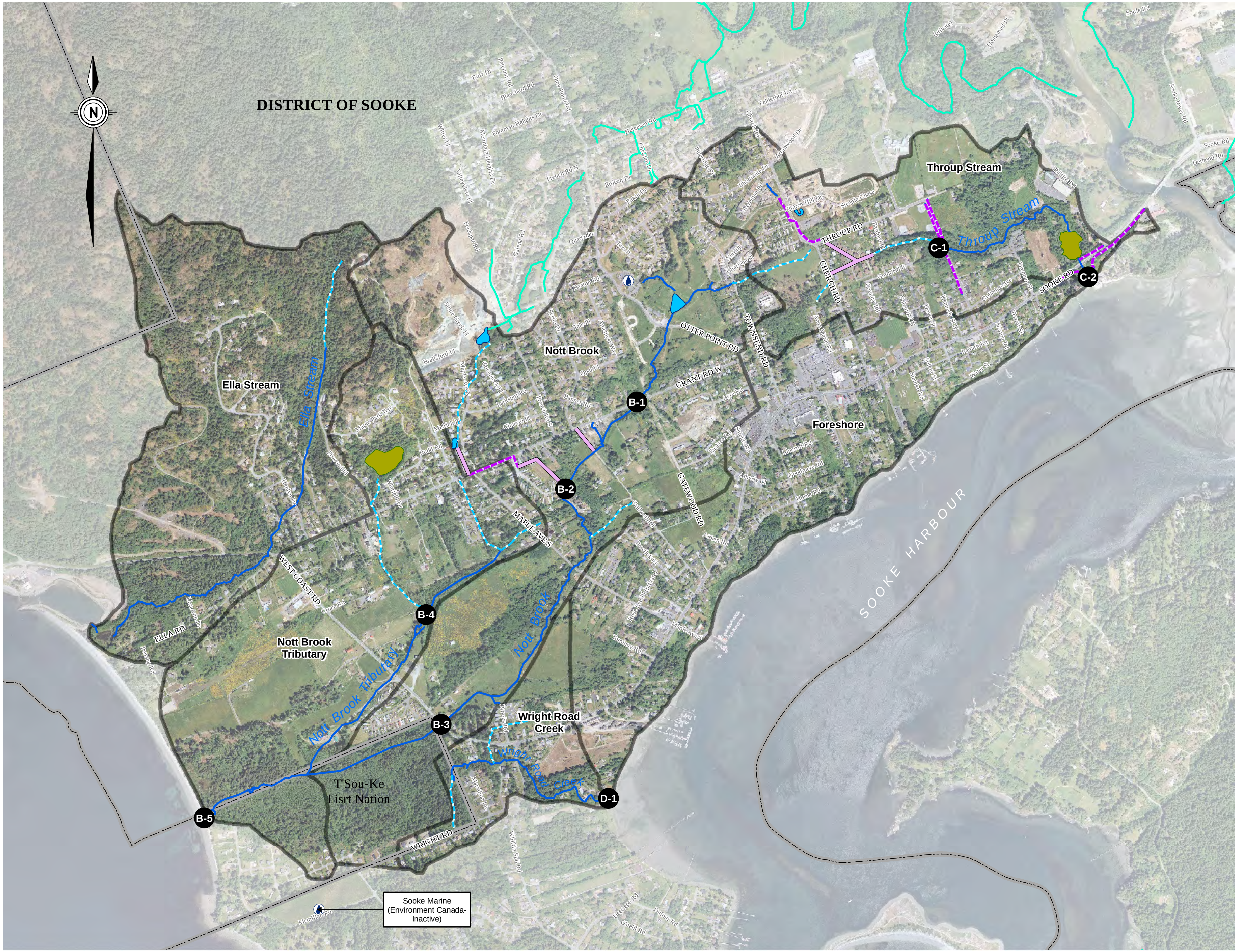
Project No.	Date
2609-001	January 2012

XP-SWMM Model Subcatchments and Schematic

Figure 4-3

Figure 4-4: Comparisons of Modelled and Recorded Flow Hydrographs

Figure 4-5: Design Storm Rainfall Hyetographs



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Modelled Streamflow Key Locations

Figure 4-6

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Author: jlau

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Section 5

Culvert Assessment

5. Culvert Assessment

5.1 Introduction

This section summarizes the drainage system assessment, evaluating the conveyance capacity of the major creek crossings to safely pass large rainfall events. A review of the model indicates that the limiting factor in the conveyance system is the culverts and storm drains, not the open channel sections. The existing and future land use models resulted in very similar peak flows at the culverts and there were no additional undersized culverts identified in the future land use model.

5.2 Culvert Assessment Design Criteria

The conveyance capacities of the major culverts/storm drains within the Nott Brook, Throup Stream, and Wright Road Creek watersheds were assessed using the District of Sooke Bylaw No. 65 Subdivision and Development Standards Bylaw, 2003 and BC *Ministry of Transportation Design Guide, 2007* criteria.

Culvert Design Criteria

- Culverts 900 mm and smaller – No surcharge during 10-year return period
- Culverts greater than 900 mm – No surcharge during 25-year return period

Additional Requirements

- Collector Roads – No overtopping during 100-year return period
- Highway 14 – No surcharge during 100-year return period
- Climate Change – If culverts are to be upgraded then culverts shall be sized to allow 15% increase in peak flow.
- Surcharing allowed where culverts pass through high (> 3 m) high road embankements and replacement would require significant excavation and backfill (e.g. Throup Stream at Charters Road).

Allowance for Climate Change

Results from other drainage and climate change impact studies recently completed in the Capital Regional District, Metro Vancouver and in Washington State show that rainfall intensity during storm events will likely increase and result in higher peak discharges. A summary of regional climate change impact studies on drainage systems is shown in Table 5-1.

Table 5-1: Summary of Regional Climate Change Impact Studies on Drainage Systems

Study	Percent Increase in Peak Precipitation	Percent Increase in Peak Flow
Bowker Creek ISMP, 2008	15% increase in 10-yr and 25-yr 1-hr rainfall	15% to 30% increase in peak flow[1]
Central Saanich ISMP, 2009	10% increase in 10-yr and 25-yr 1-hr rainfall	10% to 20% increase in peak flow
Metro Vancouver Vulnerability to Climate Change, 2008	17% increase in max. daily rainfall	N/A – Rainfall only
City of Seattle, 2006	15% increase in 10-yr daily rainfall	N/A – Rainfall only
Note:1: For Bowker Creek ISMP, increase also includes increased flows as a result of change in impervious area of about 5%.		

To account for potential increases in peak discharges as a result of climate change, the following criteria was proposed to size culvert upgrades:

- Where existing culverts have sufficient capacity, no upgrades are recommended, and
- Where existing culverts do not have sufficient capacity and upgrades are recommended, the recommended culvert size will be increased to the next available size if modelled peak flow is equal or greater than 85% of the culvert size required to pass the modelled discharge.

5.3 Culvert Conveyance Capacity Assessment Modelling Results

The modelling results of the culvert/storm drain assessment using the above criteria for the existing land-use and future land use are summarized on Figure 5-1. The model results showed 28 culverts/storm drains met the design criteria and 42 do not. These values are an assessment of each individual pipe, even if there are multiple pipes at a single location.

The modelling results are summarized in Table 5-2 and in Appendix A. The results indicate the following conclusions:

- The majority of the culverts/storm drains modelled in the Nott Brook and Throup Stream watersheds do not have adequate capacity to meet the design criteria for the existing and future land-use scenarios; and
- The culverts modelled in the Wright Road Creek watershed (except one at a trail crossing) have adequate capacity to meet the design criteria.

5.4 Mitigative Alternatives and Modelling Scenarios

To address the culvert capacity deficiencies, the following mitigative alternatives were modelled:

Table 5-2: Mitigative Alternatives and Modelling Scenerios

XP-Model	Alternative/Model Description
Future Land Use – Storage	OCP land-use, increased storage on Nott Brook upstream of Otter Point Road and on Throup Stream upstream of Church Road, existing hydraulic structures.
Future Land Use – Diversion 1	OCP land-use, existing hydraulic structures except Grant Road cross-culvert at Maple Avenue is upgraded to 450 mm and a low rock weir installed in the ditch to direct flows to 450 mm culvert.
Future Land Use – Diversion 2	OCP land-use, 14.6 ha of catchment west of French Road North diverted out of Nott Brook catchment to Helgesen Creek watershed, existing hydraulic structures.
Refer to Figures 5-2, 5-3	

Providing additional detention storage at the pond in John Phillips Memorial Park as well as at potential new location upstream of Guardian Road results in little difference in the peak flow rates and does not increase the number of culverts that meet the hydrotechnical design criteria (see Figure 5-2).

Diverting a portion of the flow from the pond at the north end of Maple Avenue North into the Helgessen Road Creek watershed to the north of the study area result in little difference in the peak flow rates in Nott Brook and does not increase the number of culverts that meet the design criteria (see Figure 5-3).

Considering the above findings, it is recommended that the District of Sooke upgrade the inadequate culverts to meet the design criteria based on the future flow rates. If road upgrades are planned upgrade the drainage infrastructure as part of these projects.

It was noted during our field visits that the driveway culverts on the north side of Grant Road West at the intersection with Maple Avenue South are subject to frequent overtopping. It is understood that Grant Road West may be upgraded in the future to accommodate the traffic volume on this route. If upgrades are made to these driveway culverts prior to the road upgrade project they should take the future road geometry into consideration. In particular the ditch and culverts should be located sufficiently away from the existing road to allow for future wider lanes and shoulders to allow for suitable ditch side slopes. Additionally the elevations of these culverts should take into consideration future road grades.

Three alternative strategies were assessed to improve upgrades to protect public safety and property including detention, diversion and culvert upgrades.

The results of the drainage assessment indicate that full culvert upgrade option is the most feasible. This is due to the large detention volumes required to reduce peak flows during extreme events and limited areas available for storage. It is likely that significant cost would be associated with the purchase of land for these detention areas.

Although full culvert upgrade is the most feasible option, upgrading the culverts will result in increased flows in downstream watersheds that will need to be considered.

In order to address channel capacity issues, construction of two-stage channels are recommended as part of riparian and habitat improvements that will be discussed as part of riparian corridor enhancement.

5.5 Recommended Culvert Upgrades

Table 5-3 summarizes the peak flow estimates at each culvert and the recommended culvert upgrades. It should be noted that although the model indicates that culverts under Highway 14 in the Throup Stream watershed are surcharing under design event conditions. They have not been recommended for replacement because of the high road embankment.

Table 5-3: Proposed Hydrotechnical Upgrades

Watershed	Link Name [1]	Diameter (m)	Future Max Flow[2] (m^3/s) Return Period			Maximum Water Elevation (US) m Return Period			Max. Surcharge Depth[3] (m) Return Period			Recommended Culvert Upgrade[4] (m) dia	Comment
			10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year		
Nott Brook	LNC01	2 - 0.9*	3.56	3.89	4.25	13.95	14.22	14.55	1.51	1.80	2.13	1.4 & 1.2*	West Coast Road Crossing
Nott Brook	LNC03	1.2	2.96	3.19	3.43	34.05	34.25	34.48	0.80	1.00	1.23	1.6 or daylight	Driveway/Trail Crossing
Nott Brook	LNC04	2 - 0.9*	2.27	2.47	2.69	34.45	34.67	34.96	0.65	0.88	1.16	0.9, 1.2* or daylight	Guardian Road Crossing
Nott Brook	LNC06	1.375	1.26	1.48	1.72	34.58	34.78	35.09	0.57	0.77	1.07	1.2	Driveway Crossing
Nott Brook	LNC08	3 - 0.6*	1.23	1.38	1.56	37.27	37.40	37.57	0.55	0.68	0.85	0.5, 0.7, 0.8*	Driveway Crossing
Nott Brook	LNC09A	0.6	1.23	1.38	1.56	37.85	38.12	38.49	0.49	0.76	1.13	0.7	Grant Road West Crossing
Nott Brook	LNC09B	0.8	-	-	-	37.58	37.79	38.06	0.22	0.43	0.70	0.9	One 0.6 m culvert and one 0.8 m culvert
Nott Brook	LNC09B2	2- 0.6*	-	-	-	37.85	38.12	38.49	0.69	0.96	1.33	2 - 0.7*	which splits into two 0.6 m culverts
Nott Brook	LNC11	0.9	0.78	0.91	1.02	41.15	41.27	41.42	-0.04	0.08	0.23	0.9	Trail Crossing
Nott Brook	LNC12	0.525	1.20	1.41	1.74	41.29	41.37	41.48	0.25	0.33	0.44	remove culverts	John Phillips Memorial Park
Nott Brook	LNC13	0.25	1.23	1.45	1.80	41.73	41.76	41.82	0.58	0.61	0.67	remove culverts	John Phillips Memorial Park
Nott Brook	LNC14	0.45	0.75	0.96	1.30	43.40	43.43	43.49	1.35	1.38	1.44	remove culverts	John Phillips Memorial Park
Nott Brook	LNT1C02	0.8	0.77	0.77	0.77	40.37	40.37	40.37	0.06	0.06	0.06	0.9	Driveway Culvert
Nott Brook	LNT1C03	0.75	0.77	0.77	0.77	43.83	43.83	43.83	0.14	0.14	0.14	0.9	Grant Road West Crossing
Nott Brook	LNT1C04	0.75	0.77	0.77	0.77	45.67	45.67	45.67	0.15	0.15	0.15	0.9	Driveway Culvert
Nott Brook	LNT1C05	0.75	0.77	0.77	0.77	46.23	46.23	46.23	0.16	0.16	0.16	0.9	Driveway Culvert
Nott Brook	LNT1C06	0.75	0.77	0.77	0.77	46.88	46.88	46.88	0.15	0.15	0.15	0.9	Driveway Culvert
Nott Brook	LNT1C07	0.75	0.77	0.77	0.77	47.24	47.24	47.24	0.37	0.37	0.37	0.9	Driveway Culvert
Nott Brook	LNT1C08	0.75	0.77	0.77	0.77	47.58	47.58	47.58	0.64	0.64	0.64	0.9	Driveway Culvert
Nott Brook	LNT1C09	0.913	0.96	0.96	0.96	48.33	48.33	48.33	0.48	0.48	0.48	1	Driveway Culvert
Nott Brook	LNTW1C02	0.45	0.23	0.27	0.30	56.59	56.69	56.76	0.14	0.24	0.31	0.6	Trail Crossing
Nott Brook	LNTWC01	0.9	1.98	2.30	2.64	17.561	17.984	18.5	0.90	1.32	1.84	1.4	
Throup Stream	LTC1	0.9	1.32	1.43	1.56	2.272	2.387	2.552	0.89	1.01	1.17	1.2	Belvista Place Crossing
Throup Stream	LTC2	0.75	1.33	1.43	1.57	3.396	3.687	4.105	2.49	2.78	3.20	1.2	Trail Crossing
Throup Stream	LTC3	2- 0.9*	1.43	1.50	1.64	3.922	4.295	4.829	0.81	1.19	1.72	high road embankment - no replacement	Sooke Road (Highway 14) Crossing
Throup Stream	LTC4	0.9	1.92	2.10	2.35	4.855	5.384	6.132	1.49	2.01	2.76	1.4	Trail Crossing
Throup Stream	LTC5	2 - 0.6*	1.41	1.62	1.88	23.181	23.456	23.85	0.14	0.42	0.81	high road embankment - no replacement	Charters Road Crossing
Throup Stream	LTC6	0.9	1.42	1.63	1.90	36.719	36.985	37.51	0.41	0.67	1.20	1.2	Banford Place Crossing
Throup Stream	LTC8	0.6	0.84	0.95	1.08	43.748	44.003	44.639	0.41	0.66	1.30	0.9	Throup Road Crossing
Throup Stream	LTT1C01	0.6	0.84	0.95	1.08	45.639	46.424	47.684	2.21	2.99	4.25	0.9	
WR	LWC06	2 - 0.5*	0.40	0.47	0.57	15.625	15.692	15.789	0.02	0.09	0.18	2 - 0.6*	Brooks Road Park Culvert

Notes:

Proposed Priorities: High Priority Projects Medium Priority Projects Long Term/Low Priority Projects

Shading indicates governing criteria

* indicates multiple culvert barrels

1 - See Figure 5-1 for culvert locations

2 - Total Maximum Flow (Total of all culvert discharges at multiple barrel crossings)

3 - Maximum surcharge depth over crown of pipe (For mutiple barrel culverts the deepest surcharge is shown)

4 - Proposed culvert size assumes hydraulic capacity governed by inlet control. Final sizing should be confirmed during detailed design.

Sizing based on drainage criteria outlined in Section 5.2 including an allowance of 15% increase in peak flows as a result of climate change.

5 - Special shape

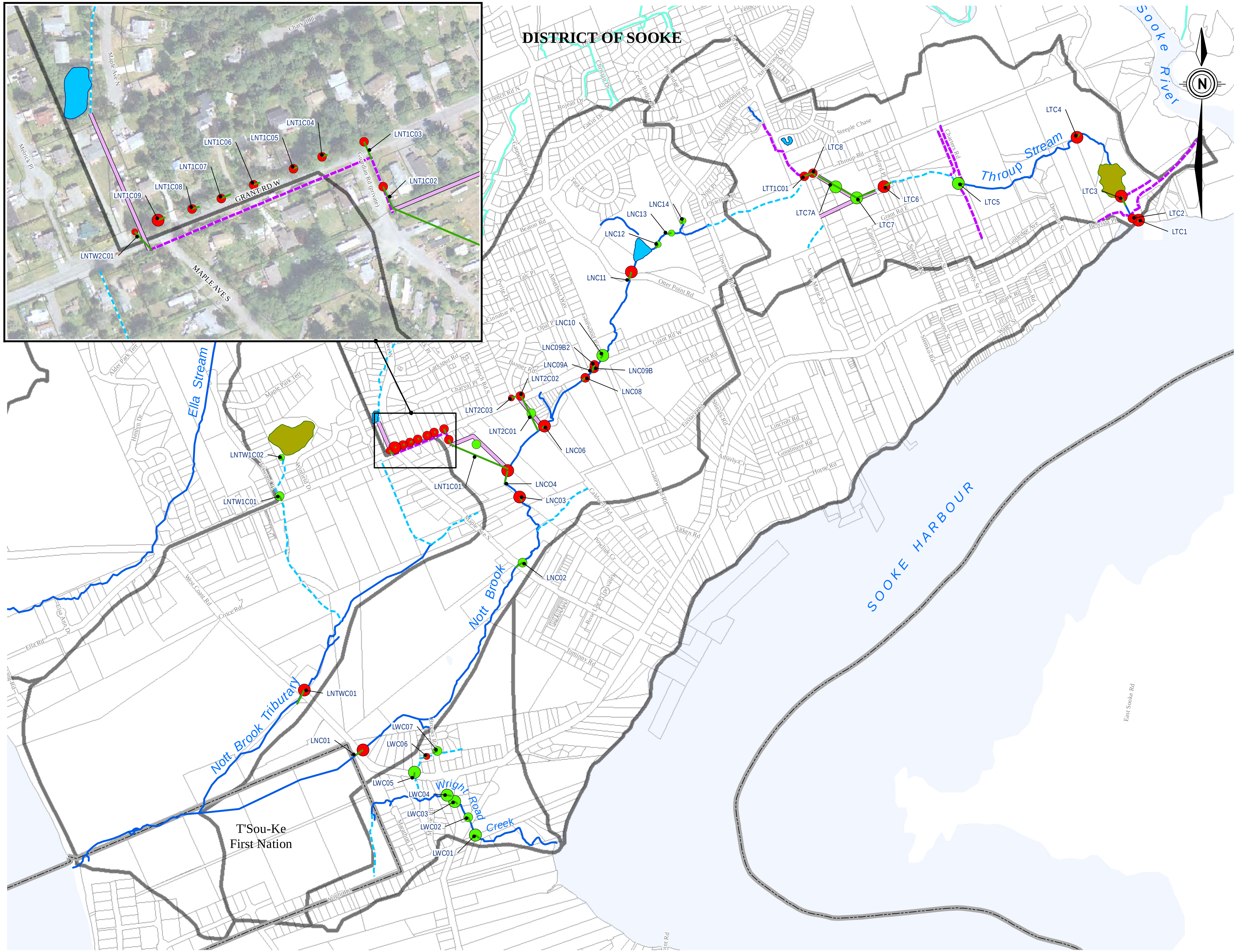
5.6 Flow Reduction Review

The model was used to assess environmental flow reduction options to protect channels from erosion. The criteria used for this assessment was reduction of the post development 2-year flow to the pre-development condition (0% impervious area). The results of several scenarios indicate the following:

- Increased detention at John Phillips Memorial Park, and North Maple Avenue Ponds could be used for flow reduction in Nott Brook for 2-year event (Figure 5-2);
- Detention storage in a potential new pond near the intersection of Throup Road and Church Road could provide sufficient capacity to reduce 2-year peak flows to protect the downstream channel from erosion. However, land costs could make this option prohibitive; and
- Partial diversion of flow in Throup Stream along new rainwater system on Throup Road could help alleviate erosion in the lower portion of Throup Stream (Figure 5-3). This work could be done as part of the upgrade of Throup Road as part of the Grant Road connector.

5.7 Drainage System for Foreshore Area Not Assessed

No detailed hydrologic or hydraulic analysis of the foreshore area was completed as part of this project. A previous study of the drainage from Highway 14 to the foreshore was completed by First Team Consulting Ltd. dated November 30, 2004. This study identified the majority of the existing main trunk storm drains have sufficient capacity but require flushing and repair of some broken sections. However, the majority of the area will be re-developed as part of the *Town Centre Plan* that will likely change drainage systems in the entire area. The rainwater system capacity should be assessed as part of the new development.



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland
- Link ID — Model Link

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Culvert

Link ID

- Less than 600 mm in diameter
- From 600 mm to 900 mm in diameter
- Greater than 900 mm in diameter

Criteria

- Meets Design Criteria
- Does Not Meet Design Criteria

REFERENCE

Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

KERR WOOD LEIDAL
consulting engineers

250 0 250 (m)
1:12,500

Project No.	Date
2609-001	January 2012

Culvert Capacity Assessment

Figure 5-1

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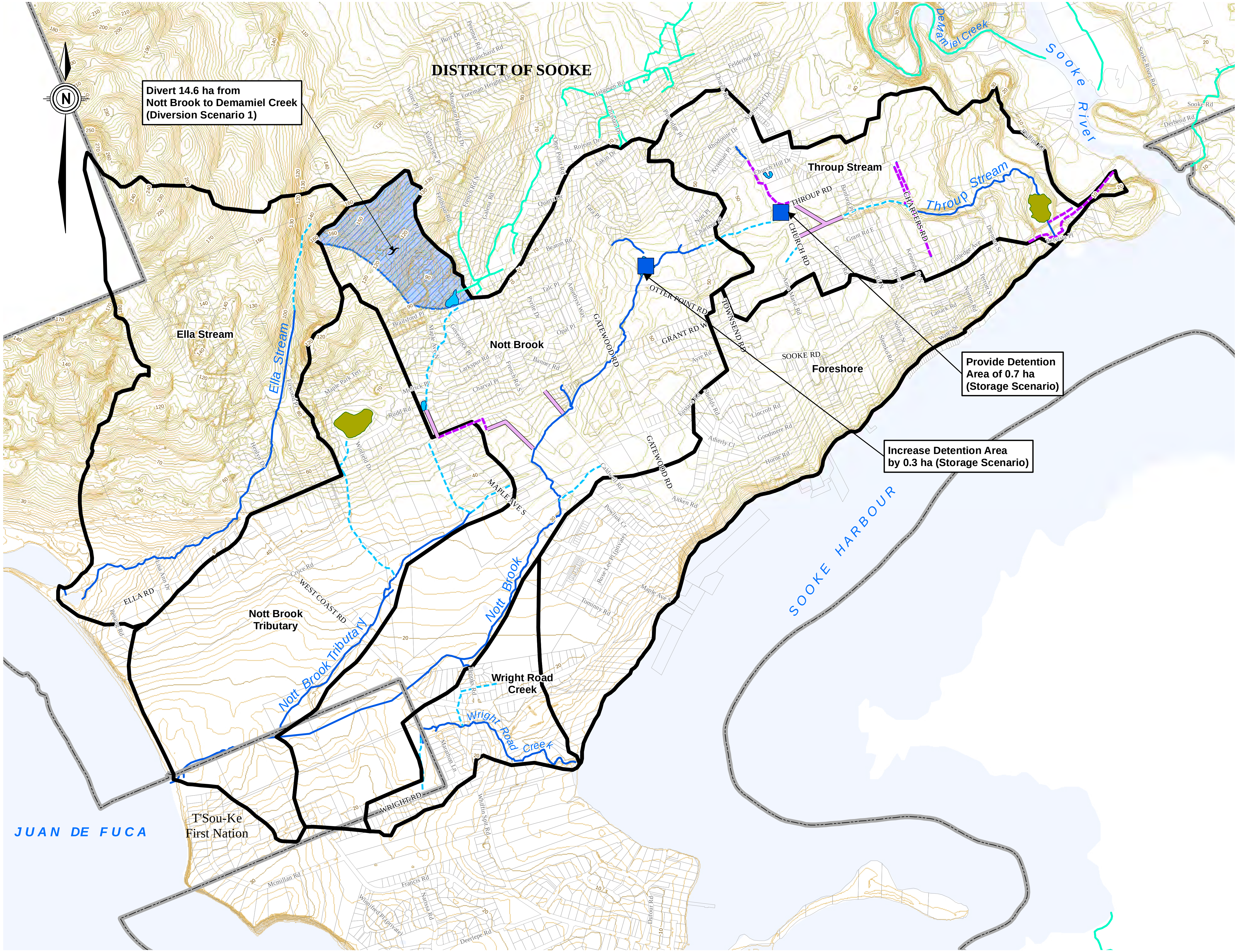
Author: jlau

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan



Legend

- Municipal Boundary
- Watershed Boundary
- Contour (2 m Interval)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

KERR WOOD LEIDAL
consulting engineers

250 0 250 (m)
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Project No.	Date
2609-001	January 2012

Flow Reduction Option 1 - Detention

Figure 5-2

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Author: jlau

Figure 5-3: Flow Reduction Option 2 – Diversions

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consulting engineers

Section 6

Mitigative Measures to Protect Watershed Health

6. Mitigative Measures to Protect Watershed Health

6.1 Introduction

In addition to hydrotechnical upgrades for safe flood conveyance, the following measures are considered to mitigate the environmental hydrologic impacts associated with development:

Table 6-1: Rainwater Best Management Practices for Environmental Protection

Best Management Practices
Planning Measures and Low Impact Development Techniques
• Protection of interception/evapotranspiration/infiltration processes in forests and forest soils
• Reduction in road density and road width
• Protection of soil structure during development
• Increased building density to allow for enhanced riparian forest or terrestrial forest protection
Source Controls
• Rain gardens, vegetated swales, pervious pavement, infiltration facilities, absorbent landscapes, green roofs
• Oil/grit separators for high-risk sites (surface parking areas, commercial sites, etc.)
Best Management Practices (BMPs)
• Water quality sedimentation ponds
• Detention ponds
• Diversions

6.2 Measures to Mitigate the Environmental Hydrologic Impacts of Development

The following stormwater management measures can be implemented to mitigate the hydrologic impacts of development:

- Low Impact Development (LID) techniques such as reduced road widths, reduced building footprints, reduced parking standards, limiting surface parking, pervious parking surfaces, building compact communities, and preserving naturally significant features;
- Source Controls such as absorbent landscaping, surface infiltration facilities, bio-retention facilities, sub-surface infiltration facilities, green roofs, rainwater harvesting and re-use;
- Water Quality Treatment BMPs such as biofilters, urban forests and leave strips, infiltration systems, constructed wetlands, and wet settling ponds. Oil and grit separators are suitable for spill control and removal of floatable petroleum-based contaminants as well as coarse grit and sediment from small areas, such as gas stations, automotive service areas and parking lots. Oil and grit separators have limited application in large-scale stormwater runoff applications, and should be limited to small area generation sites;
- Construction Best Practices for any site or subdivision work must include measures to prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substance into any ditch, watercourse, stream, or storm sewer system. The work area

should be isolated from flowing water as much as possible and diversions around the site should be provided for overland flow paths. Ensuring that all equipment used on-site is in good working order, and having a ready spill containment kit and staff trained in its use, are also critical measures; and

- Rainwater Detention Systems to limit the post-development runoff to the pre-development rate, volume, and approximate shape of the hydrograph for the 6-month/24 hour and 2-year/24-hour storm events and to maintain, as closely as possible, the natural pre-development flow pattern in the receiving watercourse.

Rainwater Infiltration Systems can retain runoff, recharge groundwater and control peak flows. The soil, through which the stormwater runoff passes, also acts as a filter removing a large percentage of the common pollutants normally discharged to the stream or creek. Infiltration can recharge local groundwater which in turn feeds smaller streams and creeks through seepage. Groundwater which is slowly discharged back into streams and can constitute all or part of a stream's baseflow. This baseflow can be critical for fish and fish habitat during extended periods of little or no precipitation and runoff. It maintains preferred spawning conditions for several salmon species which key on groundwater seepage areas for spawning and egg incubation.

In areas with well-draining soils, stormwater runoff from a site can be collected and discharged into an infiltration system where there are no conventional stormwater removal systems, or infrastructure, which reduces the costs of providing offsite conveyance.

These measures are discussed in more detail in Appendix E.

6.3 RWM Criteria for Environmental and Erosion Protection

The RWM criteria for watercourse ecological protection are summarized as follows:

- **Volume Reduction and Water Quality Treatment:** Capture 72% of 2-year, 24 hour event is a simple representation of 90% of the average annual runoff = 51 mm; and
- **Rate Control:** Detain the 2-year, 24-hour post-development event peak flows to pre-development levels, except in foreshore areas draining directly to Sooke Harbour, Sooke Basin and Sooke Bay.

These criteria are used to size source controls.

6.4 Source Control Examples for Sooke Watersheds

Source Controls

Source controls reduce runoff volumes (and localized erosion) and provide water treatment. In addition, source controls have the benefit of providing groundwater recharge and maintaining baseflow in the creek.

Selection of appropriate source controls for a particular site is dependent on the proposed land use, surficial soil type, and ground slope. The effects of these parameters are as follows:

- Proposed OCP Future Land Use: The proposed land use determines the impervious percentage of the lot, the types of pollutants that can be expected in the runoff, and the physical space constraints. Proposed OCP future land use is shown on Figure 2-3;

- Surficial Soil Type: The surficial soil type is used to calculate the infiltration rate and therefore the size of infiltration source controls. Surficial geology and infiltration and bio-retention potential is shown on Figures 3-4 and 3-5; and
- Land Slope: Land slope determines the feasibility of constructing source controls and whether infiltration into lawn/garden areas will be effective. Figure 3-5 shows the topographic contours in the watershed.

Figure 6-1 shows the assumed locations of proposed source controls. Examples of potential source controls that can be used on typical development lots are discussed in the next subsections. These examples represent worst case scenarios with small confined lots with high impervious areas and limited opportunities for rainwater facilities. They have been developed from guidance in the District of Sooke Bylaw No. 270, Sooke Zoning Bylaw (2006).

Single Family Residential Lot Example

Assuming the existing lot is 40% impervious redeveloping to 70% impervious and the native sandy loam soil has an infiltration rate of 20 mm/hr, the following source controls are proposed (Figure 6-2):

- Underground rock trench with overflow (capture and detention of 2-year provided through available storage volume in the rock pit and infiltration);
- 300 mm absorbent soils on all landscaped areas; and
- Runoff form paved areas directed to grass areas for water quality treatment.

The example property has an area of 420 m^2 (35 m x 12 m) and has an existing impervious percentage of 40%. These properties are being redeveloped to a future impervious percentage of 70% (based on air photos of recent development). A rock trench was added to this site to provide capture and detention. The rock trench would accept flow from both the roof and the other impervious surfaces on the property. The rock trench is 19 m^2 and a 1 m depth. The rock trench will have an overflow pipe to the rainwater system or ditch servicing the lot at the top of the 1 m layer of rock. Two different lot layouts were considered for the example; one that drained to the front of the property and one that drained to the back of the property. The rock pit should be located in the low spot of the property to ensure maximum capture of runoff.

Disconnected roof leaders to pervious lawn areas can be very effective on larger lots to encourage infiltration, however in these examples; there is not enough lawn area to accept the volume of roof runoff.

Multi-Family Residential Lots

Assuming the existing lots are 5% impervious (rural land use) developing to 86% impervious, the following source controls are proposed (see Figure 6-3):

- Rain garden for parking lot runoff provides water quality treatment and capture;
- Underground chamber with 150 mm depth of rock below it. The 150 mm of rock and the first 150 mm depth in the chamber provide capture for the roof water piped directly to the control manhole;
- Remaining chamber depth above outlet pipe invert and orifice in the flow control manhole outlet invert located 300 mm above bottom of rock bedding provides detention of 2-year for parking and roof areas; and

- 300 mm absorbent soils in grass or 500 mm absorbent soils in shrub and/or tree areas.

The rain garden provides the capture criteria and water quality treatment for the parking lot runoff and is located along the outer edge of the parking lot along the lot line. Figure 6-4 shows the linear treatment rain garden plan and section. The rain garden is 20 m^2 (0.75 m x 27 m) with 0.5 m thick layer of absorbent soil. Any pavement runoff that does not infiltrate into the base of the rain garden (>72% of 2-year flow) is picked up by a lawn basin and piped to the detention/capture facility located under the parking lot.

The underground detention/capture facility is located under the parking lot. The detention/capture facility consists of a rock pad that is 31 m^2 with 0.15 m thick layer of rock and six chambers that are each 2.17 m long by 1.30 m wide by 0.76 m tall. The chambers are arranged on top of the rock pad in two rows of three chambers, with a flow control manhole to detain the outflows. The roof runoff is piped directly to the control manhole and the 0.15 m rock layer plus the first 0.15 m of depth in the chambers provides the capture volume for the 35 mm of rain capture target. Water treatment is not required as runoff from the roof is generally clean. The remaining 0.61 m of depth in the chambers provides detention of the 2-year flow for the parking lot and roof areas. The outlet from the detention is located 0.3 m above the bottom of the rock pad (0.15 m above the chamber bottom). The control manhole contains a 34 mm orifice outlet located at the same level as the detention outlet and a weir at the top of chamber elevation.

Green Road Standards

Road cross-sections from the District of Sooke *Transportation Master Plan* 2008 were assessed to investigate if there was adequate space in the right-of-ways to accommodate grassy bio-swales to meet the rainwater criteria. Figure 6-5 show typical linear bio-swale details. The following cross-sections were reviewed:

- Urban/Suburban Collector;
- Urban/Suburban Local;
- Grant Road; and
- Sooke Road (Highway 14).

To meet rainwater water quality treatment, volume reduction, and rate control criteria, the road cross-sections should be modified as follows:

Apply adequate absorbent topsoil depths for plantings (i.e., 300 mm for grass, 450 to 500 mm for shrubs and/or trees);

Replace barrier or roll-over curbs with flat panel curbs so runoff can flow dispersed and not concentrated into swale and use an alternative barrier such as bollards; and

Alternatively, add curb cuts and cobbles for erosion protection. Curb cut length and spacing and pavement/swale area ratios depend on road class as shown in Table 6-2 below.

Table 6-2: Stream Health Relative to Impervious Area

Road Class	Pavement / Swale Area Ratio	Curb Cut	
		Length (m)	Spacing (m)
Urban/Suburban Collector	30:1	0.5	8
Urban/Suburban Local	50:1	1.0	30
Grant Road	30:1	0.5	15 (staggered)*
Sooke Road/Hwy 14	20:1	0.5	6
* Cuts on each side of centre median swale must not line up. If they do line up, spacing must be reduced to 8 m.			

6.5 Agricultural Management Practices

Environmental Farm Plan Program

It is recommended that the District of Sooke encourage and support the implementation of the Environmental Farm Plan (EFP) in the watershed. The EFP is a voluntary program that farmers and ranchers can use to identify both environmental strengths and potential risks on their land. The EFP program is initiated by Agriculture and Agra-Food Canada and is implemented at the provincial level through the BC Ministry of Agriculture, and the BC Agriculture Council. Please refer to the following website: http://nww.agF.gov.bc.ca/resmgnt/envirofarmplanning/index.htm. Some of the relevant references on this website include:

- Environmental Farm Drainage Management Guide, April 2005;
- Nutrient Management Reference Guide, October 2010;
- Riparian Management Field Workbook, September 2010; and
- Planning for Biodiversity: A Guide for BC Farmers and Ranchers, March 2010.

The EFP program highlights the provincial and federal legislation applicable to environmental risks in agriculture such as the provincial *Drinking Water Protection Act*, *Health Act*, *Environmental Management Act*, *Water Act*, *Wildlife Act*, *Fish Protection Act*; and the federal *Fisheries Act*, *Migratory Birds Convention Act*, and *Species At Risk Act*. The EFP process aids agriculture in meeting the regulations thus helping to reduce the need for addition environmental legislation. Through the development of a plan, farmers are encouraged to adopt beneficial management practices as laid out in the EFP literature. The plan establishes priorities and develops potential site-specific solutions. Farmers with an approved plan are then eligible to apply for cost sharing incentives through the *National Farm Stewardship Program* (NFSP) to implement identified actions.

Relative to water quality and quantity issues, the EFP addresses:

- contaminants and contaminant pathways that affect drinking water and aquatic life;
- temperature and dissolved oxygen that affect aquatic life; and
- water withdrawal affecting water quantity.

Beneficial management practices are outlined that if implemented would protect Ella Stream, Nott Brook, Throup Stream, Wright Road Creek and the underlying aquifer. These include:

- buffers to minimize movement of nutrients, pesticides, pathogens and sediment, and manage contaminated runoff;
- practices for works in and around springs and streams to protect water quality;

- surface and ground water withdrawal licenses, irrigated area and water storage (protection of aquifer water levels and creek base flow);
- managing livestock access to watercourses;
- water control structures affecting fish;
- controlling runoff to prevent surface water contamination and damage to aquatic habitat;
- containment and treatment of contaminated leachate in the soil;
- improve riparian vegetation to prevent bank erosion and improve fish habitat;
- drainage system design to minimize pollution sources and instream disturbance and mitigate peak stream flows and prevent bank erosion and downstream flooding; and
- protection of biodiversity.

In addition to the BMP for riparian areas there is an assessment checklist and guidelines for managing farm activities around riparian areas.

The process to developing a plan involves attending a workshop, conducting a risk assessment, developing a plan and having the plan approved by a recognized EFP planning advisor.

Code for Environmental Practice in Waste Management

The Code of Agricultural Practice for Waste Management is summarized on

http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/131_92.htm

In it, it states:

> *"Prohibited application*
>
> *13 Agricultural waste must not be applied to the land if, due to meteorological, topographical or soil conditions or the rate of application, runoff or the escape of agricultural waste causes pollution of a watercourse or groundwater.*
>
> *Conditions unfavourable to application*
>
> *14 Agricultural wastes must not be applied*
>
> *(a) on frozen land,*
>
> *(b) in diverting winds,*
>
> *(c) on areas having standing water,*
>
> *(d) on saturated soils, or*
>
> *(e) at rates of application that exceed the amount required for crop growth.*
>
> *if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary."*

Control of water contamination from agricultural wastes depends on compliance with the Code of Agricultural Practice for Waste Management http://www.oag.bc.ca/pubs/1998-99/report-5/sec-4-6.htm.

Normally, discharging waste to a water body in British Columbia requires a permit under the Waste Management Act. However, agricultural operations are exempt from this permit requirement if they follow the Code of Agricultural Practice for Waste Management, which lays out methods for managing agricultural waste in an environmentally sound manner. These methods are set out in more detail in a series of environmental guidelines for different agricultural specialties.

Because it lacks the staff and budget to monitor compliance with the Code of Practice, the Ministry of Environment tends to take action on possible water pollution from farm wastes only when it receives a complaint. Complaints are referred to a volunteer inspection team made up of farmers whose specialty is the same as that of the farm being investigated. This peer group can advise the farmer on how to correct any violations, and may allow up to six months for that to happen. If a farmer does not comply, then the ministry deals with the problem directly. It can investigate and, if necessary, issue a pollution abatement or pollution prevention order.

Issuing an order is an expensive and legalistic process, and orders are often appealed. Nevertheless, if an order is ignored or unsuccessfully appealed, charges can be laid under the provincial Waste Management Act or federal Fisheries Act.

To succeed, the current regulatory process depends on compliance by farmers. Although information and education programs have made farmers aware of the need for good waste management, these efforts have not convinced enough of them to follow the Code of Practice to solve the nutrient-loading problem.

Riparian Setback Standards for Agriculture

The BC Ministry of Agriculture has also produced a draft standard for *Agricultural Building Setbacks From Watercourses in Farming Areas, May 2011*. This is a prescriptive approach where the distance from a watercourse to the nearest new building, or other impervious area, is determined based on the type of watercourse classification and the nature of the building. For instance building containing solid agricultural waste should be set 30 m from a natural stream while a greenhouse can be set 15 m away. This standard complements the *Riparian Area Regulation* that has been set for urban areas.

6.6 Preservation of Riparian Areas in Accordance with RAR

The District of Sooke has incorporated the RAR into its zoning bylaw which was enacted under Section 12 of the *Fish Protection Act* in July 2004. Any new development or re-development will require preservation of these set-backs and enhancement with restoration works.

The RAR is applicable to every watercourse. Each watercourse has a 30 m Riparian Assessment Area on each side. Any proposed development within this area is subject to the *Riparian Areas Regulation* and must be assessed by a Qualified Environmental Professional.

Refer to Figure 6-1 showing RAR areas for each watercourse (30 m on each side of all ditches, creeks, wetlands, ponds and lakes).

6.7 WHTS with Source Controls & Riparian Restoration

As discussed in Section 3.4, the WHTS is a tool that can be used to predict watershed health, indicated by B-IBI, based on TIA and RFI. Figures 6-6 to 6-11 show the WHTS for Ella Stream, Throup Stream, Wright Road Creek, Nott Brook, and Nott Brook Tributary, respectively. The figures show the existing condition as well as the future condition with and without mitigation measures implemented. The future condition without mitigation assumes development in accordance with OCP without source controls and of existing riparian vegetation under the RAR. B-IBI scores were also predicted for the future mitigated conditions. The future mitigated predicted B-IBI scores assume the impacts of source controls in areas that may develop or redevelop (based on changing land use from existing to OCP) and riparian enhancement and reforestation within the RAR setbacks where the opportunity exists.

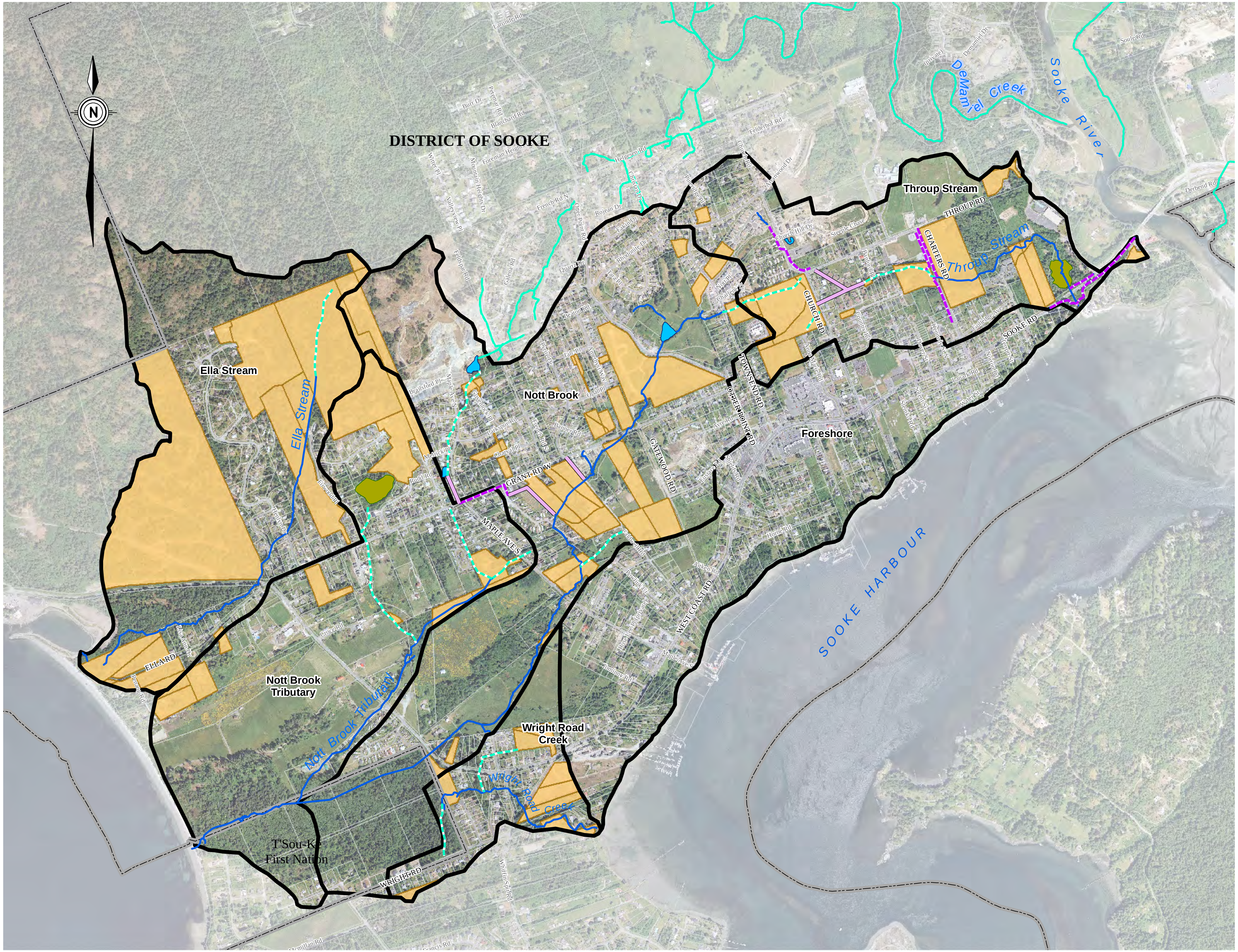
Assumptions for WHTS

- The existing point used existing Total Impervious Area (TIA) measured from 2007 aerial photography.
- The unmitigated future point used future TIA from model (assumed full OCP build out) and that RFI would be decreased to 15 m RAR buffers.
- The mitigated future point was calculated assuming that:
  - Source controls would be implemented only on the land that experiences the following conditions (see Figure 6-8 for the location of lots assumed to have source controls):
    - Vacant lots zoned residential in the existing land use and “Community Residential” OCP land use;
    - Lots zoned “Residential 2 or more acres per lot” in the existing land use and zoned “Community Residential” in the OCP land use (assumed that the lots would be subdivided and developed); and
    - Lots zoned “Agricultural, Nurseries and Greenhouses” in the existing land use and zoned “Community Residential” in the OCP land use (assumed that the lots would be subdivided and developed).
      - Single family residential (SFR) with source controls would be 4% impervious;
      - Multi-family with source controls would be 35% impervious; and
      - Ella Stream SFR will be 35% impervious (because of soils and difficulties with source controls in the area.

The goal of the RWMP is not allow watershed health for the watershed as a whole to get worse and strive to maintain the indicators at 2007 levels.

B-IBI is widely used for monitoring the biological condition of small streams because it shows a consistent relationship with independent measures of watershed-level change. B-IBI has been found to be strongly correlated with watershed imperviousness and riparian forest cover in streams in the Lower Mainland and elsewhere in the Pacific Northwest. These watershed land cover variables encompass a broad range of hydrologic, chemical, and physical stressors that affect small streams generally and the benthic invertebrate community specifically even if the causal mechanisms of their effects are unclear.

To meet the RWMP goal riparian corridors are to be protected and restored, and impervious area minimized. This includes implementing Low Impact Development techniques and mitigative source controls discussed in Section 6.



District of Sooke
Nott, Throup,Wright Road and Ella Watershed
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland
- Assumed Source Controls

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

REFERENCE

Topographic data and 2007 Aerial photography provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Lots Where Source Controls were Assumed

Figure 6-1

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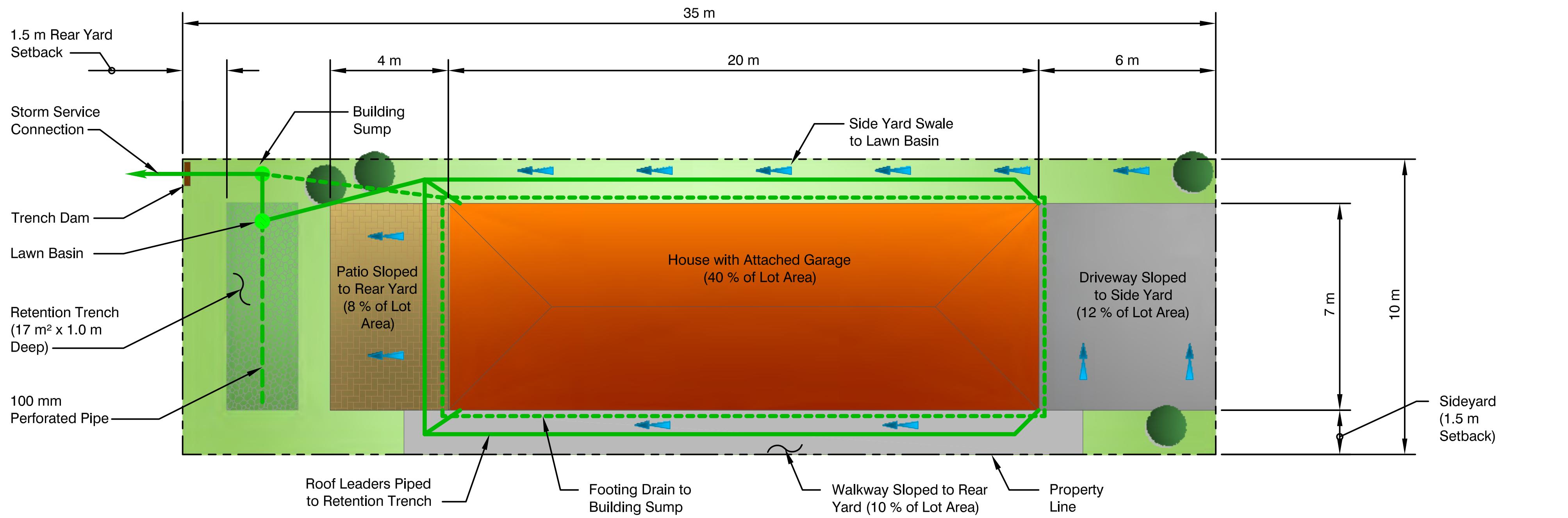
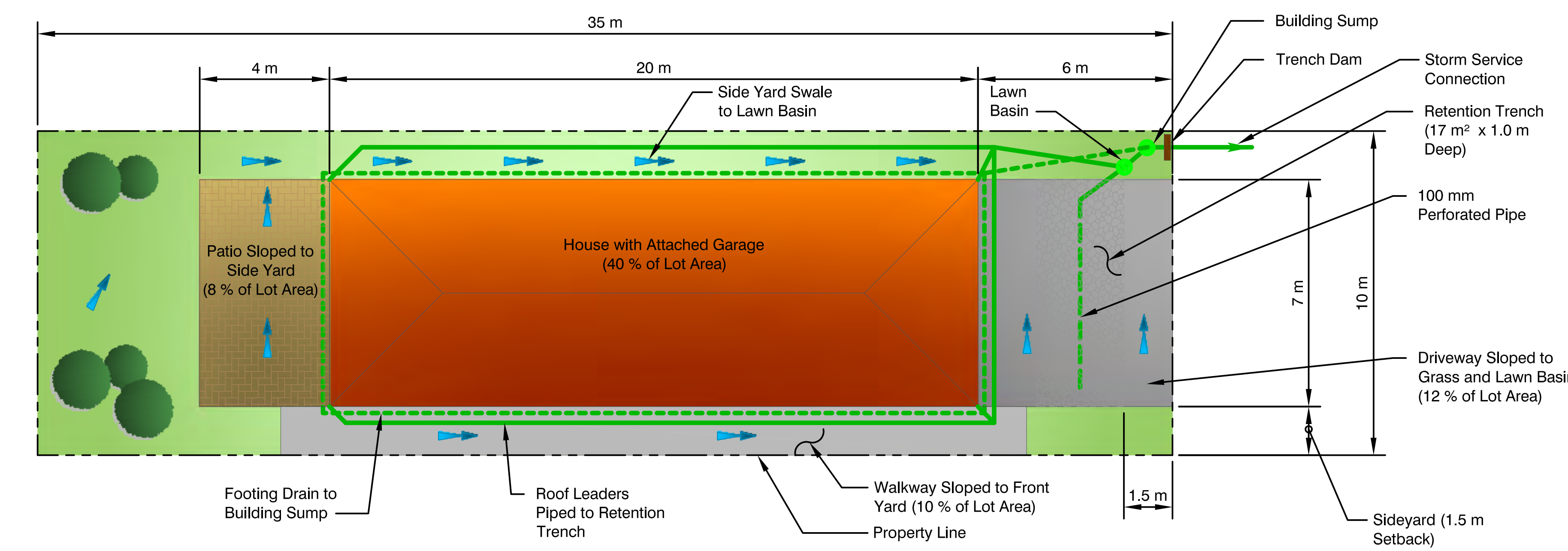
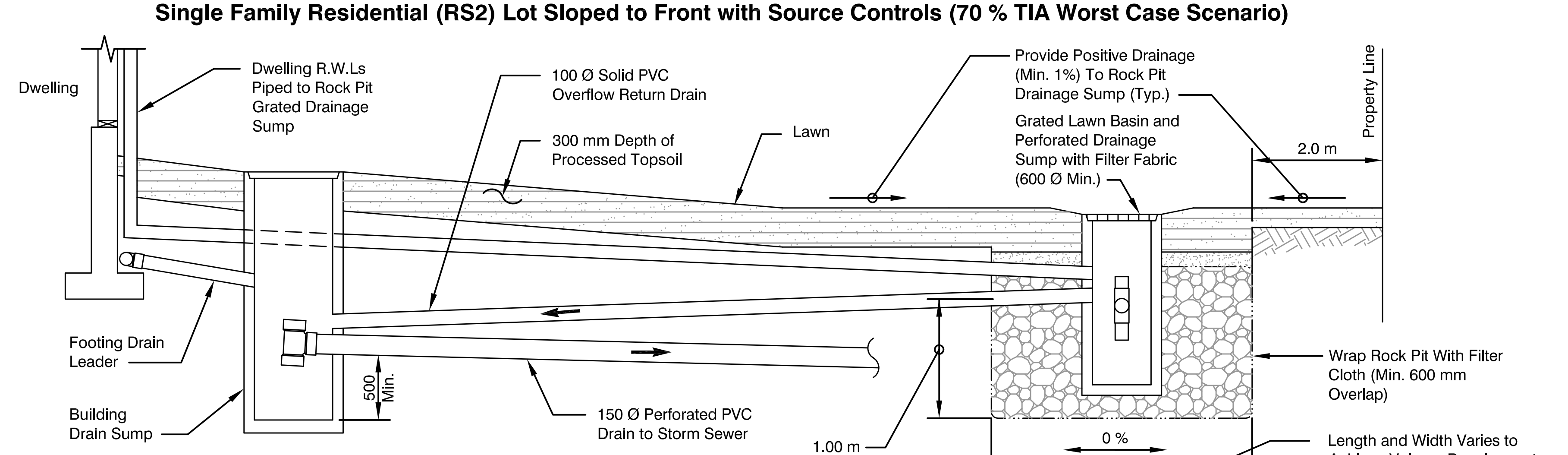
Author: jlau



Single Family Residential (RS2) Lot Sloped to Rear with Source Controls (70 % TIA Worst Case Scenario)



Single Family Residential (RS2) Lot Sloped to Front with Source Controls (70 % TIA Worst Case Scenario)



Detail

Notes:

1. Shoring may be required when constructing next to existing structures on adjacent lots.
2. Overflow pipe from lawn basin to building sump must be lower than house footing elevation where retention trench is closer than 5m to the house foundation.
3. Where retention trench is closer than 5m to existing structures on adjacent lots, ensure low permeability material is present between the trench and the property line.
4. Trench dam shall be constructed from compacted impervious backfill (glacial till) for entire service trench width. Extend to 200 mm above top of trench.
5. Rock trench footprint area required can be estimated as 5.0 % of lot area.

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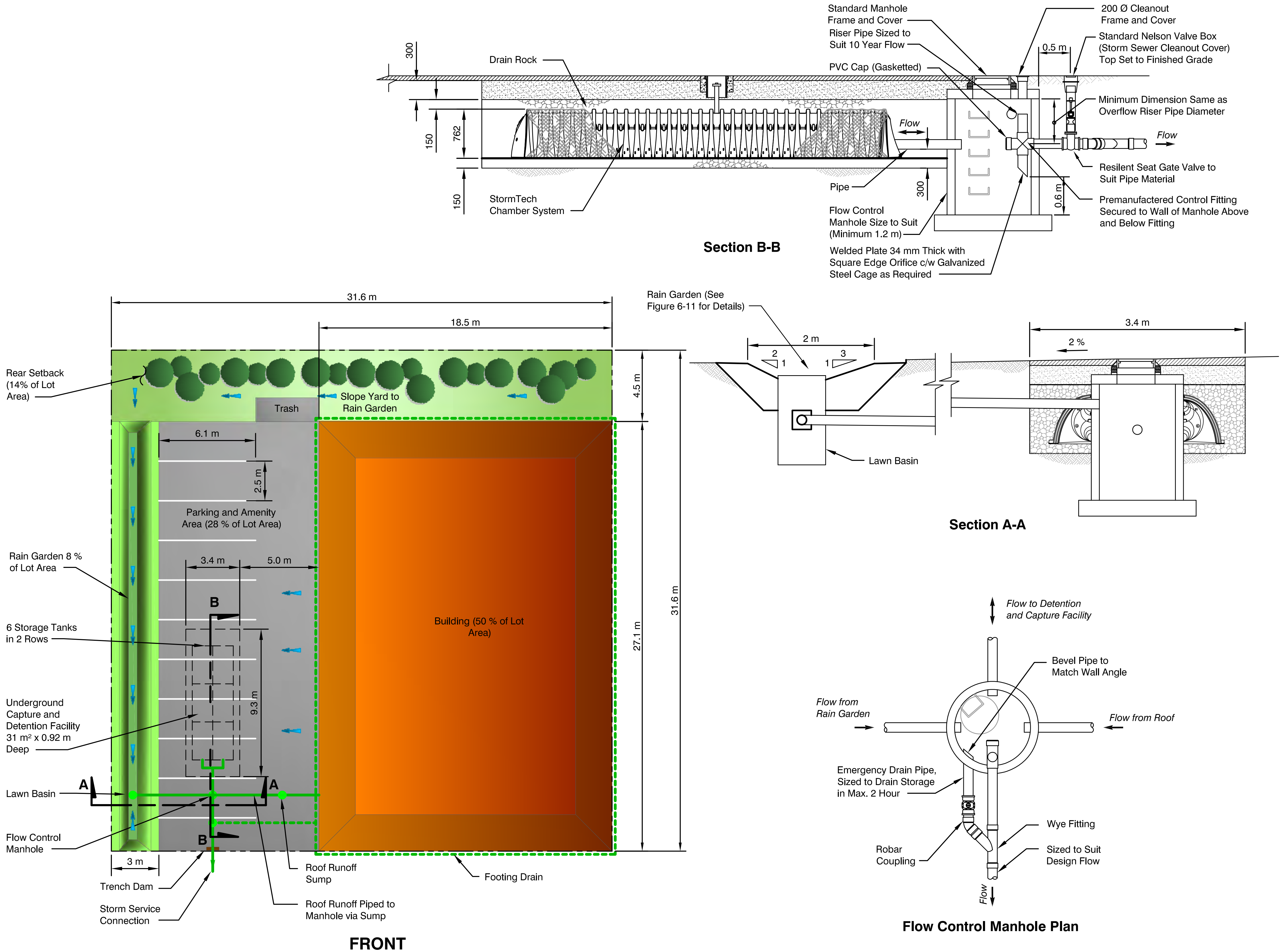
Not to Scale

Project No.	Date
2609-001	January 2012

Source Control Example Single Family Residential

Figure 6-2



Multi-Family Residential (RM4) with Source Controls (78 % TIA Worst Case Scenario)

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Notes:

1. Topsoil depth is 300 mm in grass or 500 mm in shrubs and trees.
2. Trench dam shall be constructed from compacted impervious backfill (glacial till) for entire service trench width. Extend to 200 mm above top of trench.
3. Rock trench footprint area can be estimated as 5.0 % of lot area.

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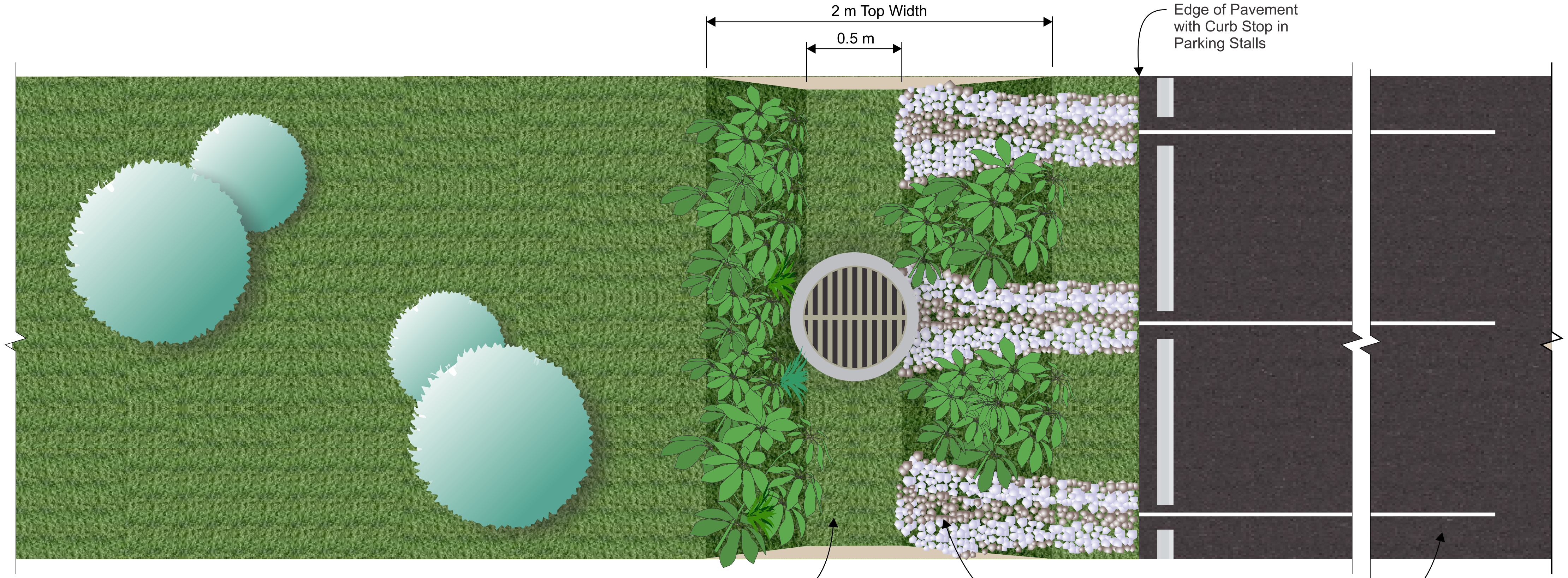
Not to Scale

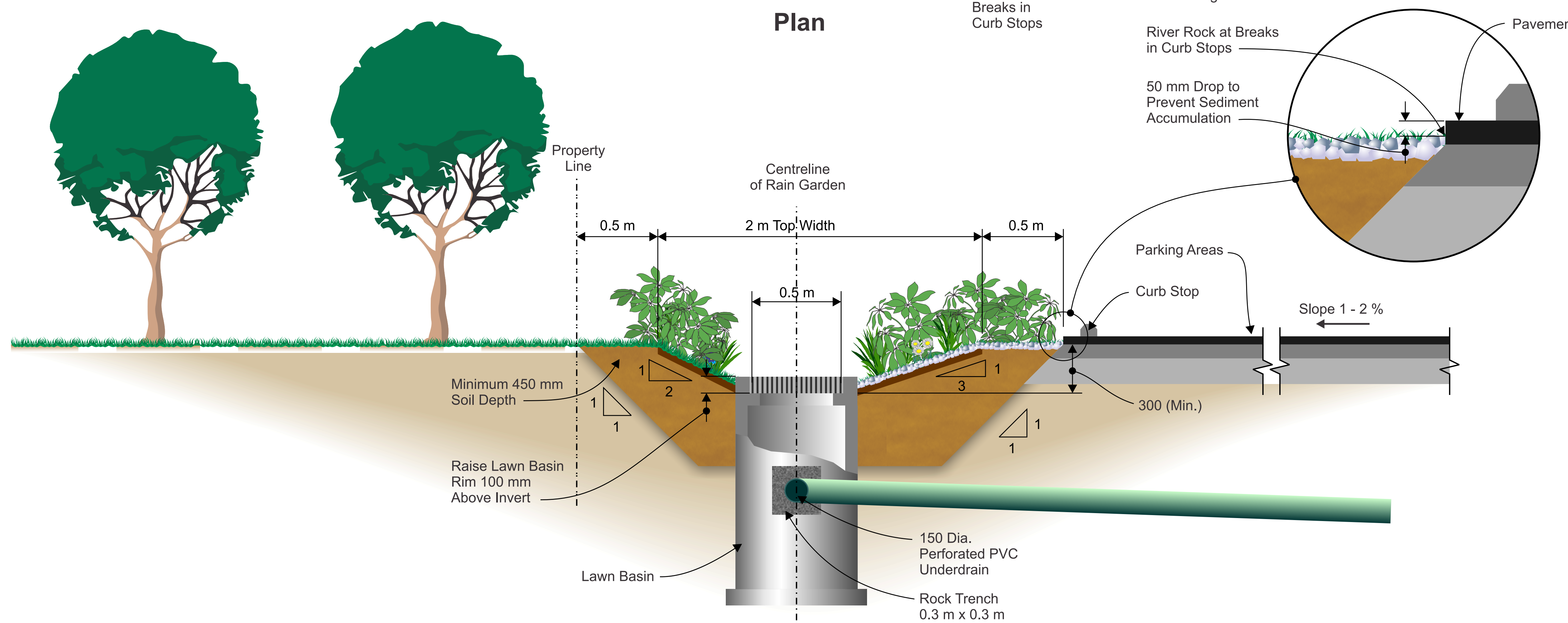
Project No.	Date
2609-001	January 2012

Source Control Example Multi-Family Residential

Figure 6-3



Plan



Section

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Notes:

1. Rain garden bottom must be a minimum of 0.15 m wide, and minimum 0.3 m deep.
2. Lot grading to provide a failsafe major flow route towards municipal major drainage system.

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Not to Scale
Dimensions in (mm)

Project No.	Date
2609-001	January 2012

Linear Treatment Rain Garden

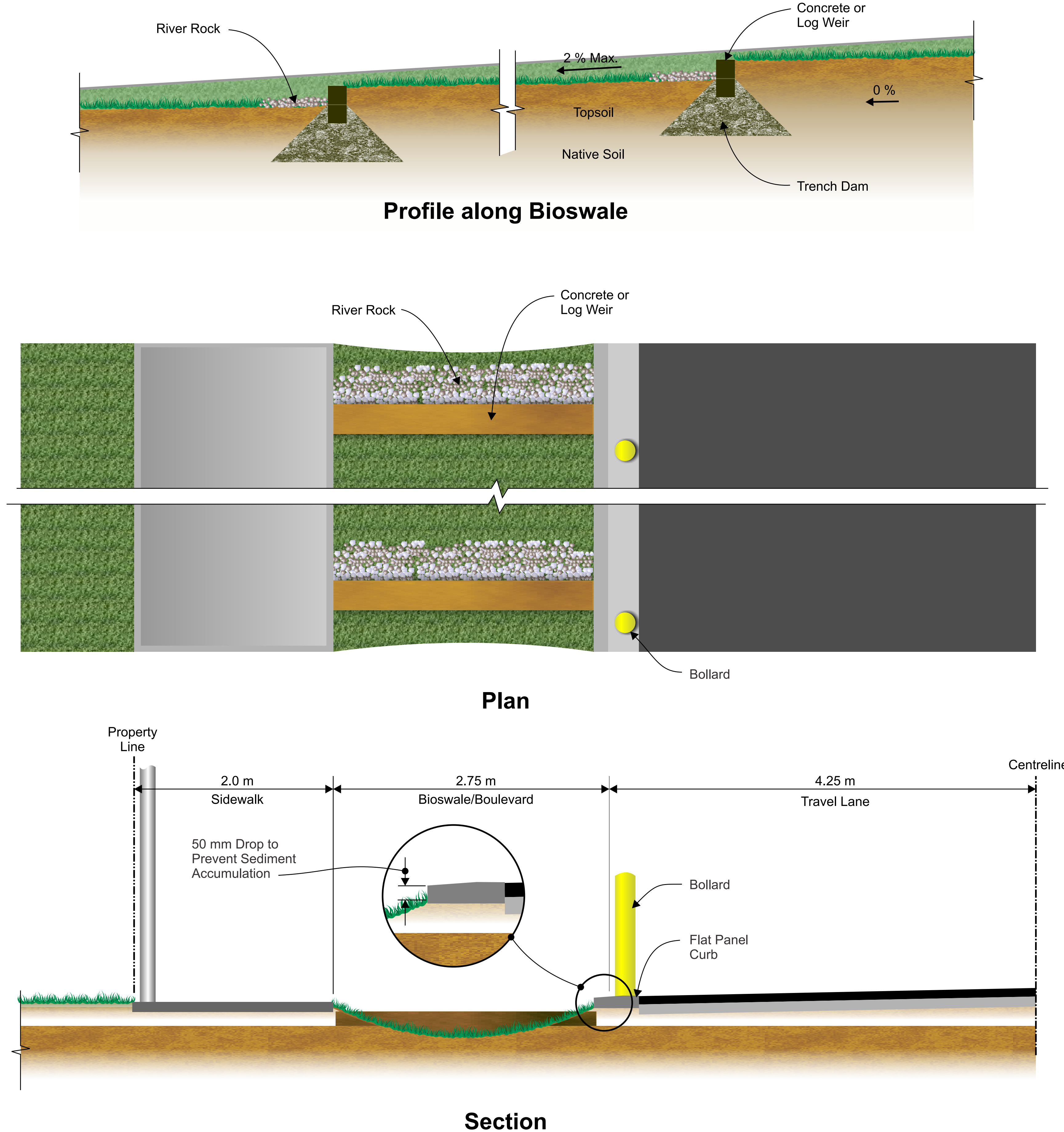
Figure 6-4

2609-001\500-Drawings\2609001Fig6-4.CDR

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Notes:

1. Rain garden bottom must be a minimum of 0.15 m wide, and minimum 0.3 m deep.
2. Lot grading to provide a failsafe major flow route towards municipal major drainage system.



KERR WOOD LEIDAL consulting engineers

Not to Scale
Dimensions in (mm)

Project No.	Date
2609-001	January 2012

Linear Treatment Bioswale

Figure 6-5

2609-001\500-Drawings\2609001Fig6-5.CDR

Figure 6-6: Watershed Health Tracking System – Ella Stream

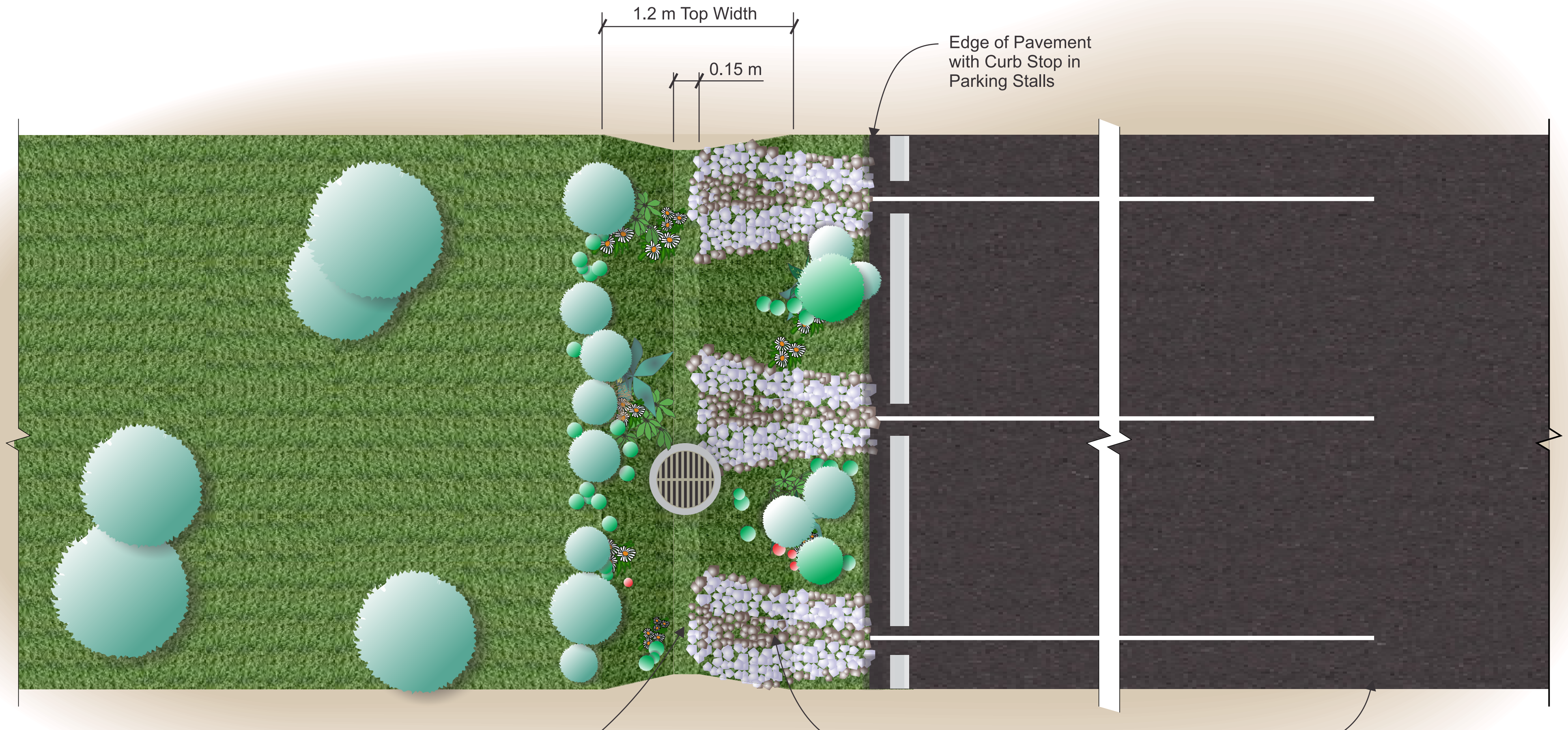
Figure 6-7: Watershed Health Tracking System – Throup Stream

Figure 6-8: Watershed Health Tracking System – Wright Road Creek

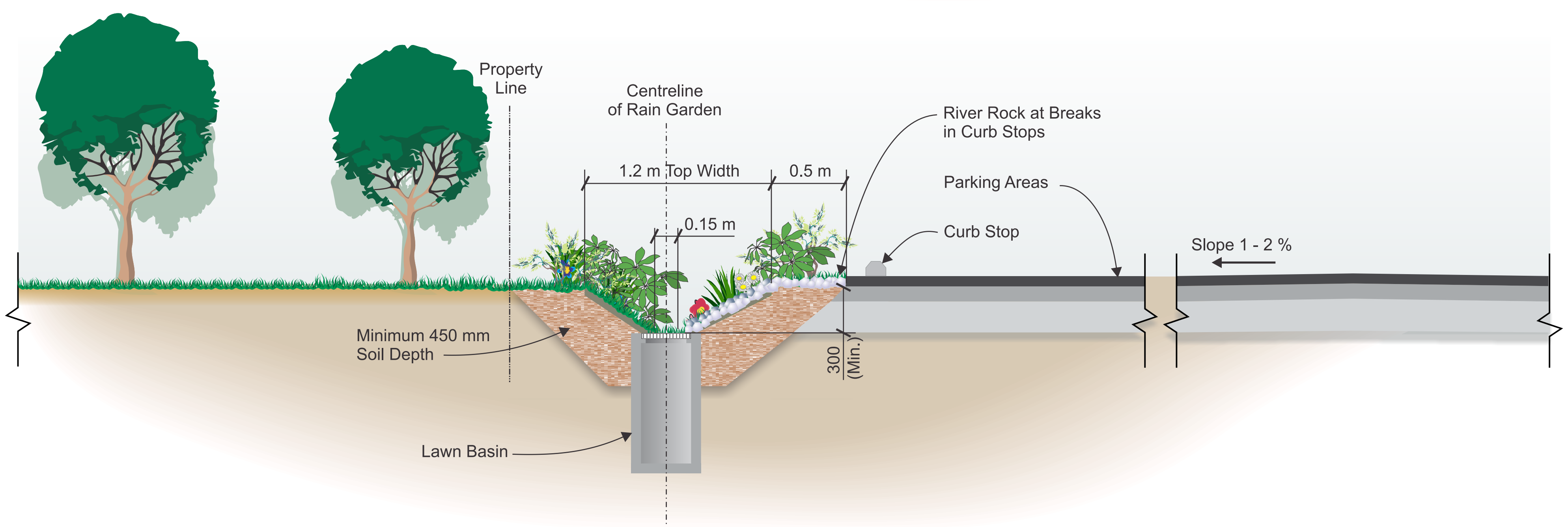
Figure 6-9: Watershed Health Tracking System – Nott Brook at Tributary Confluence

Figure 6-10: Watershed Health Tracking System – Nott Tributary

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan



Plan



Section

Notes:

1. Rain garden bottom must be a minimum of 0.15 m wide, and minimum 0.3 m deep.
2. Lot grading to provide a failsafe major flow route towards municipal major drainage system.

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Not to Scale
Dimensions in (mm)

Project No.	Date
2609-001	February, 2011

Linear Treatment Rain Garden

Figure 6-11

2609-001\500-Drawings\2609001Fig6-11.CDR

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Section 7

Proposed Rainwater Management Plan Strategy

7. Proposed RWMP Strategy

7.1 RWMP Guiding Principles

The primary objective of the RWMP is to provide “on the ground” solutions for rainwater management issues in the watersheds. The solutions address the three primary goals of the RWMP:

1. Protect public safety and private property from flooding;
2. Improve and protect stream and riparian habitat; and
3. Improve and protect water quality for instream aquatic habitat, public health and receiving waters.

The following sub-sections outline proposed strategies for each of these goals. An overview of the recommended strategies and the goals they strive to achieve is shown in Table 7-1. More detailed discussion of specific projects required to implement these strategies are outlined in Section 8 – Implementation Plan.

7.2 Traditional Urban Drainage versus Integrated Rainwater Management

Traditional urban drainage systems were designed only to protect public safety and property from flooding. They were designed to efficiently carry runoff away from development and discharge into the receiving waters. These systems include paved roads, gutters, catch basins, ditches, and storm drains. Design criteria typically required systems to be designed to handle up to large flood events that do not occur regularly (ie: between 10-year and 100-year events).

Since traditional drainage systems are very efficient at transporting runoff, they accelerate the runoff process and increase peak discharges. This can and often does have negative impacts on the receiving watercourses in the form of channel erosion, habitat degradation, reduced baseflow and reduced water quality. These systems are still a very important part of the flood conveyance system, but now there is more emphasis on the frequently occurring events and protection of watercourse health and stability.

An integrated approach considers the entire hydrological regime from large storm events that rarely occur to small rainfall events that occur on a regular basis to baseflows supporting habitat during dry periods. The *BC Stormwater Planning Guidebook* divides the hydrological regime into three components:

Rare extreme events (peak flow greater than 2-year return period) that should be efficiently carried away to protect public safety and property from flooding:

Infrequent large events (peak flow up to 2-year return period) that should be detained and released at pre-development rates to protect stream and riparian corridors from erosion and habitat degradation; and

Frequent small events (flow volume up to 72% of the 2-year return period) that should be captured and infiltrated on-site to protect baseflows and reduce erosive runoff volume and.

72% of the 2-year target equates to 90% of the average annual rainfall volume being returned to natural hydrologic pathways (evapotranspiration and infiltration). In addition to runoff controls, land use in the watershed should be managed and planned to protect streams and riparian corridors.

Table 7-1: Rainwater Management Plan Strategies

Strategy	Flood Risk	Water Quality	Stream/ Riparian Habitat	Examples	Report Section
Hydrotechincal Upgrades	X			Culvert and storm sewer upgrades, diversions.	Section 5
Two-stage Channels	X		X		Section 8
Riparian Corridor Protection	X	X	X	Right-of-way and fencing.	Section 6.4
On-site Source Controls		X	X	Rain gardens and detention tanks.	Section 6.5
Green Road Design		X	X	Curb cut-outs, bio-swales, and rain gardens.	Section 6.5
Neighbourhood Source Controls		X	X	Wetlands and detention ponds.	Section 6.5
Road Debris Management		X		Street sweeping	Section 7.5
"End of pipe" Controls		X		Oil/grit separators, vortex stormwater systems, outfall energy dissipaters.	Section 7.6
Riparian/Stream Habitat Enhancement			X	Riparian planting, stream habitat complexing, etc.	Section 3 & 8
Public Education and Outreach	X	X	X	Information boards at rainwater management facilities/green corridors. Contractor training for sediment control and installation of rainwater managment facilities	Section 7.5

7.3 Protection of Public Safety and Property from Flooding

To protect public safety and property from flooding, the drainage system should have the capacity to convey the drainage design events - 1:10-year, 1:25-year or 1:100-year return period flood events depending on culvert size and the category of the road. The modelling results showed that 31 culvert crossing (some with multiple culverts) did not meet the design criteria. Recommended culvert upgrades and channel daylighting are summarized on Table 5-3.

7.4 Protection of Stream Channel and Riparian Habitat

The second goal of the RWMP is to protect stream channel and riparian habitat. Using both the WHTS (outlined in Section 6) and the PFC assessment (outlined in Section 3), the current condition of the watershed has been determined and problem areas have been identified. The WHTS provides an overview of the watershed condition using both percentage of impervious area and percentage of riparian integrity as indicators of stream health while the PFC provides a more detailed ground based assessment of the channel condition on a reach by reach basis.

The strategies used to achieve the goal of protecting and improving stream channel and riparian habitat include:

- On-site source controls and green road standards (Section 6);
- Regional detention (Section 5); and
- Riparian corridor protection and habitat enhancement (Section 6).

7.5 Protection of Rainwater Quality

The final goal of the RWMP is to protect and improve rainwater quality for both watercourses and receiving waters. One of the primary objectives of the LWMP is to improve water quality in the Sooke Harbour. Although construction of the sanitary sewer and treatment as part of the LWMP is likely to improve water quality as a result of decrease in organic pollution (i.e., failing septic systems), on-going improvements to rainwater quality from other pollution sources is also required to fully achieve the LWMP targets. The strategies to achieve the water quality goals include:

- work with CRD to implement rainwater quality bylaw;
- require on-site source control BMPs as part of development;
- green road design, street sweeping and catch basin cleaning (Section 6);
- public education and outreach;
- develop an emergency spill response plans;
- encourage development of Environmental Farm Plans and use of agricultural BMPs for protection of water quality where appropriate;
- encourage use of industrial BMPs for protection of water quality where appropriate;
- develop and implement a cross-connection prevention program; and
- reduction or elimination of pesticide and herbicide use.

Many of these recommendations are to be implemented as part of the district wide LWMP.

7.6 Foreshore RWMP Strategies

The foreshore area watershed from Wright Road Creek to Throup Stream drains mostly through storm drains directly to the Sooke Harbour. As such, there is no need for runoff controls to protect watercourses from erosion and habitat degradation. Implementation of the RWMP in this area only requires consideration of the protection of public safety and private property and protection of water quality.

The strategies used for implementation of the RWMP in the foreshore area are:

- Improvement of drainage to meet design criteria (see Section 5.5); and
- Implementation of stormwater BMPs into re-development of the Sooke Town Centre for protection of water quality including porous pavements, green roofs, rain gardens, etc. and look for opportunties to purchase land to develop neighbourhood scale BMPs for those areas already developed.

As a large portion of the foreshore area is included in the proposed Sooke Town Centre, these items should be addressed as part of implementation of the *Sooke Town Centre Plan*.

7.7 Specific RWMP Projects

Based on the strategies outlined previously, several specific capital projects have been identified within each of the watersheds including:

Nott Brook

- Enhancement of channels and removal of obsolete culverts within John Phillips Memorial Park and property downstream of Otter Point Road which used to be part of golf course property (Project A-1 and A-3);
- Upgrades of John Philips Park detention pond to detain 2-yr and 5-yr storm events for stream habitat protection (Project A-2);
- Replacement of culverts along Grant Road between Maple Ave and Guardian Road to improve drainage and reduce potential of flooding (Project A-4);
- Improve safety of Maple Road North detention pond by installing standard fencing around pond and safety grating over outlet in short term and potentially construction of underground facility in the future (Project A-5 and Project A-14);
- Complete detailed hydro technical and habitat assessment of wetland downstream of West Coast Road culvert to review potential impacts of replacing culverts at West Coast Road (Project A-6 and A-11);
- Upgrade Grant Road drainage as part of Grant Road by-pass project (Project A-7);
- Upgrade Nott Brook at Grant Road culverts (A-8);
- Construct two-stage channel from Maple Avenue to Brooks Road to improve flood conveyance and provide opportunity for riparian planting (Project A-9);
- Enhance channel complexity from Guardian Road to Maple Ave to improve habitat (Project A-10);
- Restore riparian area along Nott Brook Tributary South of Grant Road (Project A-12);
- Remove culvert under Guardian Road and daylight channel (Project A-15);

- Improve fish access through Maple Ave. Culvert (Project A-16); and
- Plant native species along riparian areas of Nott Brook Tributary (Project A-17).

Throup Stream

- Remove bloackage at culvert entrance to reduce flooding at 2171 Chruch Ave (Project B-1)
- Investigate opportunity to construct diversion along Throup Road (Project B-2)
- Rehabilitate channel erosion downstream of Charters Road (Project B-3)
- Replace and remove undersized culvert at Seaparc Baseball Field and maintain sediment trap area (Project B-4)
- Remove culvert at Banford Place and daylight channel (Project B-5)
- Install culvert at outlet of Throup Stream at Belavisita Place and improve fish access (Project B-6)

No specific projects were identified for Wright Road Creek and Ella Streams. However, on-going protection and improvement of riparian areas will be required to maintain stream health.

A summary of the RWMP is included in Table 7-2. The locations of the hydrotechincal and environmental protection projects are shown in Figures 7-1 and 7-2, respectively. The projects have been categorized for clarity on the figures; however, some of the projects could be considered to achieve both the hydrotechnical and environmental enhancement goals.

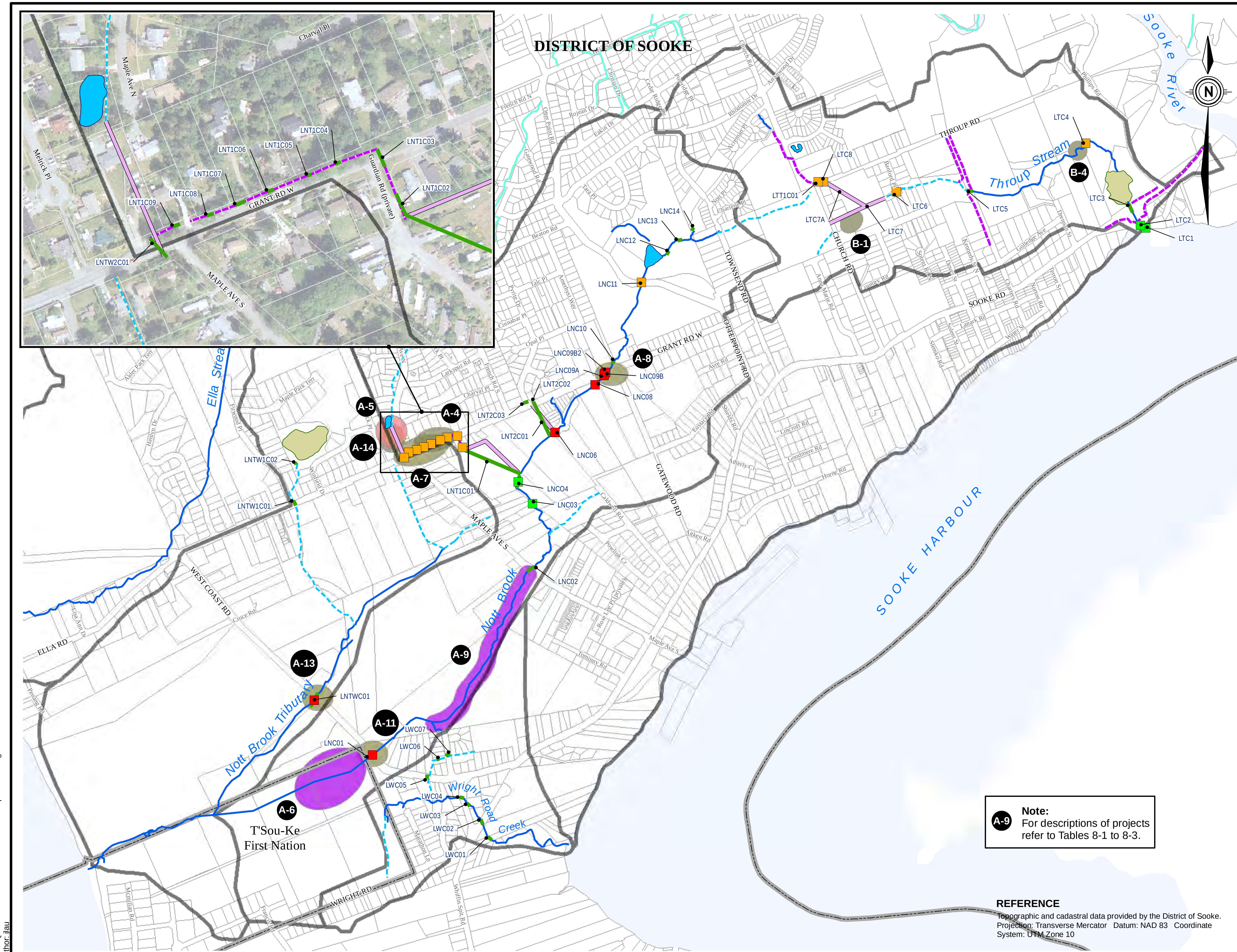
More detailed descriptions of each of the projects along with the proposed timing of implementation are outlined in Section 8, below.

Table 7-2: Summary of RWMP – Nott Brook, Throup Stream, and Wright Road Creek

Proposed RWMP		
Flood Management/Public Safety		
1.	**Upgrade Undersized Culvert Crossings**	
	• Upgrade undersized culverts on Nott Brook at West Coast Road after completion of detailed hydrotechnical and environmental impact review for T'Sooke First Nation lands downstream of culvert. • Replace undersized driveway culverts along Grant Road West from Maple Avenue to Guardian Road with new storm drain as part of proposed Grant Road upgrades. • Upgrade culvert on Nott Brook at Grant Road West as part of proposed Grant Road upgrades.	Projects: A-4, A-6, A-7, A-8, A-11, B-4 and B-5.
2.	**Upgrade Channels**	
	• Construct two-stage channel along Nott Brook as part of proposed multi-use trail project.	Project A-9
3.	**Construct Flow Diversion for Flood Management/Public Safety**	
	• Upgrade flow diversion at Grant Road and Maple Avenue South to divert more flow away from undersized culverts along Grant Road by installing rock weir downstream of diversion pipe.	Project A-4
4.	**Detention Pond Safety Upgrades**	
	• Upgrade existing Maple Avenue North detention pond to improve public safety at the pond including fencing and grating over outlet structure. • Construct underground storage as part of North/South Maple Ave Connector Road.	Project A-5, A-14
Environmental Protection Measures		
5.	**Hydrologic Volume Reduction**	
	• Implement source controls in new developments as part of Subdivision Development By-law. • Adopt example Rainwater Management Source Controls as part of subdivision development by-law. • Conduct on-site infiltration assessments as part of future developments to confirm infiltration capacity.	Section 6.3 & 6.4
6.	**Rainwater Quality Treatment**	
	• Implement rainwater quality source controls in new developments as part of Subdivision Development By-law. • Develop water quality treatment source controls as part of redevelopment of Town Centre. • Use proposed green road standards for treatment of road rainwater runoff. • Encourage use of water management BMPs as part of Environmental Farm Protection Plan for agricultural lands.	Section 6.4 & 6.5
7.	**Construct Flow Diversion for Erosion/Environmental Protection**	
	• Protect Throup Stream from on-going erosion downstream of Banford Place. • Construct Flow Diversion along Throup Road as part of proposed by-pass road to divert large and mid-range flows away from lower reaches of Throup Stream to protect stream channel and habitat from on-going erosion.	Project B-2
8.	**Hydrologic Rate Control**	
	• Increase detention capacity for John Phillips Memorial Park Pond (part of Conceptual Park Plan).	Project A-2
9.	**Protect Riparian Areas**	
	• Enforce RAR setbacks within new developing areas. • Dedicate 35 m wide riparian right-of-way along Nott Brook for proposed multi-use trail project. • Protect riparian areas within agricultural lands by installing fences to protect streamside vegetation. • Encourage planting of native species within Riparian Areas. • Protect Ella Stream riparian area as part of future development	.Project A-17
10.	**Restore Instream Complexing, Floodplain Wetlands, Off-channel Habitats**	
	• Install large woody debris and other channel complexing in channels as part of hydrotechnical improvements, road upgrades or trail construction proposed in other District plans. • Restore lower reaches of Throup Stream to enhance habitat quality. • Remove old culverts and bridges along Nott Brook channel as part of John Phillips Memorial Park upgrades. • Improve Nott Brook Channel complexity and plant riparian zone as part of multi-use trail. • Remove up to 5 culvert crossings and daylight stream channels along Nott Brook and Throup Stream.	Projects A-1, A-3, A-10, A-12, A-15, B-3, B-5
11.	**Upgrade Two Fish Passage Barriers**	
	• Upgrade culverts at Nott Brook at Maple Avenue South and Throup Stream at Belvista Place to improve fish passage.	Project A-16

Table 7-2 (cont.): Summary of RWMP – Nott Brook, Throup Stream, and Wright Road Creek

Municipal Rainwater Management Program	
Bylaws and Standards (Apply Municipality Wide)	
• Develop, adopt and enforce the following: ❖ Rainwater Management Bylaw, ❖ Examples and standards for Rainwater Source Controls to aid with implementation. ❖ Erosion and Sediment Control plans for the protection of water quality. ❖ Riparian protection measures and setbacks. ❖ Green road standards for rainwater treatment and volume reduction.	Section 7.5
Operation and Maintenance	
• Remove culvert blockage and improve drainage at 2171 Church Road. • Clean out sediment trap at SEAPARC Baseball Field. • Undertake regular inspection, operation and maintenance of rainwater management facilities and infrastructure.	Projects B-1 & B-4
Watershed Monitoring	
• Conduct watershed performance monitoring and adaptive management approach.	Section 8.5
Collaborative Work with Others	
• Work with agricultural community with the Environmental Farm Plan Program to restore & protect riparian buffers, reduce the use of pesticides and fertilizers and restrict livestock access to creek/riparian for water quality protection. • Work with Environmental Groups to implement environmental enhancement projects. • Work with MOTI, and other municipal plans to implement RWM projects and improvements.	Section 7.5



District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Major Pond
- Wetland
- Culvert

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Proposed Hydrotechnical Culvert Upgrades

- Culvert ID — High Priority
- Culvert ID — Medium Priority
- Culvert ID — Low Priority

Proposed RWNP Projects

- Hydrotechnical
- Hydrotechnical/Safety
- Hydrotechnical/Channel Upgrades

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Project No.	Date
2609-001	January 2012

Proposed Hydrotechnical Upgrades

Figure 7-1

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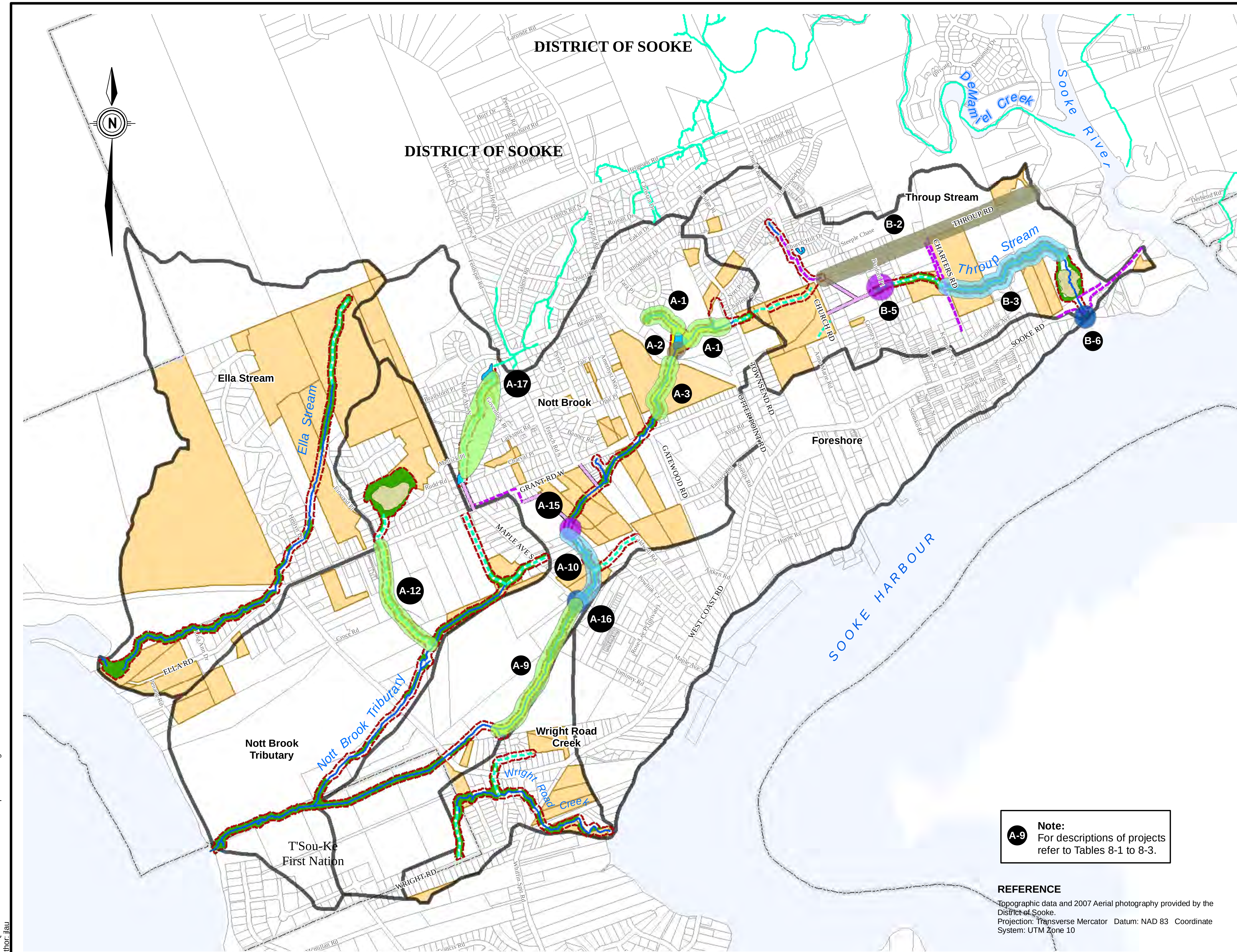

District of Sooke
Nott, Throup, Wright Road and Ella Watershed Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Vegetated Riparian Area
- Restore Riparian
- Riparian Assessment Area (15 m)
- Major Pond
- Wetland
- Stormwater Source Controls Required

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Proposed RWNP Projects

- Environmental Flow Protection
- Habitat Restoration/Erosion Protection
- Habitat/Riparian Restoration
- Habitat Restoration/Fish Access
- Habitat Restoration/Daylighting

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Project No.	Date
2609-001	January 2012

Environmental Protection Plan

Figure 7-2

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Section 8

Rainwater Management Plan Implementation

8. RWMP Implementation

8.1 Introduction

Based on the foregoing watershed inventory, technical analyses, and RWMP Strategy a list of specific projects was developed to help address hydrotechnical, environmental, and ecological issues in the watershed. They have been categorized into short term, medium term, and long term projects based on priority, ease of implementation and linkages with other planned infrastructure projects. It is recommended that implementation of RWMP projects be completed as part of other municipal capital projects outlined in the *Transportation Master Plan* and *Parks and Trails Master Plan*.

The proposed RWMP projects are shown in Figures 8-1 to 8-3 and are summarized in Tables 8-1 to 8-3. The sizing of these facilities in the RWMP is conceptual in nature and should be thoroughly assessed during pre-design.

8.2 Short Term Projects (1 – 5 yrs)

Encourage landowners to retrofit existing development to reduce peak flows for small events to protect aquatic ecosystems (e.g., raingardens, permeable driveways, bioswales, infiltration trenches, rainwater capture for irrigation).

Nott Brook Watershed

A-1 John Phillips Memorial Park Daylighting and Riparian Restoration

Remove storm drain and three culverts and replace with open channel and restore riparian areas and instream habitat. This could be completed as part of the John Phillips Memorial Park upgrades recommended in the *Conceptual Park Plan* prepared in 2006.

A-2 John Phillips Memorial Park Pond Upgrades

Upgrade storage and detention potential at John Phillips Memorial Park Pond to provide detention to reduce peak flows from upper Nott Brook Watershed to pre-development conditions for the 72% of 2-year, 2-year and 5-year return periods. This could be completed as part of the John Phillips Memorial Park upgrades recommended in the Conceptual Park Plan prepared in 2006. Any rainwater detention improvements should be pre designed and maintained to fit within the future active recreational context of the park.

Table 8-1: Short Term (1 to 5 yrs) Projects

Map ID	Location	Enhancement Type	Description	Cost ($)	Comments
Nott Brook Watershed					
A-1	John Philips Memorial Park	Habitat/Riparian Restoration	Remove culverts/storm sewers and daylight streams within park, replant riparian areas.	200,000	District Parks and Trails Plan and 2006 Conceptual Plan by John Phillips Memorial Trust Committee.
A-2	John Philips Memorial Park	Environmental / Protection	Increase pond detention capacity.	300,000	District Parks and Trails Plan and 2006 Conceptual Plan by John Phillips Memorial Trust Committee.
A-3	Downstream of Otter Point Road	Habitat/Riparian Restoration	Remove old golf course bridge/culvert crossings, replant riparian areas.	100,000	
A-4	Grant Road West Between Maple Avenue South and Guardian Road	Hydrotechnical	Remove and upgrade undersized driveway culverts to reduce flooding potential in Guardian Road.	100,000	Transportation Master Plan - possible habitat compensation for Grant Road improvements.
A-5	Maple Avenue North Detention Pond	Hydrotechnical/Safety	Improve public safety at Maple Avenue North detention pond.	50,000	
A-6	T'Sooke First Nation Downstream of West Coast Road	Hydrotechnical/ Habitat Restoration	Complete detailed drainage assessment of wetland area to assess impacts of proposed drainage upgrades.	50,000	Working in partnership with T'Sou-ke First Nation.
Throup Stream Watershed					
B-1	Throup Stream at Church Road	Hydrotechnical	Remove blockage at culvert entrance and improve conveyance of drainage system to reduce flooding at 2171 Church Road.	20,000	Not connected to plans - complete as soon as possible.
B-2	Throup Stream at Throup Road	Environmental / Protection	Investigate opportunity to construct diversion along Throup Road.	200,000	Transportation Master Plan - complete as part of Grant Road Connection project.
B-3	Throup Stream downstream of Charters Road	Habitat Restoration/ Erosion Protection	Complete channel restoration to mitigate impacts of channel erosion in this section.	200,000	District Parks and Trails Master Plan - complete as part of proposed Throup Stream hiking trail project.
B-4	Throup Stream at SEAPARC Baseball Field	Hydrotechnical	Replace or remove undersized culvert at Seaparc baseball field and clean out sediment trap area.	50,000	Not connected to plans - complete as soon as possible.
			TOTAL ($)	**1,270,000**	

Table 8-2: Medium Term (6 to 12 yrs) Projects

Map ID	Location	Enhancement Type	Description	Cost ($)	Comments
Nott Brook Watershed					
A-7	Grant Road West between Maple Avenue South and Guardian Road	Hydrotechnical	Upgrade Grant Road West drainage as part of road upgrades.	240,000	Transportation Master Plan - complete as part of Grant Road West upgrades.
A-8	Nott Brook at Grant Road West	Hydrotechnical	Upgrade Grant Road West culvert at Nott Brook.	120,000	Transportation Master Plan - complete as part of Grant Road West upgrades.
A-9	Nott Brook from Maple Avenue South to Brooks Road	Hydrotechnical/Habitat Riparian Restoration	Improve Nott Brook's channel, increase floodplain storage and plant riparian area.	600,000	District Parks and Trails Master Plan - complete as part of multi use trail School Park route as opportunity arise.
A-10	Nott Brook from Guardian Road to Maple Avenue South	Habitat Restoration	Improve Nott Brook Channel complexity by introducing large woody debris and riffle structures.	120,000	District Parks and Trails Master Plan - complete as part of multi-use trail School Park route / Transportation Master Plan - complete as part of Eustace Road Extension.
A-11	Nott Brook at West Coast Road	Hydrotechnical	Upgrade West Coast Road culvert.	120,000	Transportation Master Plan, T'Sou-ke First Nation negotiation - requires discussion with Ministry of Transportation and Infrastructure and T'Sou-ke First Nation.
A-12	Nott Brook Tributary south of Grant Road	Riparian/Habitat Restoration	Restore stream channel and replant riparian zone for Nott Brook tributary channel south of Grant Road West.	240,000	Complete as opportunity arises as part of future land development.
Throup Stream Watershed					
B-5	Throup Stream at Banford Place	Hydrotechnical/Habitat Restoration	Remove Banford Place culvert and daylight channel.	120,000	Transportation Master Plan - complete as part of Grant Road connection project.
			TOTAL ($)	**1,440,000**	

Table 8-3: Long Term (more than 12 yrs) Projects

Map ID	Location	Enhancement Type	Description	Cost ($)	Comments
Nott Brook Watershed					
A-14	Maple Avenue North Detention Pond	Hydrotechincal	Replace Maple Avenue North detention pond with underground detention.	270,000	Transportation Master Plan - complete as part of Maple Avenue connection.
A-15	Nott Brook at Guardian Road	Hydrotechnial/Riparian/Habitat Restoration	Remove culvert under Guardian Road and replace with daylight channel and bridge.	675,000	Will require land acquisition to be completed as opportunity arises.
A-16	Nott Brook at Maple Avenue South	Habitat Restoration/Fish Access	Improve fish access through Maple Avenue culvert.	140,000	Transportation Master Plan - complete as part of Maple Avenue improvements.
A-17	Maple Avenue North Tributary	Habitat/Riparian Restoration	Promote planting of native species within riparian area.	70,000	Completed as opportunity arises.
Throup Stream Watershed					
B-6	Throup Stream at Belvista Place	Hydrotechincal / Fish Access	Replace culvert at outlet of Throup Stream at Belvista Place and improve fish access to wetland area.	270,000	Not connected to plans - complete as opportunity arise.
			TOTAL ($)	**1,155,000**	

Although increasing detention at John Phillip's Memorial Park pond can not reduce 1:10-year and 1:100-year peak flows such that culverts downstream do not need to be upgraded, providing storage at John Phillip's Memorial Park for the more frequent lower intensity storms will provide required flow rate control for downstream environmental and erosion protection.

A-3 Nott Brook Habitat Improvement Downstream of Otter Point Road

This project involves removing old golf course creek crossings (culverts and bridges), restoring channel, removing invasive species and replanting riparian area. This project also provides an opportunity to showcase environmental and water stewardship in the watersheds. This work could be completed as part of multi-use trail development proposed between Grant Road West and Otter Point Road, as outlined in recommendations of the *Parks and Trails Master Plan*.

A-4 Driveway Culvert Replacement between Maple Avenue South and Guardian Road

This is one of the most critical locations for hydrotechnical upgrades. The hydrotechnical assessment indicated that all the driveway culverts located along the north side of Grant Road West between Maple Avenue South and Guardian Road are undersized and in poor condition. Recent large rainfall events have resulted in these culverts becoming back-watered with flows over-topping Grant Road West. As water crosses Grant Road West, it flows down Guardian Road and floods private properties in this area.

During the summer of 2009, a partial improvement to the drainage system was installed by the District. This included installing a 300 mm diameter pipe under Grant Road West and discharging to the road-side ditch along Maple Avenue South. Model results indicate that this solution will help reduce flows in the north road side ditch but not sufficiently to reduce over-topping. This is due to the high invert elevation of the new pipe.

As a short-term solution to the flooding issue, a rock weir should be placed in the north road-side ditch downstream of the new rainwater pipe crossing under Grant Road West. The crest of the weir should be set to allow baseflow to pass over the weir to continue along to the north roadside ditch without running through the new culvert. However, during high flow the weir will allow water level to rise sufficiently to pass water into the new 300 mm culvert. A detailed design of this option was beyond the scope of this study; however, it is likely to be a cost effective solution.

The success of this short term solution should be monitored during future large rainfall events. If over-topping continues to occur, then upgrading all the driveway culverts along the north side of Grant Road West should be considered. Model results indicate that all culverts should be upgraded to minimum 750 mm diameter. In addition, erosion in the ditch should be controlled by other erosion control measures.

It is likely that any upgrade drainage works will be replaced as part of the future west Grant Road West upgrades. However, as per the District of Sooke *Transportation Master Plan* these upgrades are scheduled to be completed in the next 5 to 12 years. During the proposed future upgrades to Grant Road West, the final drainage improvements for this area can be designed and installed.

A-5 Maple Avenue North Detention Pond

During field investigations it was noted that the detention pond near the south end of Maple Avenue North is in a poor state of repair and is considered to be a public safety concern. Safety improvement upgrades to the pond should be considered including erection of proper perimeter fencing, installation of trash rack and safety grill over the outlet structure and stabilization of pond slopes with native riparian vegetation.

A-6 Detailed Hydraulic and Habitat Assessment of Upgrading West Coast Road Culvert

A detailed hydraulic and habitat assessment of the wetland located on Nott Brook downstream of the West Coast Road culvert should be completed. The hydrotechnical assessment indicated that the West Coast Road culvert should be replaced.

Although increasing culvert capacity would increase peak discharges downstream, it is unclear what flooding impacts this would have downstream. The low lying wetland area immediately downstream of the culvert does not have defined channels passing through it. The wetland is located on the watershed boundary between Nott Brook and Wright Road Creek watersheds. Therefore, it is unclear if flow from Nott Brook passes through the wetland into Wright Road Creek during times of high water. During periods of high flows, this could result in more water flowing into Wright Road Creek with less flowing into the downstream portion of Nott Brook.

A more detailed assessment is required to investigate the impacts of replacing the West Coast Road culvert on peak flows and water levels in the wetland and in both Wright Road Creek and Nott Brook Creek downstream. This would include a more detailed hydraulic investigation using detailed topographic information to assess water level impacts.

Based on the results of the detailed hydraulic assessment, impacts as a result of upgrading the West Coast Road culvert on ecological function and future development on T'Sou-ke Nation lands could be assessed.

Throup Stream Watershed

B-1 Improve Drainage at 2171 Church Road

Currently the inlet to the storm drain on the east boundary of the property at 2171 Church Road is partially blocked. This blockage results in flooding of the property at 2171 Church Road from flows from the upstream watershed. The hydrotechnical modelling results indicate that the downstream drainage system has sufficient capacity and the blockage should be removed to allow proper drainage of the property at 2171 Church Road. However, no detailed investigation of the condition of the storm drain system at 6579 Throup Road was carried out. Prior to removing the blockage at the culvert inlet, it is recommended that a CCTV inspection of the drain system be carried out to confirm the condition of the pipes and check for any additional blockages.

B-2 Throup Road Diversion

The watershed inventory completed for the Throup Stream watershed indicated that significant erosion is occurring along the lower sections of Throup Stream downstream of Charters Road. The hydrotechnical investigation concluded that providing detention storage to reduce peak flows in the lower section of the creek would be impractical because of the limited space available for storage. Therefore, an option to divert flows from the upper portion of the watershed along the new Grant Road Connector extension along Throup Road should be investigated. This diversion would allow base flows to continue along Throup Stream but would by-pass larger flows away from the vulnerable downstream reaches. A diversion pipe could be installed as part of the proposed Throup Road upgrades and could carry flows from the Church Road/Throup Road intersection to the large wetland area at the downstream end of Throup Stream.

B-3 Throup Stream Restoration

Due to the erosion of Throup Stream between Charters Road and the wetland, stream channel restoration to improve ecological function is recommended. However, diversion of large flows from the upper reaches of the watershed should be completed prior to restoration activities taking place.

Restoration works could be carried out as part of the proposed Throup Stream hiking trail project discussed in the *Parks and Trails Master Plan*.

B-4 SEAPARC Baseball Field

The culvert crossing at the SEAPARC baseball field is undersized and should be replaced. It appears that this culvert provides a trail crossing and should be replaced with a foot bridge. This will allow for open channel and improved habitat function. In addition to removal of the undersized culvert, sediment accumulated in the channel should be removed and the channel restored in this section.

However, diversion of large flows from the upper reaches of the watershed should be completed prior to restoration activities taking place.

8.3 Medium Term Projects (6 – 12 yrs)

Nott Brook Watershed

A-7 Grant Road West and Maple Avenue South Drainage

The undersized driveway culverts and eroding ditch on the north side of Grant Road West between Maple Avenue South and Guardian Road should be replaced with a new storm-drain. This work should be designed and constructed as part of the Grant Road West upgrades proposed as part of the new Grant Road Connector project identified in the District *Transportation Master Plan*.

A-8 Nott Brook at Grant Road West Culvert

The undersized culvert crossing of the Nott Brook main stem at Grant Road should be upgraded. This work should be designed and constructed as part of the West Grant Road upgrades proposed as part of the new Grant Road upgrade project identified in the District *Transportation Master Plan*.

A-9 Restoration of Nott Brook from Maple Avenue South to Brooks Road

The reach of Nott Brook from Maple Avenue to Brook Road has been identified as “Not Functioning” as part of the PFC assessment. Currently, this reach passes through agricultural property and has no riparian vegetation. The channel has been straightened and is eroding, including headcutting.

The District *Parks and Trails Master Plan* proposes a multi-use trail to be constructed along this section of Nott Brook. As part of this project the stream and riparian area should be restored. The construction of the trail would provide an ideal opportunity to restore this section of Nott Brook and would be the longest reach of restored channel in the watershed (representing about one quarter of the total length of the main stem of Nott Brook).

Providing sufficient room for a multi-use trail, riparian and channel restoration would require a right-of-way between 30 m to 35 m wide. Figure 8-4 shows a potential typical section of the stream and trail. This is for illustration a typical section, and it is recognized that the final alignments of stream and path may meander within the RIW and in some cases the stream and trail may take different alignments to meet constraints.

Construction of the trail and stream restoration would require land acquisition and would have to occur as the opportunity arises. However, shorter term protection of the stream could be provided by installing fencing to isolate the stream from livestock.

A-10 Restoration of Nott Brook from Guardian Road to Maple Avenue South

The reach of Nott Brook from Guardian Road to Maple Avenue South has been identified as being at risk as part of the PFC assessment. Although this section of the stream has relatively good riparian vegetation, the channel has been straightened and is lacking channel complexity. Improving stream habitat along this section of Nott Brook should be considered as part of the proposed Nott Brook multi-use trail.

A-11 Upgrade Nott Brook at West Coast Road Culvert

Based on the results of the detailed hydraulic assessment (Project A-6), the Nott Brook culvert passing under West Coast Road should be replaced. Replacement of this culvert will need to be negotiated with Ministry of Transportation infrastructure and the T'Sou-ke First Nation. The results of the detailed hydraulic assessment would assist with these negotiations.

A-12 Nott Brook Tributary Restoration

The Nott Brook tributary south of Grant Road West has eroded and is lacking riparian vegetation. Providing riparian protection, re-planting riparian area and restoration of the channel should be completed as opportunity arises as part of future development.

A-13 Upgrade Nott Brook Tributary at West Coast Road Culvert

The hydrotechnical assessment carried out as part of this project indicates that the culvert on the Nott Brook tributary at West Coast Road has insufficient capacity to meet the design criteria. As part of future upgrades to West Coast Road, it is recommended that this culvert be replaced. It should be noted that this culvert is wood stave and appears to be in fair condition but will likely need to be replaced in the next 10 years.

Throup Stream Watershed

B-5 Banford Place Daylighting

The hydrotechnical assessment has indicated that the culvert under Banford Place is undersized. Banford Place is a dead end road and the culvert passes under the cul-de-sac. As the road does not provide access to any property beyond the culvert, removal of the culvert could provide a good opportunity to daylight a short portion of the creek.

8.4 Long Term Projects (> 12 yrs)

Nott Brook Watershed

A-14 Maple Avenue North Detention Pond

Replace Maple Avenue North detention pond with underground detention to eliminate public safety risk and improve public amenity value of the land adjacent to the pond. This work should be designed and constructed as part of the Maple Avenue North connection identified in the *Transportation Master Plan*.

A-15 Nott Brook at Guardian Road Culvert

Remove culvert under Guardian Road and replace with daylighted channel and bridge. This will require land acquisition and should be completed as opportunity arises.

A-16 Nott Brook at Maple Avenue South Fish Passage

Improve fish access through Maple Avenue culvert. This work should be designed and constructed as part of Maple Avenue South improvements of the *Transportation Master Plan*.

A-17 Maple Avenue North Tributary Riparian Restoration

Promote planting of native species within riparian area. Complete as opportunity arises.

Throup Stream Watershed

B-6 Throup Stream at Belvista Place Culvert

Replace culvert at outlet of Throup Stream at Belvista Place and improve fish access to wetland area. Complete as opportunity arises.

8.5 On-going Monitoring and Adaptive Management

To measure the success of rainwater management and other mitigation measures, the following adaptive management plan is proposed. The implementation plan and schedule should be monitored continuously and reviewed annually to assess:

1. How education/permitting/enforcement by the District is progressing once the RWMP is adopted. Are all developers being told to incorporate proposed mitigation measures?
2. How development is incorporating the proposed mitigation measures. Are developers incorporating the measures properly?

The monitoring strategy will include the following performance indicators and the duration and frequency associated with each. The monitoring program is outlined in Table __.

1. Continuous flow monitoring of Nott Brook and rainfall monitoring at the District of Sooke Municipal Hall beginning in 2011 and ending a minimum of 10 years following adoption of the RWMP.
2. Total annual runoff (average discharge per unit area) should be compared to total annual rainfall on annual basis to monitor changes in rainfall-runoff ratio overtime as well as baseflow monitoring.
3. Continued water quality monitoring at mouth of Nott Brook, Wright Road Creek, and Throup Stream as part of CRD Monitoring program.
4. Re-evaluation of WHTS including riparian health index when updated air photos become available.
5. Re-evaulation of PFC assessment at ten year intervals to monitor physical and biological health of stream channels.
6. Monitoring of identified erosion sites every ten years to monitor on-going stability of channel morphology.

These proposed on-going monitoring programs would satisfy the recommendations for on-going monitoring of rainwater discharges, watercourses and the marine receiving environment outlined in Section F of the LWMP (Rainwater) implementation plan.

Table 8-4: Monitoring Program Summary Table

In addition to monitoring the implementation plan it is also necessary to have a method for correcting any shortcomings. The results of the monitoring program should be reviewed as they become available and provide input for modifying District policies, rainwater source controls, and mitigation strategies.

8.6 Implementation Costs

Budgetary cost estimates have been provided for each of the proposed projects and are outlined in Tables 8-1 to 8-3. The total estimated cost to implement the projects is shown in Table 8-4.

Table 8-5: Estimated Project Implementation Costs

Projects	Period	Cost*
Short Term	1 to 5 years	$1.1 M
Medium Term	6 to 12 –year	$1.7 M
Long Term	Greater than 12-years	$1.5 M
Total		$4.3 M
* Costs are conceptual budgetary estimates with Medium and Long-term projects adjusted for average annual inflation of 3%.		

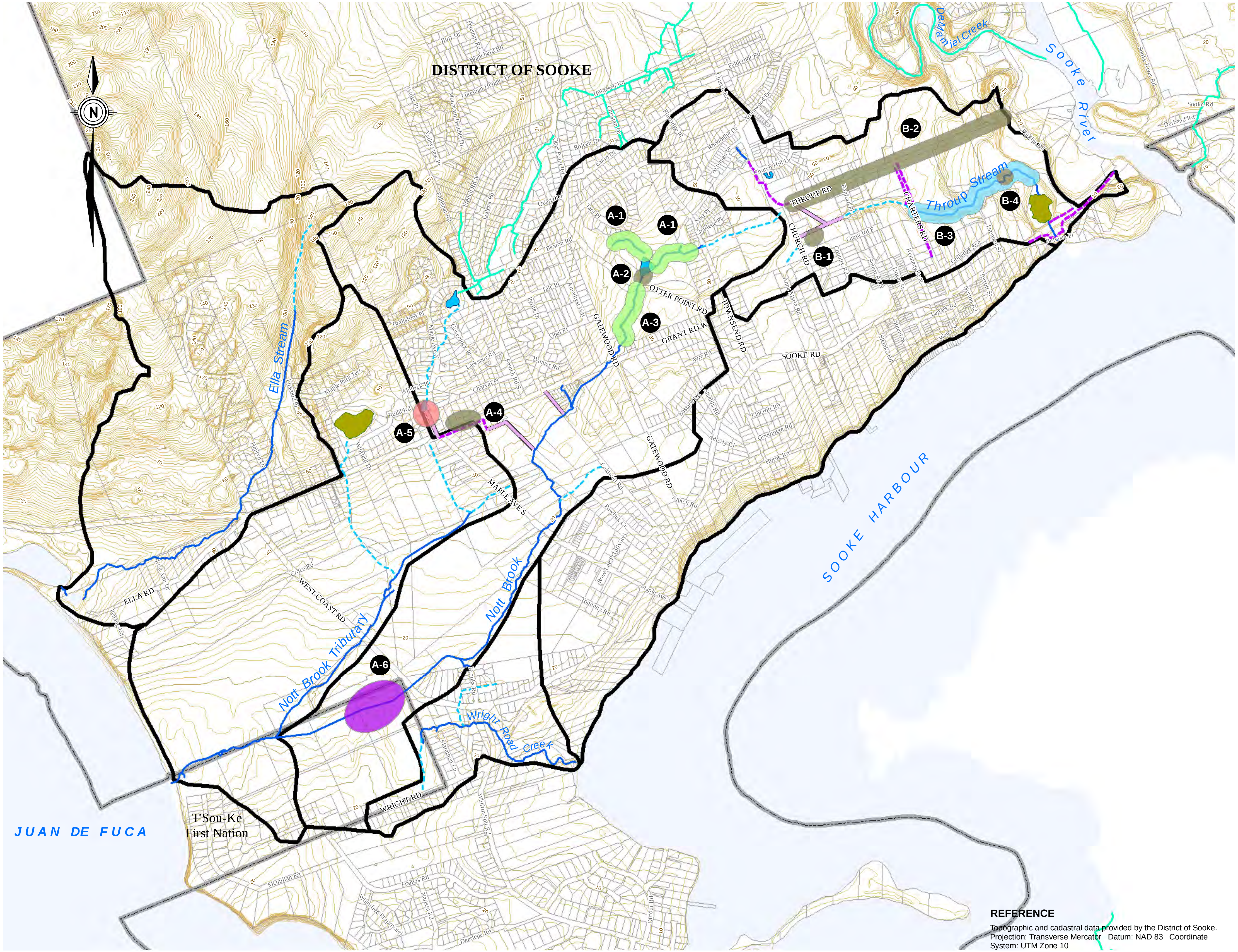
The costs are conceptual and are suitable for budgeting purposes. They are based on typical current 2010 costs for construction of similar projects. The cost for land acquisitions have not been included as all proposed projects are either located within lands currently managed or owned by the District of Sooke or the project would be implemented as part of re-development as the opportunity arises.

8.7 Funding Opportunities

Table 8-6 summarizes the funding opportunities which exist to assist with implementation of RWMP projects. An updated list of available funding sources can be found on the Civicinfo BC website.

Table 8-6: Available Funding Sources

Name	Agency	Cost Share	Amount
Agricultural			
Agricultural Environmental Initiatives Fund	Agricultural Environment Partnership Initiatives	Up to 80%	Up to $50,000
Ducks Unlimited Fund	Ducks Unlimited	Riparian Mgmt up to 10% Wetland Mgmt up to 10%	Riparian Mgmt up to $4K Wetland Mgmt up to $8000
National Farm Stewardship Program	BC Agricultural Council	Up to 50%	Up to $50,000
Infrastructure			
Building Canada Fund	Infrastructure Canada	Varies	Varies
Gas Tax	Infrastructure Canada	Varies	Varies
Green Municipal Fund	Union of BC Municipalities	Up to 50%	Up to $350,000
Infrastructure Planning Grant Program	BC Ministry of Community Development	Up to 50%	Up to $10,000
Stewardship/Habitat Enhancement			
EcoAction Community Funding	Environment Canada	Up to 50%	Up to $100,000
Evergreen Foundation	Evergreen Foundation	Up to 100%	Up to $2000
Habitat Conservation Trust Fund	Habitat Conservation Trust Foundation	Varies	Varies
Source: Civicinfo BC – www.civivinfo.bc.ca – Accessed June 2011			



REFERENCE

Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Contour (2 m Interval)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Proposed RWNP Projects

- Habitat Restoration/Erosion Protection
- Hydrotechnical
- Hydrotechnical/Channel Improvements/ Habitat Restoration
- Hydrotechnical/Safety
- Habitat/Riparian Restoration
- B-3 Map ID Corresponds to Table 8-1

KERR WOOD LEIDAL
consulting engineers

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Project No.	Date
2609-001	January 2012

Short Term Projects (1-5 Years)

Figure 8-1

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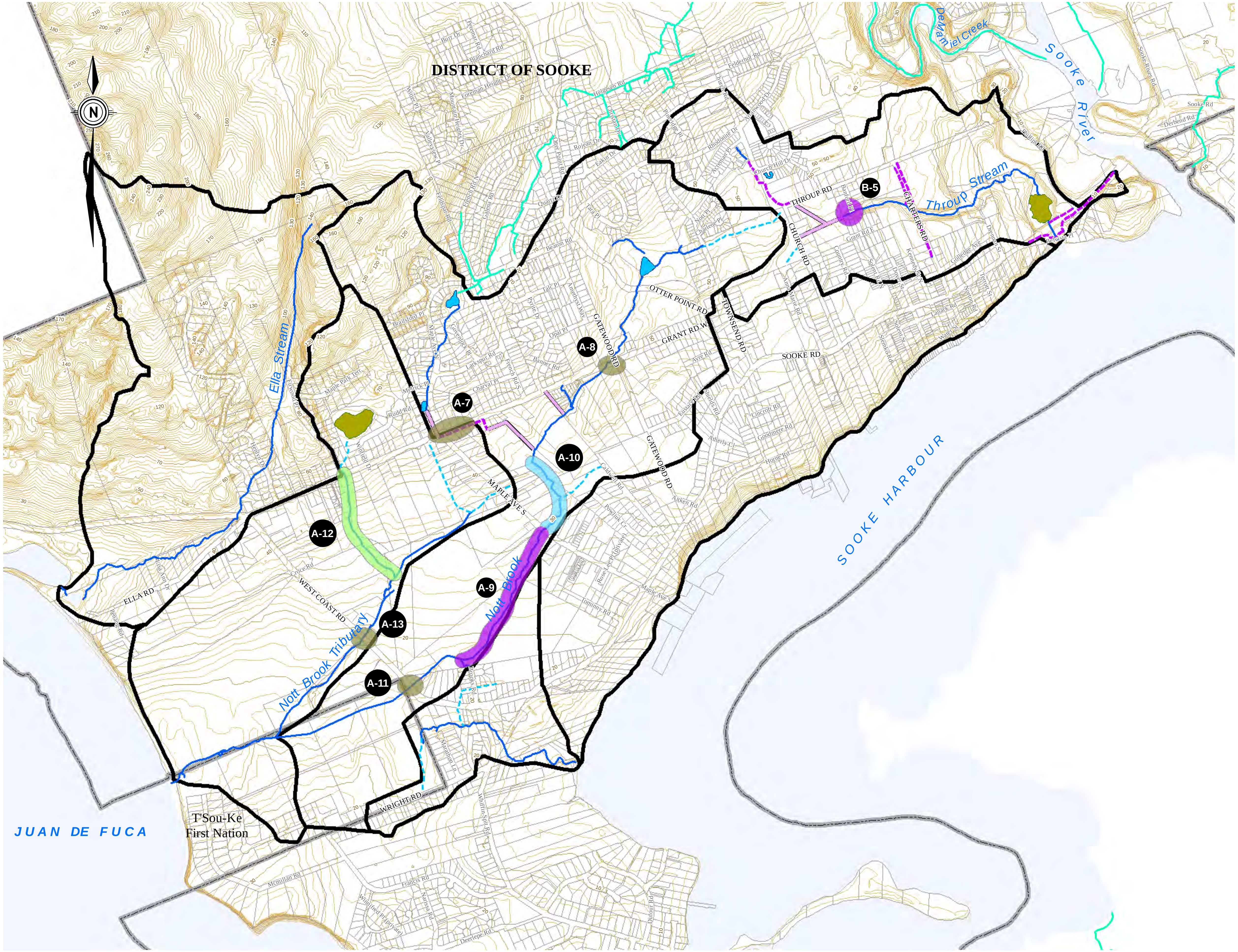

District of Sooke
Nott, Throup, Wright Road and Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Contour (2 m Interval)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Proposed RWNP Projects

- Habitat Restoration
- Hydrotechnical
- Hydrotechnical/Habitat Restoration
- Habitat/Riparian Restoration
- B-3 Map ID Corresponds to Table 8-2

REFERENCE

Topographic and cadastral data provided by the District of Sooke.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

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Project No.	Date
2609-001	January 2012

Medium Term Projects (6-12 Years)

Figure 8-2

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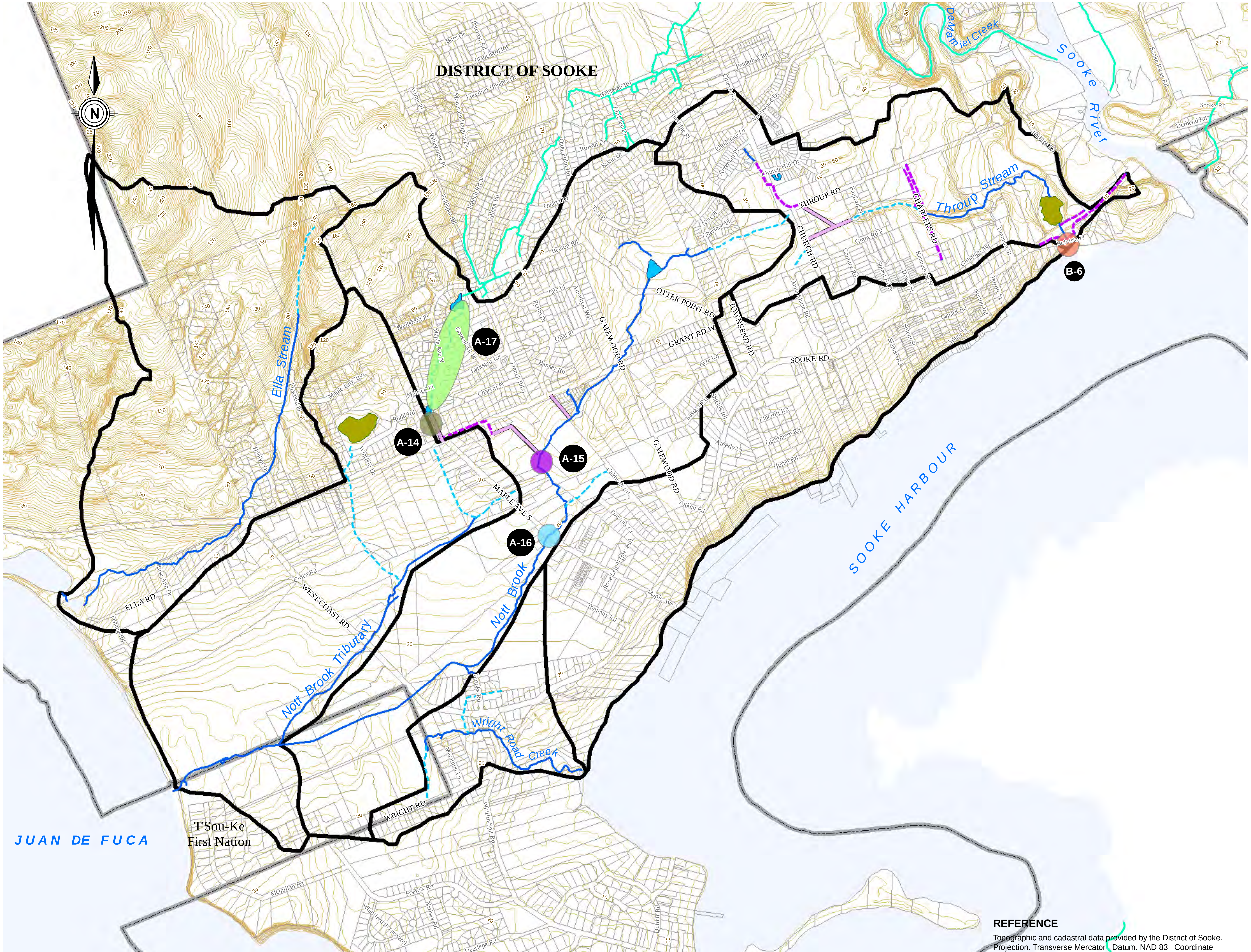

District of Sooke
Nott, Throup, Wright Road and
Ella Watersheds
Rainwater Management Plan

Legend

- Municipal Boundary
- Watershed Boundary
- Contour (2 m Interval)
- Major Pond
- Wetland

Watercourse

- Permanent
- Ephemeral
- Watercourse Outside of Study Area

Major Rainwater System

- Major Rainwater Drain
- Major Road Side Ditch

Proposed RWNP Projects

- Habitat Restoration/Fish Access
- Hydrotechnical
- Hydrotechnical/Fish Access
- Hydrotechnical/Habitat Restoration
- Habitat/Riparian Restoration
- B-3 Map ID Corresponds to Table 8-3

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Project No.	Date
2609-001	January 2012

Long Term Projects (> 12 Years)

Figure 8-3

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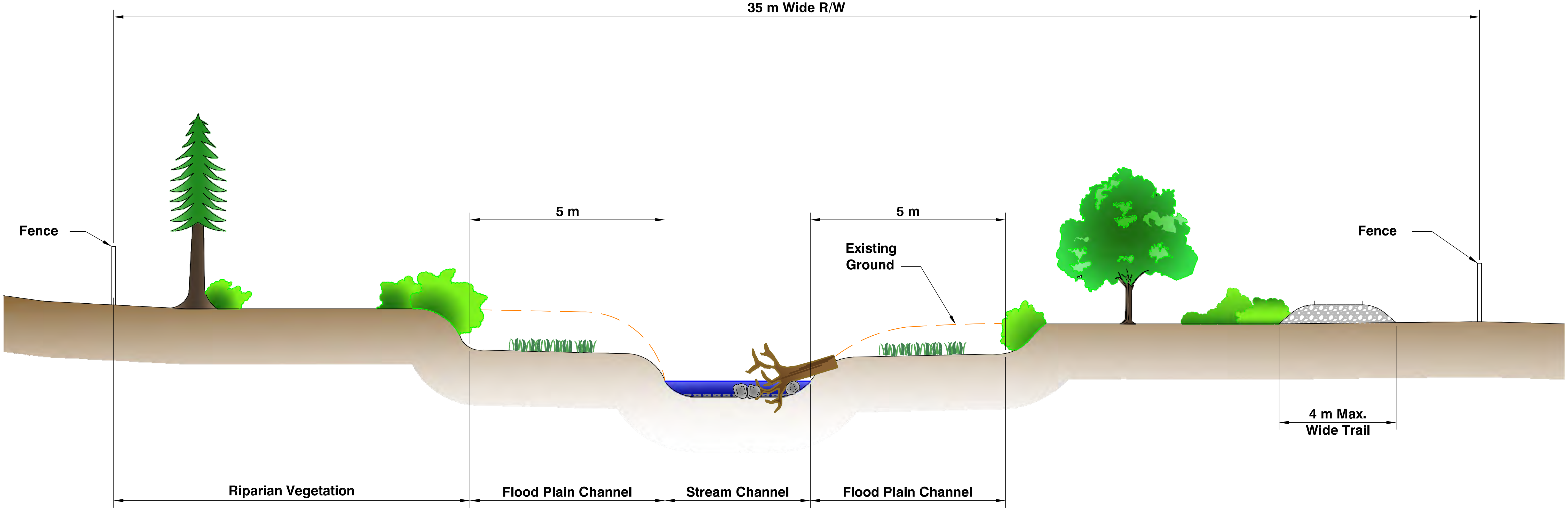

Note:
This is a typical section for illustration. It is recognized that the final alignment of trail and stream channel may meander within the R/W.

Profile

N.T.S.

Conceptual Nott Brook Habitat Enhancement / Regional Trail

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Figure 8-4

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Section 9

Recommendations

9. Recommendations

Based on the foregoing, it is recommended that the District of Sooke:

Goal 1: Protection of Public Safety and Private Property

1. Implement the full hydrotechnical upgrade option and replace existing undersized culverts as outlined in the implementation plan. Prior to final design of the upgraded culverts, the hydrologic/hydraulic model should be updated with additional hydraulic structure details that were not available at the time of the development of the current model. The current model should also be verified and re-calibrated, if necessary, using additional flow monitoring data that is now available from the Nott Brook at Maple Avenue South hydrometric gauge. The results of the updated model should be used to confirm final sizing for upgraded culverts;
2. Improve public safety of the Maple Avenue North detention pond by installing fencing around the pond and grating at the outlet structure meeting appropriate safety standards. Install underground detention as part of future Maple Avenue North connection to Grant Road recommended in *Transportation Master Plan*;
3. Improve drainage along Grant Road between Maple Avenue South and Guardian Avenue in the short term by:
   a) designing and installing a rock weir downstream of the diversion pipe installed under Grant Road West to help direct more flow into the diversion pipe during high flow;
   b) re-grading ditch and protecting ditch from ongoing erosion; and
   c) upgrading undersized driveway culverts.
4. Improve drainage along Grant Road West from Maple Avenue South to Guardian as part of Grant Road Connector project improvements identified in the *Transportation Master Plan*; and
5. Review and confirm capacity of foreshore area rainwater drainage system as part of the re-development of the town centre, outlined in the *Town Centre Plan*.

Goal 2: Protect Riparian and Aquatic Habitat

1. Update District of Sooke Bylaw No. 65, Subdivision and Development Standards Bylaw, 2003 to include stormwater environmental protection measures such as
   a) new rainwater management criteria for volume reduction, water quality treatment, and rate control;
   b) standards for LID measures and source controls; and
   c) erosion and sediment control plans during construction.

   This would be beneficial in mitigating the hydrologic impacts associated with development and re-development, and maintaining and protecting the ecological health of Sooke's watercourses not only in the subject watersheds, but District-wide.
2. Implement and enforce the requirements of the Riparian Areas Regulation, as part of new development or re-development of lands in the watersheds. This would be beneficial in maintaining and protecting the ecological health of Sooke's water resources not only in the subject watersheds, but district wide;
3. Require a minimum of 51 mm rainwater capture (72% of 2-year event) in 24-hrs, including requirements for on-lot BMP's and minimum soil depths;

4. Require detention of 2-year storm event to pre-development levels except in foreshore areas draining directly to Sooke Harbour, Sooke Basin and Sooke Bay;
5. Install public information boards outlining importance of aquatic and riparian habitat quality as part of trail development outlined in *Parks and Trails Master Plan*; and
6. Implement riparian and aquatic habitat enhancement projects outlined in the implementation plan.

Goal 3: Protect Watercourse and Receiving Water Quality

1. Implement water quality protection projects as outlined in the implementation plan;
2. Use Green Road Standards outlined in Transportation Master Plan as part of new road development including bio-swales, rain gardens, and reduced pavement widths;
3. Encourage use of innovative rainwater BMP designs and LEED™ development in buildings including permeable pavement, green roofs, and rainwater harvesting;
4. Add requirement for water injection testing to confirm rainwater infiltration potential for proposed development sites to future District of Sooke Bylaw 65, <u>Subdivision and Development Standards Bylaw</u>, 2003 updates;
5. Develop a comprehensive street sweeping and catch basin cleaning program;
6. Develop public education and information on protection of water quality and impacts on receiving waters. Encourage landowners to retrofit their property to benefit aquatic ecosystems (rain gardens, bioswales, rainwater capture, permeable driveways, etc.), and reduce use of deleterious substances such as fertilizers, cleaning agents and other toxic chemicals;
7. Require comprehensive erosion and sediment control plans as part of land development and construction;
8. Encourage development of Environmental Farm Plans and use of the Code for Environmental Practice for Waste Management for the protection of water quality on agricultural lands; and
9. Develop and implement Contractor Education/Training Program for sediment management and construction of rainwater management infrastructure (rain gardens, infiltration, etc).

Monitoring and Adaptive Management

1. Continue monitoring of Nott Brook streamflow, rainfall at Sooke Municipal Hall, and water quality at stream outlets;
2. Prepare annual "State of the Watersheds" report to monitor implementation and report success of the plan. This plan will include a brief summary of the previous years activities including programs or projects implemented and status of future projects as well as a summary of the performance monitoring results;
3. Review and update plan every five years to include new techniques, technologies or lessons learned and work completed; and
4. Review and update WHTS and PFC assessment every 10 years to provide indication of success of plan implementation.

9.1 Report Submission

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