ANDERSON
Civil Engineering

A N D E R S O N

Village of Cumberland
2673 Dunsmuir Avenue
PO Box 340
Cumberland, BC V0R 1S0

file: 2032

May 15, 2003

Attention: Mac Fraser
Manager of Operations

Dear Mac,

Re: Liquid Waste Management Plan, Stage 2
Final Report

We are pleased to enclose copies of the Final Report, Liquid Waste Management Plan, Stage 2. The report was published in two volumes:

- Volume 1 - Final Report
- Volume 2 – Supplementary Reports

Fifteen copies of Volume 1 are enclosed, following the approval by the Ministry of Water Land and Air Protection. These copies are intended for your use in support of the CBCIP application, discussion with potential funding partners, and general reference in your office. One copy of Volume 2 was provided to you on January 23, 2003.

A copy on CD (Adobe Acrobat pdf format) is enclosed, and additional copies can be provided as required.

This final report is unchanged from the Final Report provided on January 23, 2003, but includes the letter of approval from MWLAP dated April 11,2003.

We thank you for your support and encouragement throughout the process.

Yours truly,

Douglas W. Anderson, P.Eng.

DWA/cp

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206 b - 335 Wesley Street, Nanaimo, B.C. V9R 2T5
Tel *250 754 1877* Fax *250 754 4375* email *civileng@andersoncivil.com*

1. Executive Summary

The Village of Cumberland Liquid Waste Management Plan Stage 2 is based on the final report of the Stage 1 Plan (February 2001). The principal goals for Stage 2 included completing environmental assessments and identifying and selecting an appropriate treatment technology for continued effluent discharge to Maple Lake Creek. The process for Stage 2 included completing each individual study and publishing it as a Technical Memorandum for review and discussion by the Technical Advisory Group (TAG). An initial meeting of TAG was held in September 25, 2001, all technical memoranda were circulated for review by June 2002, and principle reviews by members of TAG were completed by September 17, 2002.

The Public Advisory Committee (PAG) was kept advised throughout the process and copies of technical memoranda and documents were available at the municipal offices. Copies of the memoranda were circulated to the local First Nations for their review and comment. A Public Open House meeting was hosted by PAG in the community hall on Thursday, September 19, 2002. The consultant presented the findings and recommendations for the Stage 2 Plan, and municipal staff presented the funding alternatives and cost implications to the taxpayers.

The principle goals of this Stage 2 Plan were to identify the environmental impacts from proposed construction and discharge, and to identify and confirm appropriate treatment technology for the sanitary effluent.

An environmental investigation of the downstream Maple Lake Creek and Trent River was completed in the summer of 2001, and provided some baseline information on the condition of those watercourses and the fishery resource potential. As a result of this study and other work by Ministry of Water Land and Air Protection (MWLAP), the principle impact was identified as algal growth in the Trent River resulting from nutrient discharge. The principle controlling nutrient was identified as orthophosphate, and this controls the planning and design of the proposed treatment process.

An environmental habitat and wildlife investigation of the area between the existing lagoons and Cumberland Road was completed. This investigation identified areas that have been impacted by previous land uses, including farming, and identified these as the most suitable for future construction of the new treatment process expansion. A fen/bog area south of Cumberland Road and west of Maple Lake Creek was identified with high environmental value, and this will be isolated from the future construction and protected. The proposed construction areas were of concern to the Canadian Wildlife Service (CWS) of Environment Canada. The area finally identified and selected for construction has been reviewed and agreed with CWS.

The existing flows of wastewater to the treatment plant were analysed and identified separately as sanitary, infiltration, exfiltration and inflow components. A large part of the older infrastructure in the Village of Cumberland collects combined sanitary and stormwater flows. An analysis was completed to identify the impact of separating the sanitary from stormwater flows. It is recommended that these be separated, in order to minimise the projected future flows to the treatment process. The effectiveness of the aerated lagoon system is contingent on adequate residence time.

Design flows were developed from an analysis of the existing flow components, together with a projection of each into the future to allow for the increased population and service area. These flows were used in an assessment of alternative treatment technologies, for performance projection of the proposed treatment process, and for projecting possible augmentation flows to the Trent River in summer. Although the cost of separating either the sanitary or stormwater systems is large, some significant upgrading is required of the existing system to avoid the potential for overloading and overflow. This report recommends separating the existing combined system, and upgrading a few sections to provide sufficient capacity to avoid the potential for sewage overflows.

A number of alternate discharge options were reviewed with the goal of eliminating the discharge of nutrients to Maple Lake Creek in the summer. The alternates included storage of all summer flows, discharge to land in the summer, connection to the Courtenay / Comox system or discharge to Comox Lake. In view of the costs, environmental impacts, and need for low flow augmentation in the Trent River, none of these alternate discharge options is recommended.

The Trent River, like most rivers on the east coast of Vancouver Island, suffers from very low flows in the summer. The Trent River appears to have much lower flows than adjacent rivers, and the contribution from the discharge of municipal effluent into Maple Lake Creek is significant. A detailed analysis indicates that municipal effluent represents approximately 10% of the total flow in the Trent River during summer low flow periods. For the sake of sustaining viable fish populations in the Trent River and the lower reaches of Maple Lake Creek, continued discharge of municipal effluent to Maple Lake Creek is recommended.

A full spectrum of treatment alternatives was reviewed. These included a wide range of electro-mechanical processes, and focusing on the removal of phosphorous. The effectiveness, capital cost and operating costs of suitable technologies were summarized. Similar evaluation was completed for a Constructed Treatment Wetland (CTW), to be incorporated as an additional process downstream of the existing aerated/facultative lagoon system. Two principle advantages of the CTW were identified as seasonal removal of the critical constituent (orthophosphate) during the summer months, and very low annual operating costs. The capital cost of constructing a CTW was comparable to the cost of the next most effective electro-mechanical process (Sequencing Batch Reactor). Chemical precipitation for phosphorous removal is identified as a necessary component of all processes.

From the assessment of the impact on Maple Lake Creek and downstream on the Trent River, and from the goal of meeting of Municipal Sewage Regulation (MSR) Criteria for Reclaimed Water for Streamflow Augmentation, an effluent meeting the British Columbia Approved Water Quality Guidelines (January 2001) is recommended with orthophosphate limited to 100 μg/ℓ during the summer.

This Plan includes the Capital Construction Cost Estimates for the recommended works. The impact of potential grants from senior government is reviewed, and the potential final cost to individual consumer identified.

The final recommendations of this report on the Stage 2 Plan include:

- Continuing the discharge of wastewater effluent to Maple Lake Creek.
- Separating the existing combined sewers, and requiring that all new construction be separated.
- Constructing some sections of replacement infrastructure to avoid the potential for Combined Sewer Overflows (CSO's).
- Developing a Constructed Treatment Wetland, together with the existing lagoon system, in order to meet the water quality objectives and to significantly reduce the discharge of orthophosphate during the summer months.
- A programme of replacing the oldest sanitary sewers in the core area of the village in order to reduce infiltration and eliminate exfiltration.

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2. Abbreviations and Glossary

2.1 Abbreviations

ADWF	Average Dry Weather Flow
AWWF	Average Wet Weather Flow
BAT	Best Available Technology
BMP	Best Management Practices
BOD_5	Biochemical Oxygen Demand (5 day)
CTW	Constructed Treatment Wetland
I&I	Inflow and Infiltration
LWMP	Liquid Waste Management Plan
MCAWS	Ministry of Community, Aboriginal and Women's Services
MOH	Ministry of Health
MSR	Municipal Sewage Regulation
MWLAP	Ministry of Water, Land and Air Protection
O&G	Oil and Grease
OCP	Official Community Plan
PAG	Public Advisory Group
TAG	Technical Advisory Group
TSS	Total Suspended Solids
WQG	BC Approved Water Quality Guidelines

2.2 Glossary

A glossary of terms to assist the non-technical reader of the report

attenuation:	- reduction of peak flows through direct or indirect storage.
average daily flow	- the total flow over 24 hours, expressed as ℓcd or m^3/d, usually used to specify sanitary sewage flow.
average dry weather flow (ADWF)	- sewage flow during periods of little or no rainfall.
combined sewer area	- the area that contributes stormwater flow to the sanitary sewer pipe network.
constructed treatment wetland	- a wetland that has been enhanced, restored, or built with the purpose of treating municipal storm or sanitary wastewater.
design population	- the population for which design will be completed, usually a future population based on growth expectations.
exfiltration	- leakage out of the pipe network through joints, cracks, manholes and services and into the surrounding ground, usually occurring in dry weather conditions.
hydrograph	- a graphical representation of runoff or discharge of liquid waste.
infiltration	- groundwater that enters the sewage collection system through leaking joints, cracks, manholes and services, usually occurring in wet weather.
inflow	- stormwater flow that enters a sanitary sewer from sources other than infiltration, that includes roof leaders, foundation and basement drains, catch basins and manhole covers.
peak instantaneous flow	- maximum inflow that occurs from a specified rainstorm, combined with peak daily sanitary flow and infiltration, usually expressed as ℓ/s.

peaking factor	- a factor applied to average sanitary flow to estimate peak flow (in this report, calculated with the Harmon formula).
rainfall events	- rainstorms that show start and end points.
residential flow	- flow generated from domestic uses, not commercial, industrial or institutional.
service population	- the population serviced by the referenced utility, i.e. those people with service connections to the utility.
'x' year return storm	- the rainstorm that has a recurrence interval of 'x' years, that has a probability of occurring in any one year of 1/x.

3. Units

d	days
h	hours
ha	hectare
igpd	Imperial gallons per day
igpm	Imperial gallons per minute
kg/ha	kilogram per hectare
ℓ/c/d	litres per capita per day
ℓ/ha/d	litres per hectare per day
ℓ/s	litres per second
ℓ/s/ha	litres per second per hectare
m	metre
mm	millimetre
m^3/d	cubic metres per day
mg/ℓ	milligrams per litre
µg/ℓ	micrograms per litre

4. Introduction

This report is submitted to the Ministry of Water, Land and Air Protection (MWLAP) for approval as the Village of Cumberland Liquid Waste Management Plan - Stage Two. The process leading to municipal liquid waste management planning has been highly participative for residents, major landowners, municipal officials, provincial ministries and federal departments. Because of this dedication to proper process, liquid waste management planning in Cumberland is built upon a strong foundation of public involvement and support. As in all municipal planning in Cumberland, liquid waste management has been driven by interested citizens and their elected public officials, the Village Council.

The report has been written in accordance with three primary reference documents; the Village of Cumberland Official Community Plan, December 1998, the MWLAP Guidelines for Developing a Liquid Waste Management Plan, August 1992, and the Village of Cumberland Liquid Waste Management Plan, Stage 1, Final Report, February 2001. Other technical and policy documents have been used to supplement and support the intent of these primary references. The objective of this report is to create a technically viable, socially acceptable, economically practical and environmentally suitable Liquid Waste Management Plan for the Village of Cumberland.

On completion of Stage 1 of the Plan, and together with the letter of approval from MWLAP, a list of recommendations set out the tasks for Stage 2:

- Complete an environmental assessment downstream on Maple Lake Creek and Trent River.
- Develop appropriate design flows for the collection system, with and without separation of stormwater inflows.
- Prepare cost estimates for alternatives for separating stormwater inflows, and eliminating the combined sewer system.
- Review alternative treatment and discharge options and identify those preferred for more detailed study.
- Study options and prepare cost estimates for appropriate treatment technologies, with particular emphasis on phosphorous reduction.
- Identify and evaluate options for summer low flow augmentation to the Trent River.
- Develop a capital works programme and funding options.
- Develop implementation of the recommendations of the Stormwater Management Plan.

- Continue communication with the local First Nations.
- Develop a plan to connect the existing on-site serviced areas to the collection system.
- Review the impact of the laundry facility for the quality and quantity contributed.

These actions have all been completed and the results and recommendations incorporated in this LWMP Stage 2 Plan.

5. Background

The background to the Village of Cumberland Liquid Waste Management Plan was comprehensively discussed in the Stage 1 report. The history of the Village starts in 1898 as a company town; the history of the sewage treatment plant started with a treatment plant in 1967; the recent social planning for the community dates from the current Official Community Plan in 1998.

The goal of the Stage 1 study was to complete a comprehensive study of liquid waste management in the Village of Cumberland. Topics covered in Stage 1 included:

- Previous studies, reports and permits.
- Land Use and Community Planning.
- Population and Industrial Growth.
- Septic tanks and On-site discharges.
- Estimated wastewater quantities.
- Sewer collection system and Combined Sewer Overflows.
- Commercial and Industrial wastes.
- Regional District context.
- Source Control.
- Inflow and Infiltration.
- Opportunities for Effluent Reuse.
- Septage treatment and disposal.
- Stormwater Management.
- Capacity of receiving environment.
- Options for treatment.
- Treatment Site location options.

Each of these was studied in depth, and through a thorough public consultation process managed by the Public Advisory Group, the Stage 1 plan was developed. The findings of the studies were reviewed and discussed with the Technical Advisory Group.

The final plan was published in February 2001, and after review, was approved by the Ministry of Water, Land and Air Protection (MWLAP) in a letter dated June 13, 2001.

The "Recommended Course of Action for Stage 2" developed in Stage 1, is included in Appendix B.

The Stage 2 process has proceeded actively since June 2001 by completion of a series of Technical Memoranda for each individual recommended action. Subsequent reports built on the foundation of previous work. The reports were circulated to TAG and their reviews were discussed at a meeting in September 2002.

The original eight Technical Memoranda have been incorporated into this report with additional material prepared as necessary to complete a comprehensive LWMP Stage 2 Plan.

6. Environment

6.1 Introduction

The Liquid Waste Management Plan, Stage 1, reviewed a number of options for treatment including conventional electro-mechanical plants and Constructed Treatment Wetlands. The plan reviewed site location options and concluded that adjacent to the existing treatment plant was the preferred location.

The first activity identified in the Stage 1 Plan to be undertaken in Stage 2 was to: *Complete an Environmental Impact Assessment for discharge to Maple Lake Creek receiving water, considering the range of treatment options .*

6.2 Background

As part of the Stage 2 planning process, it was important to identify the potential impact of the future discharge on Maple Lake creek and downstream on the Trent River. It was also important to assess the impact of constructing additional treatment facilities in the area adjacent to the existing treatment process.

Appropriate reports included in the Stage 1 plan were reviewed:

Technical Report and Addenda on Cumberland Sewage Treatment Plant, MELP, October 1995, November 1995, October 1997 (Stage 1, Volume 2).

Report on Cumberland Sewage Treatment Plant and Impacts on the Trent River, MELP, December 1998 (Stage 1, Volume 2).

Additional reports were commissioned for the Stage 2 planning process:

Environmental Assessment for the Proposed Cumberland Treatment Wetlands and Sewage Discharge, Mimulus Biological Consultants, November, 2001 (Volume 2).

Ground-truthing, Delineation and Conservation Evaluation of Part of Sensitive Ecosystem Polygon #65003, Cumberland, Canadian Wildlife Service, R. Buechert, BSc., July 2001 (Volume 2).

This chapter includes a review of these reports and incorporates the review and analysis by the Technical Advisory Group (TAG).

6.3 Downstream Impact

The Village of Cumberland has been discharging sewage from a combined sewer system into the watershed of Maple Lake Creek since the community was first founded in the 1890's. In 1967 a sewage treatment plant was constructed, and received major improvements in 1971. No significant improvements to the treatment process have been made since, although the Ministry of Environment (now MWLAP) has been expressing concern at the quality of effluent and the impact downstream. The Village commissioned reports in 1987, 1990 and 1991 (refer to Stage 1 Plan, Volume 2) to review alternatives for improving the treatment process and reducing the impact downstream.

The community, through the Stage 1 Plan public information process, confirmed their commitment to reduce or eliminate the impact of the Village of Cumberland on the surrounding environment. The object of the Stage 2 Plan is to improve the understanding of the receiving waters and to establish appropriate values for effluent characteristics.

6.3.1 Fisheries Resource

Mimulus identified the fisheries resources in the lower reaches of Maple Lake Creek (approximately the last 1000 m upstream from the Trent River). There is a 12 m high waterfall approximately 500 m above the confluence that presents a total barrier to the upstream migration of fish. Above the falls (Reach 3) electro-fishing found only one three-spine stickleback; no other fish were found. The reaches below the falls, and for several hundred metres upstream, exhibit good fisheries habitat, although moss and algae growth are significant.

The assessment found significant impact on the Trent River by algae growth downstream of the confluence. Exposed rocks are covered in a white film, probably resulting from algae growth exposed at low water. The algae growth and white film were not as evident in the lower kilometre of the Trent River.

No odours were observed in any part of Maple Lake Creek.

6.3.2 Water Quality

Mimulus sampled five locations (identified in Mimulus Figure 5.1) on five occasions in the summer of 2001. Each of these samples was analysed for 19 indicator parameters (Mimulus Appendix E). These results are reviewed and discussed in Mimulus Chapter 5 and summarised below:

- Sample Site 1 represents Maple Lake Creek above any influence of effluent discharge, Site 2 reflects Maple Lake Creek below the initial dilution zone for effluent, Site 3 represents Maple Lake Creek immediately above the confluence with Trent River, Site 4 represents Trent River below the confluence with Maple Lake Creek and Site 5 is above the confluence. Generally these sites correspond to MWLAP sites that have been monitored over a number of years.

- BOD5 levels were typically less than 5 except at Site 2 (downstream of the discharge) where they ranged between 6.9 and 15.6.
- DO levels were typically 3.0 or 4.0 at Site 1, 1.0 at Site 2, and 10.0 at Sites 3, 4 and 5.
- TSS values were typically elevated at Site 2, but sporadic elevated results were also obtained from Sites 1, 4 and 5.
- Fecal Coliform levels at Site 2 were typically moderate, but high levels were also recorded upstream at Site 1, and occasionally much higher levels at Sites 3, 4 and 5 downstream. These results appear to show contamination with other than sewage effluent.
- Ammonia levels at all sites, except Site 2, were much below the BC Approved Water Quality Guidelines (2001) (WQG) values (30 day limit 1.32 mg/ℓ, maximum 18.0). At Site 2 the values ranged from 6.93 to 12.9 mg/ℓ indicating consistently high results locally near the Initial Dilution Zone.
- A range of typical metals was tested and both cadmium and lead found to be below acceptable limits (WQG). The detection limit for silver was not low enough to confirm acceptable levels. Copper was found to be acceptable with all sites except Site 2, where the level was between 2 and 4 times the acceptable level.
- Dissolved oxygen levels were typically recorded at values of 3 and 4 at Site 1 above the discharge point. At Site 2 below the effluent discharge DO levels were typically at 1.0. At all other sites in the low reaches of Maple Lake Creek and the Trent River, values were at 10 or 11.
- Total phosphorous and ortho-phosphate results below the point of discharge were high at Sites 2, 3 and 5 downstream into the Trent River. This is discussed further below.
- Chlorophyll a was not sampled as part of this programme.

6.3.3 Construction Area Assessment

The provincial government, as MELP and now MWLAP, has prepared several reports since 1990 on the downstream impacts of the effluent discharge.

Reports have included observations by John Deniseger, Environmental Impact Biologist, MWLAP, of extensive algae growth in the Trent River downstream of the confluence. (Reference LWMP Stage 1, Volume 2, E). High levels of orthophosphate from Maple Lake Creek have been identified as the principle cause. Although phosphorous and orthophosphate levels are not set in the WQG, chlorophyll *a* values are identified as a measure of the algae growth caused by nutrients, including phosphates. Measurements of chlorophyll *a* were made in 1997, 1998, and 2002.

Table 6.1 - Trent River Chlorophyll a Results (mg/m2)

Site / Date	Trent River 100 m upstream	Trent River 400 m down-stream	Trent River 1 km down-stream	Trent River 1.5 km down-stream	Trent River 2 km down-stream	Trent River upstream at Trestle
12/8/97	2.7	19.7				
9/9/97	5.6	552.0				
7/7/98	6.1	125.3				
8/9/98	40.7	216.0				
28/8/02	6	57	37	119	52	129

BC Approved Water Quality Guidelines limits are 50 mg/m^2 for Recreation and 100 mg/m^2 for Aquatic life.

Table 6.2 - Trent River / Maple Lake creek Orthophosphate (μg/ℓ)

Site / Date	Trent River 100 m upstream	Maple Lake Creek at Trent River	Trent River 400 m down-stream	Trent River 1 km down-stream	Trent River 1.5 km down-stream	Trent River 2 km down-stream	Trent River upstream at Trestle
11/7/97	9	27	6				
10/9/97	2	167	16				
18 /6 /98	2	380	47				
23/9/98	<1	334	89				
28/8/02	2	408	101	66	68	43	3

A presentation at the TAG meeting on September 17, 2002, explained the impact on the Trent River from orthophosphate discharges in the effluent. Typical summer effluent discharge concentrations range from 2,000 to 2,500 μg/ℓ (winter levels 1,000 μg/ℓ). In Maple Lake Creek above the confluence there is typically an 85% reduction to 350μg/ℓ at the lowest reaches, resulting in less than 100 μg/ℓ in the

Trent River. Elevated concentrations cause elevated algae growth when sunlight and temperature are sufficient.

The effect is evident from the confluence downstream through the steep-sided narrow valley to the more open area above the E & N railway. There the growth becomes denser as the sunlight increases.

Discussions with Dr. Max L. Bothwell, at the Pacific Biological Station, Nanaimo, confirm the understanding of the mechanisms for algae growth and the influence of orthophosphates on East Coast Vancouver Island streams. The high values, and consequently behaviour, in Maple Lake Creek are beyond Dr. Bothwell's experience.

6.4 Construction Area Assessment

6.4.1 Plants and Wildlife

The LWMP Stage 1 identified the area adjacent to the existing treatment lagoons as the only suitable site for future treatment upgrading.

Mimulus completed a biological assessment of the plant communities and wildlife in June and July 2001. Communities were identified and mapped (Mimulus Figure 2.2, Figure 3.1); the boundaries are shown in Figure 6.1 (Appendix C). No rare, endangered or protected plant species were found. Six provincially blue-listed wildlife species were identified.

There are large areas impacted by earlier agricultural uses including: pens for mine mules; hayfields; market gardens; and a skeet range. These areas were assessed as having little or no value for preservation.

The areas identified with highest sensitivity and environmental value were all west of Maple Lake Creek and in particular the fen area including the Shore Pine / Labrador Tea Forest. Some adjacent areas were also recommended for avoidance. As the communities are based on a wet fen regime, it is important not to alter the groundwater flows in this area.

6.4.2 Sensitive Ecosystem

The Comox-Strathcona Sensitive Habitat Atlas (95F065-2-4) included a polygon (#65003) based on the open wetlands and Maple Lake Creek. On the basis of this information, the Village of Cumberland acquired ownership of the property under the Federal / Provincial Ecogift Programme. This programme is administered by the Canadian Wildlife Service (CWS) of Environment Canada.

The Mimulus report shows that the area within the SEI polygon is heavily impacted, and that the areas of environmental value lie to the northwest. A brief groundtruthing was carried out for CWS by Ron Buechert (July 2001) (Volume 2) and generally confirmed parts of the assessment.

Further review of these studies by CWS, and participation through TAG has confirmed the area available for construction of the treatment plant expansion. The approved areas are shown on Figure 6.1 (Appendix C). These are based on the communities identified by Mimulus, the detailed work in some areas by Buechert, and a hydraulic buffer zone west of Maple Lake Creek to preserve the groundwater regime.

6.5 Recommendations

6.5.1 Receiving waters

Discharge should meet the objectives of the MSR. As there is usually less than 10:1 dilution by Maple Lake Creek, the provisions of Schedule 3 will not apply, but Reclaimed Water Standards are appropriate. More detailed discussion is included in Chapter 11.

The discharge water quality should meet the BC Approved Water Quality Guidelines (2001) (WQG). As phosphorous limits are not set in this guide, the downstream impact on the Trent River is the controlling impact for algae growth, measured by chlorophyll *a*. Based on the existing impact and approximately 85% reduction in orthophosphate through Maple Lake Creek, a discharge target of 100 μg/ℓ (0.10 mg/ℓ) orthophosphate in the effluent is recommended.

As the downstream impact is algae growth, which is dependent on temperature and sunlight, there is no need to limit orthophosphate between September 30 and May 1.

6.5.2 Construction Area

The form of treatment expansion, the recommended process and land areas required are discussed later in Chapters 10 and 11.

The potential area is identified as north and east of the existing lagoon system. Much of the open areas have been severely impacted by earlier uses and developments.

An area of valuable habitat for preservation was identified in the Mimulus report and reconfirmed by the Canadian Wildlife Service. The remaining areas available for construction are shown on Figure 6.1 (Appendix C).

A key characteristic of the sensitive area is the bog/fen hydraulic regime. To maintain this without disturbance, the west leg of Maple Lake Creek should remain unchanged. A controlled hydraulic buffer, e.g. open ditch, should be created with the treatment expansion on the south side of the area to maintain the existing regime. Potential addition of nutrients to the fen/bog should be prevented.

Groundwater monitoring wells should be placed before winter 2002/2003 to gather data on the existing hydraulic regime.

7. Design Flows

7.1 INTRODUCTION

Flows in the sanitary system were calculated to develop design flows for the future treatment system, to evaluate the existing collection, and to design future collection system components. This chapter provides flows calculated using municipal design and textbook criteria, results from existing flow records, and stormwater inflow results.

Flows are referred to in the following categories:

Sanitary flow - generated from sanitary and wastewater flows from inside individual buildings.

Infiltration - generated from leakage into pipes, manholes, and structures from groundwater.

Inflow - generated from stormwater reaching the sewers through roof leaders, manhole lids, storm services, and directly connected catch basins in the streets.

Municipal design and textbook criteria specify separate values for sanitary flows and infiltration and inflow (I&I), whereas the existing flow records provide a summary of total flows. For this report, these total flows from records were separated into components of sanitary flow, infiltration and inflow using techniques detailed in Section 7.5.

Stormwater runoff calculations provided results of stormwater inflow to the sanitary pipe network for a specific 1 in 5 year, 6-hour duration storm.

7.2 PREVIOUS WORK

Previous work was reviewed in order to provide a background for calculations.

A "*Master Sewerage and Drainage Plan*" was completed for the Village of Cumberland by Ker Priestman & Associates Ltd. in April 1987, with the goal of planning sewerage and drainage system improvements.

A "*Feasibility Study for Sewerage and Wastewater Disposal*" was completed by KPA Engineering Ltd. in November 1990. This document was written to address specific concerns regarding the Trent River dilution capacity, sewage lagoon capacity and nutrient and coliform loading of the effluent.

In 1991 *"Preliminary Design for Wastewater Treatment Improvements"* by KPA Engineering Ltd. specified measures to improve the treatment system.

In October 1998, CK Ventures Ltd. completed a study titled *"A Constructed Wetland for Stormwater Management, Tertiary Wastewater Treatment, and Low Flow Stream Augmentation."* This was a feasibility study for a constructed treatment wetland to treat stormwater and sanitary sewage for Cumberland.

a) Details of the individual reports:

i) Ker Priestman and Associates, 1987

"A Master Sewerage and Drainage Plan" listed the following estimated sewage and stormwater volumes for the 1987 population of 2,143 people.

Average daily sanitary sewage flow:
600 m^3/d based on Metcalf & Eddy (1979) criteria of 280 ℓcd.

Infiltration:
4400 m^3/d from 125 ha (35 m^3/ha/d) (p.5) – maximum during wet period

Stormwater inflow:
8800 m^3/d from a 2-year event in the "core area"

ii) KPA Engineering Ltd., 1990

The *"Feasibility Study for Sewerage and Wastewater Disposal"* (November 1990) estimated flows at:

Sanitary sewage flow:
A 1990 average daily sanitary sewage flow of 727 m^3/d was estimated from averaging water consumption data, summer sewage flow, and Metcalf and Eddy (1979) criteria of 280 ℓcd, for a population of 1,928 (p. 13).

Infiltration:
An infiltration area of 180 hectares and an infiltration rate of 15 m^3/ha/d were utilised (p. 13), for total infiltration of 2700 m^3/day (p. 13).

Stormwater inflow:
Flow from the peak 10 year storm, over 36 hectares of combined sewer area, gave peak inflow to the pipe network of 1341 ℓ/s (116,000 m^3/d).

Comparing report population numbers, there is discrepancy (2,143 people in the year 1987, and 1,928 people in the year 1990). Census data are:

1976 census	1,896 people
1986 census	1,853 people
1996 census	2,548 people

iii) KPA Engineering Ltd. 1991

A *"Feasibility Study and Preliminary Design for Wastewater Treatment Improvements"* identified works to improve lagoon operations and reduce impact on receiving waters. A hydrograph of average lagoon discharges from flow records indicates a maximum of 7800 m^3/d in February 1991. Theoretical calculations of flows were not made in the document.

iv) CK Ventures Ltd., 1998

Sanitary sewage flow estimates were made for a current service population of 2,430 assuming that "the existing population of Cumberland is approximately 2,560 people (including 130 on septic)". (p. 6)

Sanitary sewer flow: 1030 m^3/d (average daily) (based on 425 ℓcd)

Infiltration: 1800 m^3/d from 120 ha (15 $m^3/ha/d$)

Stormwater inflow: 2700 m^3/d (maximum)

Based on the "Village of Cumberland Official Community Plan" (OCP), September 1998, flow calculations were projected for an ultimate population of 5,500 and a larger service area, (Table 2, p 8)

Sanitary sewer flow: 2340 m^3/d

Infiltration: 3000 m^3/d over 200 ha (15 $m^3/ha/d$)

Stormwater inflow: 2700 m^3/d (unchanged from 1998)

The report states, "as the design population increases, the stormwater component will not increase" (p. 6). This assumes no separation of storm and sanitary sewer pipes and no extension of combined pipes into unserviced areas.

b) Summary of Previous Work

The differences in sanitary sewage flow are due to different criteria used: a base residential flow from Metcalf and Eddy (KPA 1987), an averaging of water consumption, summer sewage and Metcalf and Eddy criteria (KPA 1990), and the CK Ventures criteria of 425 ℓcd.

The infiltration rate is consistent for these studies at 15 m^3/ha/d, except for the KPA Study (1987) that specifies 35 m^3/ha/d as a maximum. Infiltration areas vary between 120 ha (present) and 200 ha (ultimate). Infiltration flows vary between 8,800 m^3/d, 1,341 ℓ/s (115,862 m^3/d), and 2,700 m^3/d. The 8,800 m^3/d inflow was calculated during the mean annual two-year storm, over one day. The 1,341 ℓ/s inflow refers to peak instantaneous flow calculations from HYDSYS analysis of the ten-year return storm. The 2,700 m^3/d is obtained from flow chart observation, and is average monthly inflow divided by thirty days.

There is such a wide variation in suggested design flows that further analysis is required. This analysis is developed in Section 7.6.

7.3 MUNICIPAL CRITERIA

A comparison was completed of sanitary sewage flow standards from other municipalities on Vancouver Island. All specifications are for peak flows, with the exceptions of the City of Parksville and the Village of Cumberland that specify average daily flow for design. No municipal standards allow for separate stormwater inflow but include basic allowances for combined inflow and infiltration. Refer to Table 7.1 for a summary of criteria.

a) Other municipalities

i) <u>City of Nanaimo</u>

The "*Engineering Standards and Specifications (2001)*" specify a peak sanitary sewage flow plus an allowance for infiltration. The peak sanitary sewage flow is calculated using a peaking factor, $1 + 14 / (4 + P^{1/2})$, based on the Harmon formula, applied to an Average Dry Weather Flow (ADWF) of 230 ℓcd. In cases of trunk sewer design, 80% of the Harmon value may be used. There is an additional allowance for inflow and infiltration (I & I) of 25 m^3/ha/d (the 1:25 year storm).

ii) <u>City of Parksville</u>

The "*Design Manual*" specifies that design flows are the average daily flow plus infiltration. Residential flow is specified on a per capita per day basis of 410 ℓcd, with industrial and commercial specified on a per day per hectare basis (22500 ℓ/d/ha). Infiltration is specified as 8.64 m^3/ha/d and inflow is not specified separately.

iii) <u>District of North Cowichan</u>

The "*Engineering Standards*" specify a peak sanitary sewage flow for 2,000 to 5,000 people of 1365 ℓcd. Infiltration is added to the sanitary sewage at a rate of 5.615 m^3/ha/d. No separate provision is made for inflow.

iv) District of Campbell River

Separate industrial and commercial calculations are required, and a peaking factor, according to the Harmon formula, is applied to average residential flows of 360 ℓcd. Sewage from non-residential sources is converted to population equivalents and added to the population number. Infiltration is calculated at a rate of 5.2 m^3/ha/d (as for the District of North Cowichan). Inflow is not specified separately.

v) Regional District of Nanaimo

Peak flow is obtained from a curve of *peak unit flow* vs. *contributory equivalent population.* To obtain industrial and commercial flows, the following minimum design population density is specified: Industrial and commercial zoning - equivalent of 50 persons/ha. This is then combined into residential calculations. The infiltration allowance at 10 m^3/ha/d is the same as that specified by the City of Parksville. No separate provision is made for inflow.

vi) Village of Cumberland

The Village of Cumberland's *"Subdivision Control Bylaw No. 652"* specifies, "new systems shall be designed on the basis of an average daily per capita flow of not less than 360 ℓ/d". Peaking factors, infiltration and inflow are not specified.

Table 7.1 - Criteria Summary

Municipality/ Regional District	Residential	Peaking Factor	Commercial	Industrial	Industrial & Commercial	Infiltration $m^3/ha/d$
City of Nanaimo	230 ℓcd	1+14/(4+P1/2) (x 80% for trunk sewers)				25
City of Parksville	410 ℓcd (average flow)				22,500 ℓ/d/ha	8.64
District of North Cowichan	1365 ℓcd (peak flow)					5.6
District of Campbell River	360 ℓcd	1+14/(4+P1/2) (Note 1)	(Note 2)	11,000 ℓ/d/ha		5.2
Regional District of Nanaimo	peak unit flow from chart x population				Equivalent of 50 persons per hectare (Note 3)	10
Village of Cumberland	360 ℓcd					------

Notes: 1 - P includes population equivalents for sewage from non-residential sources.
2 - School: 45 ℓ/c/d; Hotel: 1000 ℓ/room; Motel: 350 ℓ/unit; Restaurant: 150 ℓ/seat; Retail & Office: 120 ℓ/employee.
3 - Add to residential population

c) Application to the Village of Cumberland

Using the municipal criteria, calculations of sewage generation were completed for both present and future populations. The resulting flows are shown in Table 7.2.

i) Population

According to census data, the population of the Village of Cumberland in 1996 was 2,548. A population of 2,750 was utilised as a present (2001) population number, assuming a 1.5% yearly increase from 1996. A future population of 5,000 was assumed in accordance with the Village of Cumberland OCP. It is expected that the Village will manage growth to ensure that the population does not exceed 5,000.

ii) Industrial and Commercial

Schedule "B" from the Village of Cumberland's "*Zoning Bylaw*" shows that Cumberland has the potential for 20 ha of industrial land and 5.8 ha of commercial land within the sewer service area. The following areas were used to calculate flows:

- Commercial: present 2.9 ha, future 5.8 ha;
- Industrial: present 9 ha, future 19.4 ha.

Where criteria require an estimate of institutional flows, hospital laundry flows of 157 m^3/d (present) and 260 m^3/d (future) were utilised. (Refer to letter from Mac Fraser, Superintendent of Public Works to the Administrator, September 30, 1997, Liquid Waste Management Plan, Stage 1, Volume 1, Appendix A.)

iii) Results

Results from District of North Cowichan criteria are similar to those from District of Campbell River criteria partly because infiltration is specified at a similar rate for both municipalities. City of Nanaimo results are similar to Campbell River and North Cowichan; despite a much higher City of Nanaimo allowance for infiltration of 25 $m^3/ha/d$. Results using Regional District of Nanaimo criteria are lower than those above.

Results using City of Parksville criteria are 30% lower than the Regional District of Nanaimo, because average sewage flows, rather than peaks, are specified for design by Parksville.

Village of Cumberland criteria result in the lowest flows because average residential flow is specified without an allowance for infiltration, or a peaking factor.

Table 7.2 - Sewage Flow Comparison For Cumberland

Municipality/ Regional District	Sewage		Commercial		Institutional		Industrial		Infiltration		TOTAL	*TOTAL*
	Present - m^3/day	*Future - m^3/day*	Present - m^3/day	*Future*	Present - m^3/day	*Future - m^3/day*	Present - m^3/day	*Future*	Present (120ha) - m^3/day	*Future (200ha) - m^3/day*	Present - m^3/day	*Future - m^3/day*
City of Nanaimo (peak)	1758	*2985*							3000	*5000*	4758	*7985*
City of Parksville (average)	1128	*2050*					268	*581*	1037	*1728*	2433	*4359*
District of North Cowichan (peak)	3754	*6826*							674	*1123*	4428	*7949*
District of Campbell River (peak)	3435	*5652*	57	*104*			99	*213*	622	*1037*	4072	*7013*
Regional District of Nanaimo (peak)	2468	*3775*			157	*260*			1200	*2000*	3825	*6035*
Village of Cumberland	990	*1800*	Not applicable								990	*1800*

present = 2,750 people, future = 5,000 people

7.4 STANDARDS

a) Metcalf & Eddy

"Wastewater Engineering: Treatment, Disposal, and Reuse" (1991), (Metcalf & Eddy), specifies criteria for wastewater generation. Sanitary flow is based on a per capita allowance for residential flows of 250 ℓcd, a per hectare allowance for commercial (11 m^3/ha/d), institutional, and a per hectare allowance for industrial sewage flows (2 m^3/ha/d). Infiltration and inflow (I&I) is specified as an additional flow that varies from 0.2 to 28 m^3/ha/d.

Table 7.3 - Criteria Summary

	Metcalf & Eddy
Residential	250 ℓcd
Commercial	11 m^3/ha/d
Institutional	(laundry)
Industrial	2 m^3/ha/d
Inflow & Infiltration	0.2 - 28 m^3/ha/d

d) Ministry of Health

Criteria in the *"Sewage Disposal Regulation"* of the BC Health Act (1992) specify flow from residences, apartments, institutions, and commercial establishments. For example, for a 3-bedroom house, 1.36 m^3/d are specified. Health criteria are specified as minimum flows for design of septic fields, compared with municipal criteria that are specified as peak or average daily flow for design of pipe systems.

e) Application to the Village of Cumberland

Results using Metcalf & Eddy criteria vary because of the range specified for I&I. Interestingly, the high end of the range, when applied to the Village of Cumberland, corresponds almost exactly to the results obtained using City of Nanaimo criteria (4,757 m^3/d compared to 4,758 m^3/d). For the Village of Cumberland institutional flows, 157 m^3/d was allowed for the laundry. Results using Ministry of Health criteria are low, because no allowance is made for I&I, and because results are averaged daily flows, appropriate for septic field design only.

Table 7.4 - Sewage Flow Comparison for Village of Cumberland

All values are in m^3/d.

Flow Component	Metcalf & Eddy		Ministry of Health	
	Present	Future	Present	Future
Sewage	750	1250	1203	2187
Commercial	32	64	84.1	152.9
Institutional	157	260	202	367
Industrial	18	38.8	4.1	7.5
Inflow & Infiltration	24 - 3360	40 - 5600	not specified	
Total	981 - 4317	1653 - 7213	1493	2715

7.5 HISTORICAL FLOWS

The Village of Cumberland measures continuous discharge at the outlet of its second treatment lagoon, using a circular chart recorder at a V-notch weir. These measurements include total flow: sanitary sewage, infiltration and stormwater inflow.

The charts reflect the rainfall at Cumberland, because a storm that brings inflow to the sewage system is represented by an increase in the chart reading, culminating in a peak that then falls gradually to background infiltration levels. Background infiltration is represented on the charts by periods of uniform, consistent flows. The wet weather months contain peak infiltration levels where the ground is saturated with a high groundwater table, and also low inflow levels during storm-free periods.

For the purposes of this report, a peak infiltration level was used. The charts measure discharge at the outlet of the lagoons and provide a good indication of daily fluctuations in sanitary sewage flow, but not instantaneous peaks in stormwater inflow because of attenuation in the lagoons.

Flow charts were reviewed for January 1998 through April 2001 and average sanitary sewage flow and peak infiltration were estimated, using a population of 2,750 people.

Average daily sanitary sewage flow and infiltration:

1. The flow charts were reviewed to ascertain a background level that represented peak infiltration. By inspection, without stormwater peaks, a winter flow consisting of sanitary sewage and peak infiltration was 450 Igal/min (34.1 ℓ/s). (Refer to flow charts for the weeks of March 18 - 24 and December 10 - 16, 1998, Figure 7.1, Figure 7.2, Appendix C.) This constitutes a first equation: sanitary sewage + infiltration = 34.1.

2. The flow charts were reviewed for summer flows, to give an indication of sanitary sewage minus any amount exfiltrated through leaky pipes. It was determined that average summer flows (sanitary sewage minus exfiltration) were 50 Igal/min (3.8 ℓ/s). (Refer to flow chart for the week of September 13 - 19, 2000 Figure 7.3, Appendix C.) This constitutes a second equation: sanitary sewage - exfiltration = 3.8.

3. To proceed with calculations of infiltration and sanitary sewage flow, it was assumed that infiltration is 2.5 times exfiltration. This arbitrary selection is based on exfiltration proportional to the partly full depth of flow in the pipes, and infiltration proportional to the greater height of groundwater above the pipe inverts. This constitutes a third equation: infiltration = 2.5 x exfiltration.

With three unknowns (sanitary sewage, infiltration, and exfiltration) these three equations were solvable. It was derived that:

- exfiltration = 8.7 ℓ/s
- sanitary sewage flow = 12.4 ℓ/s.
- infiltration = 21.6 ℓ/s (15.6 m3/ha/d over 120 hectares).

7.6 DERIVATION OF DESIGN FLOWS

The sanitary sewer pipe network at the Village of Cumberland conveys sewage to the treatment lagoons, and treated effluent is discharged to Maple Lake Creek. Because part of the pipe network consists of vitrified clay pipes, some of which date back to the 1890's, infiltration into the system is high. For the purposes of this report, it was assumed that infiltration is consistent throughout the pipe network. An analysis of where infiltration is occurring does not constitute part of this study.

Stormwater inflow is an existing component of the sewage, because parts of Cumberland are not serviced by separate storm sewers. In these areas, direct connections from roof leaders and catch basins in the streets were made to the sanitary sewer pipes. Plans of the sanitary and storm piping networks were analysed to determine where inflow is likely occurring. Areas serviced by sanitary sewers but not storm sewers were assumed to be sources of inflow to the sanitary sewer system, and estimated to be 42 hectares.

a) Sanitary sewage flows

i) Average Flow

The total average flow is 1070 m^3/d (12.4 ℓ/s, Section 7.5). Based on the current population of 2,750, the average overall sanitary sewage flow is equivalent to 390 ℓcd.

ii) Component Flows

The sanitary flow was divided into component parts, according to source.

The institutional flow from the laundry is 157 m^3/d (Section 7.3 b) ii) above). Criteria for Campbell River for commercial flows were used as follows:

Table 7.5 Commercial Flows

2 Schools (200 people)	45 ℓcd	= 9,000 ℓ/d
1 Hotel (20 rooms)	1,000 ℓ/room/d	= 20,000 ℓ/d
2 Motels (20 units)	350 ℓ/unit/d	= 7,000 ℓ/d
3 Restaurants (60 seats)	150 ℓ/seat/d	= 9,000 ℓ/d
100 Retail & office employees	120 ℓ/employee/d	= 12,000 ℓ/d
	Total:	**57,000 ℓ/d**
		or 57 m^3/d

Industrial flow was estimated from review of the OCP and known conditions at Cumberland, with an estimate of 10 employees/hectare. Using 45 ℓ/d/employee from the *Sewage Disposal Regulation* results in 0.45 m^3/ha/d and a total of 4.0 m^3/d over the present 9 ha.

Table 7.6 - Average Sanitary Sewage Flow According to Source

Source	Unit Rate	Total Flow (present) m^3/d
Total Flow		1070
- Institutional	(laundry)	157
- Commercial (2.9 ha)	19.7 $m^3/ha/d$	57
- Industrial (9 ha)	0.45 $m^3/ha/d$	4
= Residential (2,750)	310 ℓcd	852

iii) Peak Flow

The Harmon peaking factor of $1 + 14/(4+ P^{1/2})$, (= 3.47), was applied to total average sanitary sewage flow (1070) to obtain peak flows.

The resultant peak flow, for a population of 2,750 is 3,720 m^3/d.

f) Infiltration

Infiltration into the pipe network was calculated on a per hectare basis. For the present network covering an area of 120 hectares, an infiltration rate of 15.6 $m^3/ha/d$, derived from flow chart analysis was applied. (See Section 7.5 - Historical Flows, above.)

It was projected that ultimate build-out of the sewer system will occupy a total of 200 hectares. However, infiltration will decrease into any additional sanitary sewer pipes, because of higher design and construction standards. Infiltration design value for the new infrastructure is recommended at 5.2 $m^3/ha/d$. (See Section 7.3 - Municipal Criteria above.)

For the total future service area of 200 hectares, 120 ha will have an infiltration rate of 15.6 $m^3/ha/d$ and 80 ha will have an infiltration rate of 5.2 $m^3/ha/d$.

g) Stormwater inflow

A stormwater model was utilised to predict stormwater inflow into the sewage pipe network to obtain an estimate of flows resulting from the 5-year storm. The 5-year storm is established by the Ministry of Water, Land & Air Protection (MWLAP) as a criteria for containing and treating combined sewer overflows (CSO's).

The IDF curve from the Atmospheric Environment Service of Environment Canada for Courtenay Puntledge BCHP and the SCS Type 1A storm distribution were used to create hyetographs for the 5-year storm with durations of 24 hours, 12 hours, 6 hours, and 2 hours. Each storm was used to model runoff through the system to determine which storm generated the maximum peak stormwater inflow. It was determined that the 6-hour storm was the event that produced maximum peak flows.

The peak inflow for a 5-year, 6-hour storm is 336 ℓ/s (29,000 m^3/d), at the downstream end of the collection system.

Figure 7.4 - 6 Hour Storm, SCS Type 1A Distribution

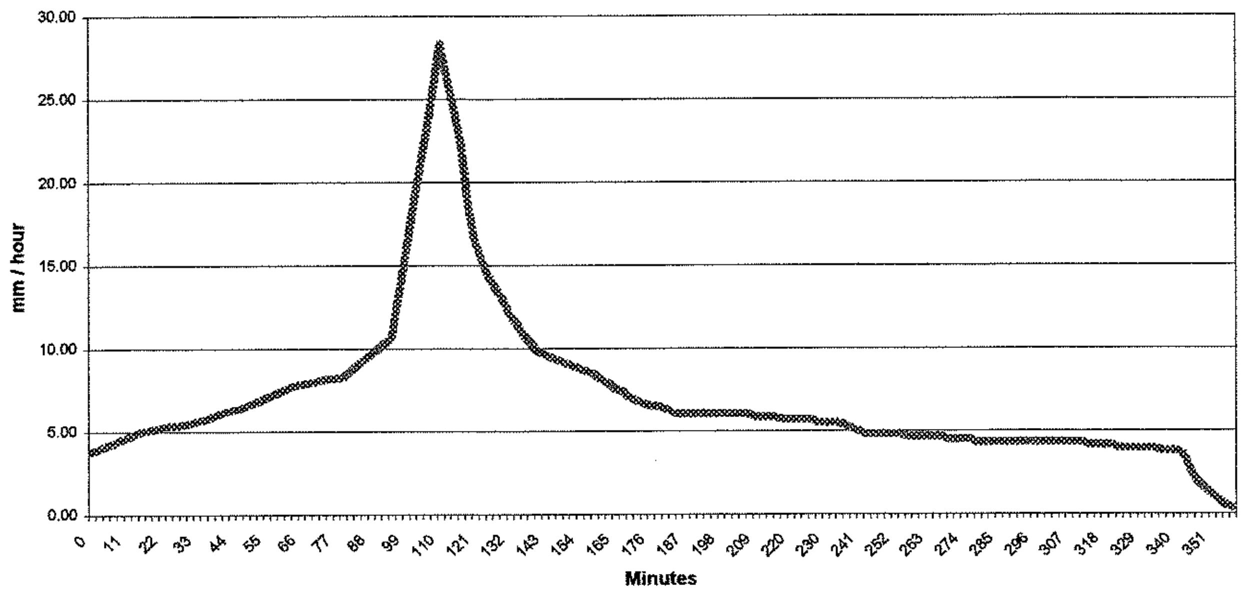
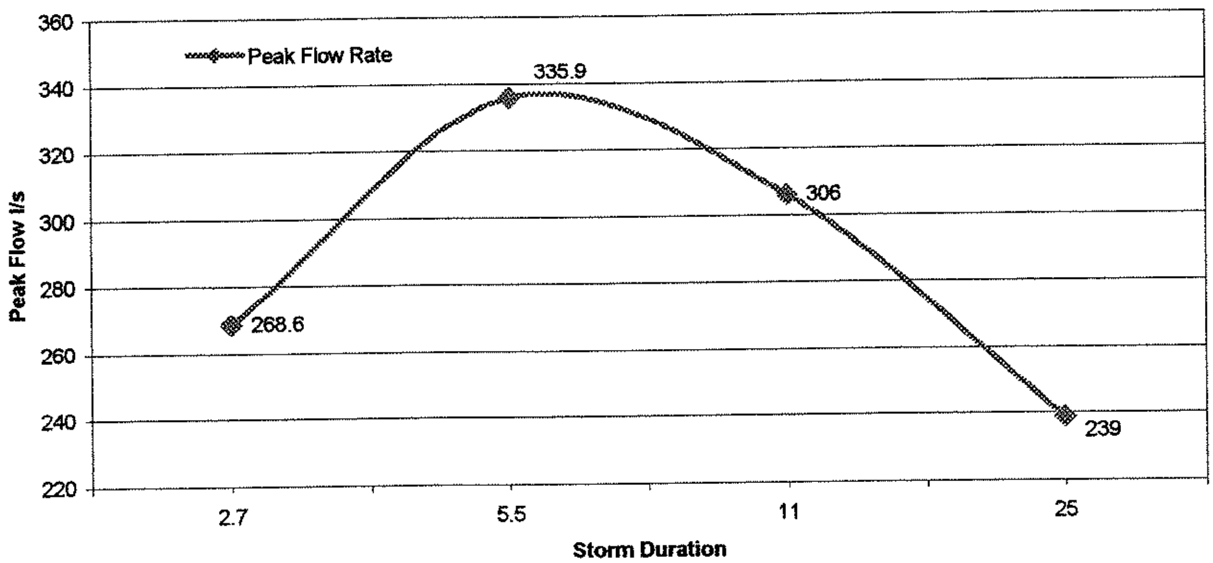


Figure 7.5 - Critical Storm Duration



7.7 MODEL CALIBRATION

The computer model was calibrated by adding the lagoon at the discharge of the pipe network and by adding a hydrograph, representing sanitary flow and infiltration, prior to the lagoon, so that existing flow charts of the lagoon discharge could be compared to flows generated by the model. At Cumberland, conditions at the outlet of the lagoon are controlled by a V-notch weir, so the discharge / storage relationship for the model was derived from a V-notch weir equation.

Rainfall data for two storms, March 23 - 24, 1998 and November 23 - 24, 1998 were obtained from the BC Hydro CMX DCP station at the north end of Comox Lake. These two storms were utilised in the model.

a) Infiltration and Sanitary Hydrograph

Background infiltration is dependent on the time of year and the antecedent rainfall conditions. Therefore, infiltration for each storm was put into the model based on information on the flow charts for the time preceding and following the two storm events. The March 23 - 24, 1998 storm was preceded by background infiltration and sanitary flow of 11 ℓ/s, and followed by a flow of 34 ℓ/s, whereas the November 23 - 24, 1998 storm was preceded and followed by a flow of 34 ℓ/s. This background flow was input into the model for a period of two days prior to the storm to allow build-up in the storage.

By inputting infiltration and sanitary flow into the model in this manner, the shape of the hydrograph at the outlet of the lagoon more closely resembled the shape of the flow chart data.

b) Lagoon Storage

Model runs were completed for the March 23 - 24, 1998 storm event with the total area of the lagoons used for storage. The peak modelled flows and the shape of the Outlet hydrograph (Figure 7.7) corresponded well with the chart records (refer to Figure 7.1, Appendix C). By reference to Figure 7.6 it is seen that the theoretical 5-year, 6-hour storm is similar to the March 1998 storm, and will generate similar flows at the outlet.

Figure 7.6 - March 23 - 24, 1998

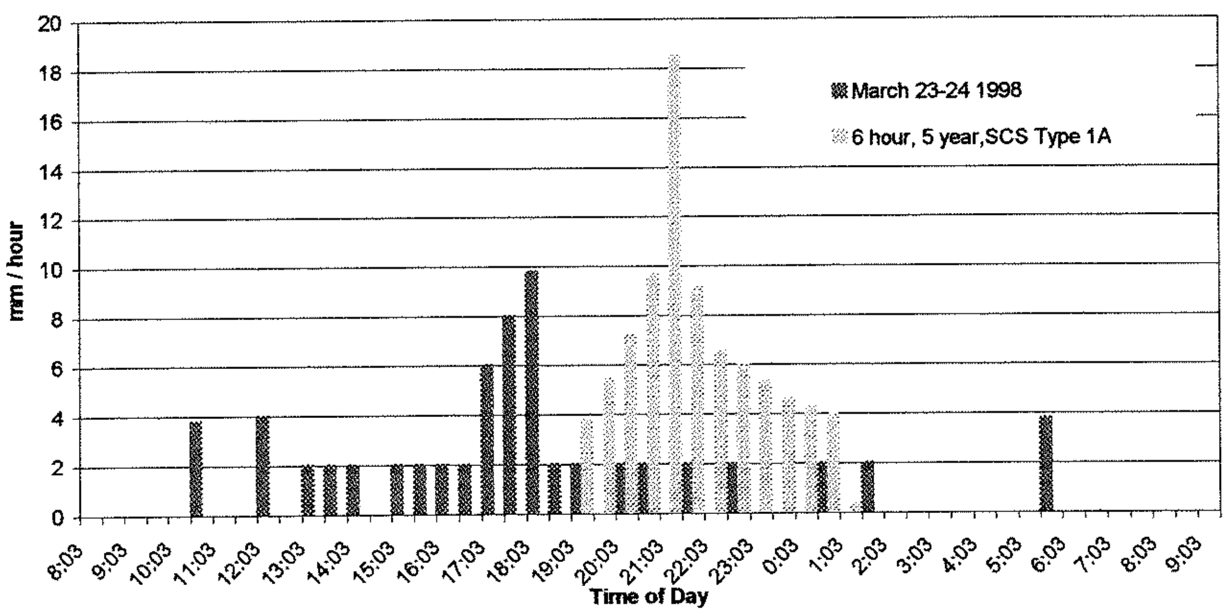
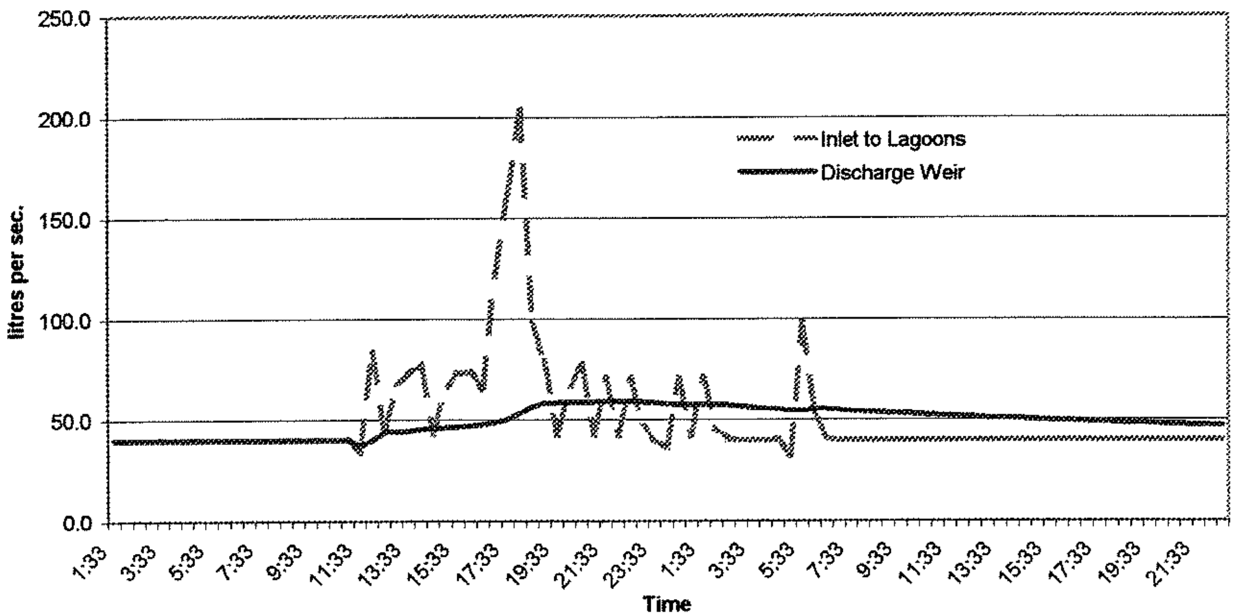


Figure 7.7 - March 23 - 24, 1998 Lagoon Storage Calibration



c) Manning's "n"

The Manning's "n" value was varied during runs of the model. It was determined that varying the "n" value does not affect the peak flow significantly but does change the shape of the output curve, rounding sharp peaks to indicate increased delay in the pipe network.

d) Discharge - Storage Relationship

Conditions at the V-notch weir were modelled in two different ways:

1. with zero discharge and zero storage at the base of the V-notch weir, and
2. with zero discharge at the base of the V-notch but with zero storage corresponding to the pre-storm base flow.

The second scenario with zero storage above base flow, resulted in better calibration with flow charts. This confirms that active storage of the storm begins with storm inflow. The model was otherwise too slow to stabilise background levels of infiltration and sewage flow.

e) Conclusion

Reasonable correlation between modelled and measured flows was obtained. These support the use of this model for prediction of storm inflows to the combined sewer system.

7.8 PROJECTIONS

a) Sanitary sewage flows

Projections of sanitary flow were made for populations of 2,500 – 5,000 in increments of 500. To obtain peak values, Harmon peaking factors were calculated for each population and applied to a base per capita sanitary sewage flow of 390 ℓcd. It was assumed that the per capita sanitary flow rate does not change with population increase.

b) Infiltration

Refer to Table 7.7 below for infiltration values calculated using the methodology outlined in Section 7.6 b) above.

c) Stormwater inflow

Peak stormwater inflow from the 5-year, 6-hour storm over the 42 ha of combined sewers results in a peak of 336 ℓ/s prior to attenuation in the lagoons (see Section 7.6 c) above).

Table 7.7 - Flow Results

All values are in ℓ/s.

Population	2,500	3,000	3,500	4,000	4,500	5,000
Average Sanitary	11.3	13.5	15.8	18.1	20.3	22.6
Peak Sanitary	39.6	46.6	53.5	60.2	66.8	73.2
Wet weather infiltration	20.8	22.4	23.5	24.5	25.5	26.5
Subtotal: Average daily, no inflow	32.1	35.9	39.3	42.6	45.8	49.1
Subtotal: Peak, no inflow	60.4	69.0	77.0	84.7	92.3	99.7
Peak Inflow - 5 yr, 6 hr storm	336	336	336	336	336	336
Total: Average daily with inflow	368.1	371.9	375.3	378.6	381.8	385.1
Total: Peak with inflow	396.4	405.0	413	420.7	428.3	435.7

7.9 SUMMARY

Several approaches were taken to derive flows through the sanitary sewer network at Cumberland:

- Previous flow analysis work was reviewed. Because of a wide variation in design flows in the work of Ker Priestman and Associates, KPA Engineering Ltd. and CK Ventures Ltd., other investigation was completed.
- Flow calculations were made for Cumberland using criteria from other municipalities, from Metcalf & Eddy and the Ministry of Health. There was a wide variation in results.
- Flow charts of the discharge from the lagoon were analysed to obtain historical flows. Wet weather measurements include sewage flows, infiltration, and inflow; dry weather months only include sewage flows, with exfiltration. Wet weather infiltration varies depending on the antecedent moisture conditions in the ground, with peak infiltration used in this report. Sanitary flow was separated from infiltration in the winter and exfiltration in the summer to arrive at an average sanitary flow and peak infiltration rate.

  Sanitary flow was divided according to sources: residential, commercial, industrial and institutional, using assumptions for commercial and industrial flows derived from municipal and textbook criteria and review of the OCP.

  Data obtained in this manner provided reliability for estimating average sewage flows and infiltration. Daily peaks for sanitary flow were estimated using the Harmon peaking factor.
- In order to specify peak inflow from a specific storm, stormwater inflow was modelled. The model was calibrated using the March 23-24 and November 23-24, 1998 storms. A detention lagoon was included at the end of the pipe network, with infiltration and sanitary flow added as background values, so that the flow chart data could be compared to model results. The 5-year, 6-hour storm was run, with only the existing combined sewer areas contributing stormwater.

Projections were made for populations of 2,500 – 5,000 people, with the assumption that infiltration and inflow will be reduced in future piping.

7.10 RECOMMENDATIONS

For future design, it is recommended that the following parameters for flow be used at the inlet to the treatment process.

a) Sanitary sewage flows

An average per capita sanitary flow of 390 ℓcd includes generation from residential, commercial, industrial, and institutional sources.

The sanitary flow can be divided, according to source, as follows:

- Residential 310 ℓcd
- Commercial 19.7 m3/ha/d
- Industrial 0.5 m3/ha/d
- Institutional site specific
  (presently the hospital laundry is at 157 m^3/d.)

For peak daily sanitary flow, the Harmon formula $1 + 14/(4 + P^{1/2})$ should be applied to average flow.

b) Infiltration

For the existing old sanitary sewer network, distributed over 120 ha, infiltration is 15.6 m^3/ha/d. For newly built pipes the infiltration rate should be 5.2 m^3/ha/d. Note that an additional 80 ha is available for future development in Cumberland.

c) Inflow

Peak inflow for the 5-year, 6-hour storm through 42 ha of combined sewers is 336 ℓ/s.

8. Sewer Collection System

8.1 Introduction

The Ministry of Water, Land and Air Protection (MWLAP) issued Permit PE 197 to the Village of Cumberland on August 25, 1967 for discharge of effluent from the wastewater treatment system. The Permit was amended on December 3, 1997 to include a requirement for sanitary and storm sewer separation by September 1, 2015. *The Waste Management Act, Municipal Sewage Regulation* (MSR), April 23, 1999 requires that the feasibility of sewer separation be assessed and that storm and sanitary sewers are separated at the time of repair (Schedule 1, section 14(3)). In 1990, KPA Engineering Ltd identified costs as over one million dollars for storm sewer separation and over 2.4 million dollars for sanitary sewer separation (2002 dollars).

Although the potential exists in the existing system for Combined Sewer Overflows (CSO), none has ever been identified or recorded, despite recent high rainfall events.

Chapter 7 determined the separate components of sanitary, infiltration, and inflow that are generated by the Cumberland sewer system. Both infiltration and inflow values are high. Infiltration can only be dealt with by extensive repair and replacement of the existing collection system infrastructure.

8.2 Sewer Separation

Although newer areas of development are not served by combined sewers, and no new areas will be, there is an extensive older area that has a partially combined sewer system. Refer to Figures 8.1 and 8.2 in Appendix C.

a) Alternatives

Alternatives for dealing with the Inflow component include:

a) Separation of the storm system by construction of new storm drains.

b) Separation of the sanitary flows by construction of a new collection system.

c) Acceptance of the existing level of inflow through the system to the point of discharge. This alternative would include:

- a systematic reduction of inflow connections and implementation of the stormwater management regime being developed through the UBC *Small Town Program*, (Refer to Chapter 19),
- reduction of infiltration by a programme of pipe repair and replacement,

- identification and elimination of specific capacity bottlenecks, for elimination of potential overflows,
- implementation of a treatment process that would accommodate the projected flows.

This chapter identifies the extent of construction and costs for separation of stormwater from sanitary flow, and examines the potential for overflows. The purpose is to provide separate sanitary and stormwater servicing to the residents living in the existing combined sewer area of Cumberland. Dwellings that currently discharge stormwater to a sanitary sewer pipe would be connected to the separated storm sewer system.

The two proposed options for sewer separation are:

Option 1. Build a new storm sewer system in the combined sewer area of Cumberland, and continue to use the existing pipe network for sanitary sewage.

Option 2. Build a new sanitary sewer system in the combined sewer area and use the existing pipe network for stormwater collection and disposal. In this case, some upgrading and addition to the existing network would be required to accommodate the stormwater.

b) Methodology

The following tasks were completed for this study:

- Review of previous work,
- Storm sewer flow calculations,
- Storm sewer pipe sizing,
- Preliminary design of new storm sewer system,
- HYDSYS modelling of 5 year, 6 hour storm to gather information on pipe surcharging,
- Scope of works and cost estimates for:
  - A new storm sewer system based on preliminary design and pipe sizing,
  - A new sanitary sewer system based on duplicating the existing sanitary system, with existing piping upgraded to accommodate stormwater,
  - System upgrades to eliminate CSO's.

8.3 Background Information

a) Data Collection and Review

Previous work was reviewed and data collected to provide a background for calculations:

- The *Feasibility Study for Sewerage and Wastewater Disposal,* KPA Engineering Ltd., November, 1990,
- Digital plan of the existing sanitary sewer pipe network provided by Cumberland,
- The existing storm sewer network drawn onto KPA drawing *Combined Sewer Plan*, No. C4013-917-RE-101 by the Cumberland staff,
- *Village of Cumberland Stormwater Management Plan*, by Anderson Civil Engineering, May 2000. Drainage basins delineated in the southern upland and urban drainage areas and data from the field work including existing stormwater infrastructure locations, were incorporated.

KPA Engineering Ltd., (November 1990), addressed the dilution capacity of the Trent River, treatment capacity of the sewage lagoons, nutrient and coliform loading by sewage effluent and health concerns with effluent contact.

Separation of storm and sanitary sewers was recommended to reduce hydraulic loading to the treatment system and to increase dilution at the point of discharge.

Based on their earlier 1987 study, capital costs were estimated for sewer separation (KPA page 36). These costs are updated in the following table to 2002 costs using the Engineering News Record (ENR) ratio.

Table 8.1 - KPA Costs for Separation

	ENR Index	New Storm Sewers	New Sanitary Sewers
1990 costs	4732	$ 795,000	$1,806,000
2002 costs	6500	$1,092,000	$2,481,000
Engineering & Contingency Costs (35%)		$ 382,000	$ 868,000
Total:		**$1,474,000**	**$3,349,000**

b) Existing System

Much of Cumberland is serviced by a combined sewer system that dates back to the 1890's. Through a series of sewer system extensions in 1960's and 1970's and the construction of a major interceptor pipe, all of the sewage and some of the storm drainage are conveyed to the treatment lagoons. Newer areas of development and construction have been correctly serviced with separate sanitary sewers and storm drainage system. The areas of combined sewer system were identified in LWMP, Stage 1, and shown on Figure 4 in that report. Because of the street layout and topography, a few smaller areas in the older part of Cumberland are already serviced by separate storm sewer systems.

Parts of the central collection system may have been laid as long ago as 100 years. Because of their age, and quality of original construction, these sections suffer significantly from infiltration and exfiltration.

c) Design Standards

Criteria from the Village of Cumberland, Subdivision Control Bylaw # 652, September 1993, were used to design the proposed storm and sanitary sewer networks. To provide additional specific criteria, other Vancouver Island municipal standards were referenced. The criteria used in this report include:

Sanitary Sewers

- Minimum 200 mm dia., except for 150 mm dia. in last leg that cannot be extended.
- Minimum velocity 0.75 m/s flowing full.
- Manning roughness coefficient 0.013.
- Service connections 100 mm dia.
- Maximum manhole spacing 120 m.

Storm Sewers

- Minimum 250 mm dia., except for 200 mm dia. in last leg that cannot be extended.
- Minimum velocity 1.0 m/s flowing full.
- Manning roughness coefficient 0.013.
- Maximum manhole spacing 120 m.

8.4 Preliminary Design for Separation

After a review of the existing storm and sanitary sewer networks, two conceptual plans were prepared for sewer separation, as well as an option for retaining the existing combined system :

i) Option 1: Proposed Storm Sewer Network

This includes a new storm sewer network, using the existing sanitary pipe network for the collection of sanitary flows. Refer to Figure 8.1 (Appendix C) for the proposed storm sewer concept plan.

The proposed storm sewer network was designed to discharge to the nearest watercourse or wetland, using multiple dispersed outfalls as recommended in the *Village of Cumberland Stormwater Management Plan*. No discharges to parks or playing fields were used. This may be an option at the detailed design stage. The proposed storm sewer network was designed to follow existing road rights-of-way, and to integrate with existing storm sewer infrastructure. Only areas presently serviced with potential combined sewers were considered for the proposed storm sewers.

The Rational Method was used to estimate stormwater inflow into the storm sewer network. The IDF curve (Atmospheric Environment Service, Environment Canada) for Courtenay Puntledge BCHP was used to estimate rainfall intensity, and a run-off coefficient of 0.6 was used to calculate flows. Manning's formula was used to size pipes for the entire network, including a check on the capacity of existing pipes.

ii) Option 2: Proposed Sanitary Sewer Network

This includes a new sanitary sewer network, using the existing sanitary pipe network for the collection of stormwater flows. Refer to Figure 8.2 (Appendix C) for the proposed sanitary sewer concept plan.

This option proposes a new sanitary sewer network in the combined sewer area only. The existing sanitary sewer network would be used to convey stormwater, with some re-design to accommodate storm flows that are larger, and to direct stormwater to the nearest water body rather than to the treatment plant.

The proposed sanitary sewer network was designed approximately along the alignment of the existing sanitary sewers, but with pipes that are presently located across private property moved to the road right-of-way where possible.

Separate flow calculation was not completed for Option 2. It was assumed that:

- Proposed sanitary sewer pipe sizes will not be different from existing sanitary pipe sizes,

- Storm flows from Option 1 can be applied to Option 2.

Sanitary sewer pipes are proposed only in the areas of Cumberland where:

- Combined sanitary and storm pipes presently exist, i.e. where there are presently no storm sewer pipes, or
- Existing sanitary sewer pipes are required to convey stormwater. No new trunk sanitary pipes are required in the south of Cumberland, because stormwater does not need to be routed to the treatment plant.

iii) Option 3: Retain Existing System

If the existing combined sanitary and storm sewer pipes remain, then discharges to the environment from the system, as Combined Sewer Overflows (CSO), must not occur.

The existing combined network was checked for the possibility of overflows occurring with a population of 2,750 people (Year 2001). The stormwater model HYDSYS was run with a hyetograph developed from the 5-year, 6-hour storm, the IDF curve for Courtenay Puntledge BCHP, and the Type 1A storm distribution. Sanitary sewage and infiltration base flows were put into the model as constants at applicable nodes throughout the system.

The original "ravine" in Cumberland runs north/south parallel to and between Fourth and Fifth Streets. The existing pipes are generally twinned mains of uncertain vintage or quality. Based on flow calibrations, the pipes are believed to suffer severely from infiltration, and consequently exfiltration in the dry season. Downstream sections have insufficient capacity to carry the design flows and may be susceptible to CSO's.

The flow into the north end of this system at Windermere Avenue should be diverted north into a new 600 mm dia. main. The remaining very old pipes and under-capacity sections should be replaced with new mains. Because of the shape of the ground, the new alignment must follow approximately the existing route through private property. Alternative replacement can be by open trenched excavation or one of a number of trenchless technologies. The most economical should be used in each section, but costs include an allowance for the higher cost of working either on or under private property.

Reduced capacity under combined flows was identified in the existing 200 mm diameter sewer main parallel to Derwent Avenue between Sutton Drive and the bottom of Second Street. The proposed works include a parallel diversion on the extension of Derwent Avenue and along the old Wellington Colliery railway grade.

8.5 Preliminary Design for System Upgrades

Even after the separation of the storm flows (inflow) from the sanitary system, the remaining system is still significantly deficient. Because of the age of the system, there is still high infiltration and exfiltration.

The infiltration causes high background flows during the winter months when the groundwater is high. The exfiltration has the potential to contaminate the soil and groundwater with untreated wastewater.

A detailed investigation of the condition of the older sections of the system is required. Deficient sections should be replaced, repaired or lined to bring them to current standards.

For the cost estimates it is projected that 80% of the pipes in the older part of the Village will be affected and require upgrading.

After separation of the storm flows, the diversion on Derwent Avenue should not be needed, and the pipe diameters in the "Ravine" will be reduced.

8.6 Cost Estimates

Class C, preliminary cost estimates were completed. These costs are basic costs to separate storm and sanitary flows, and include the cost of upgrading the existing sanitary sewer network to accommodate stormwater flow in Option 2. The costs of construction do not include extending the network into unserviced areas.

An allowance for engineering (including studies and design) and contingency is included. Costs do not include municipal financing, administration or legal costs.

a) Option 1 - Storm Separation

The following table shows the cost to construct new storm sewer pipes, while continuing to use the existing pipe network for sanitary flow.

Table 8.2 New Storm Sewers

Description	Units	Rate	Quantity	Total
200 Ø PVC Pipe	m	$ 120	900	$ 108,000
250 Ø PVC Pipe	m	$ 130	2000	$ 260,000
375 Ø PVC Pipe	m	$ 185	1000	$ 185,000
450 Ø PVC Pipe	m	$ 160	380	$ 60,800
525 Ø non reinforced concrete Pipe	m	$ 175	270	$ 47,250
cleanouts	each	$ 665	20	$ 13,300
manholes	each	$3,000	35	$ 105,000
catch basins & leads	each	$1,500	90	$ 135,000
100 Ø service connections	each	$1,000	250	$ 250,000
outfalls	each	$1,500	4	$ 6,000
Tie-ins to existing pipe	each	$ 900	30	$ 27,000
		Construction Total		$ 1,197,350
	Engineering & Contingency (35%)			$ 419,150
			Total:	**$ 1,616,500**

This table does not include the cost of improvements to the existing sanitary system to reduce infiltration or eliminate exfiltration.

b) Option 2 - Sanitary Separation

The following tables show the cost to build a new sanitary sewer network in the area of combined sewers, and retaining the existing sanitary pipe network for stormwater.

Table 8.3 Upgrades to Existing Network to Accommodate Stormwater

Description	Units	Rate	Quantity	Total
200 Ø Pipe	m	$ 135	510	$ 68,850
250 Ø Pipe	m	$ 150	530	$ 79,500
300 Ø Pipe	m	$ 160	70	$ 11,200
375 Ø Pipe	m	$ 210	1100	$231,000
450 Ø Pipe	m	$ 175	160	$ 28,000
outfalls	ea.	$1500	10	$ 15,000
catch basins & leads	ea.	$1500	145	$217,500
			Subtotal:	**$651,050**

Table 8.4 New Sanitary Sewers

Description	Units	Rate	Quantity	Total
200 Ø PVC Pipe	m	$ 135	6300	$ 850,500
250 Ø PVC Pipe	m	$ 150	860	$ 129,000
300 Ø PVC Pipe	m	$ 160	360	$ 57,600
600 Ø PVC Pipe	m	$ 260	200	$ 52,000
cleanouts	each	$ 665	50	$ 33,250
manholes	each	$3,000	70	$ 210,000
100 Ø service connections	each	$1,000	550	$ 550,000
Tie-ins to existing pipe	each	$ 900	25	$ 22,500
			Sub Total:	**$1,904,850**
			Upgrading of pipe network (Table 8.3)	$ 651,050
			Construction Total:	**$2,555,900**
			Engineering & Contingency (35%)	$ 894,600
			Total:	**$3,450,500**

If Option 2 is implemented, it will be necessary to upgrade the capacity of the existing sanitary sewer in some areas to handle the storm flows. The cost of these upgrades is detailed in Table 8.3, and is included as a line item in Table 8.4.

c) Option 3 - Combined System

The following table shows the cost to upgrade sections of the existing system to sufficient capacity for elimination of CSO's but otherwise retaining the existing combined sewer system. Refer to Figure 8.3 (Appendix C) for the proposed works.

Table 8.5 Sanitary Sewer Upgrades to Eliminate CSO

Description	Units	Rate	Quantity	Total
Upstream Diversion at Ulverston Avenue				
600 Ø pipe	m	$ 260	440	$114,400
manholes	each	$3,000	5	$ 15,000
100 Ø service connections	each	$ 1,000	25	$ 25,000
tie in to existing	each	$ 900	5	$ 4,500
			Subtotal:	**$ 158,900**
Derwent diversion,				
200 Ø pipe	m	$ 165	300	$49,500
manholes	each	$3,000	2	$6,000
tie-in to existing pipe	each	$ 900	2	$1,800
			Subtotal:	**$57,300**
Ravine replacement				
250 Ø pipe (refer to Sec. 8.4 iii)	m	$ 210	240	$50,400
300 Ø pipe (refer to Sec. 8.4 iii)	m	$ 220	280	$61,600
manholes	each	$3,000	7	$ 21,000
remove existing structures	each	$1,000	8	$8,000
100 Ø service connections	each	$ 1,000	20	$ 20,000
tie-in to existing pipe	each	$ 900	11	$ 9,900
			Subtotal	**$ 170,900**
		Construction Total		$ 387,100
		Engineering & Contingency (35%)		$ 135,500
			Total	**$ 522,600**

d) System Upgrades

The following table shows the cost to upgrade or place the older sections of sanitary pipework in the original area of combined sewers. Refer to Figure 8.3, (Appendix C). The extent of these works is based on completion of storm flow separation under Option 1 above.

Table 8.6 - Sanitary Sewer Upgrades for Infiltration

Description	Units	Rate	Quantity	Total
150 Ø PVC pipe	m	$ 105	2100	$220,500
200 Ø PVC pipe	m	$ 135	2500	$337,500
cleanouts	each	$ 650	20	$ 13,000
manholes	each	$3,000	87	$261,000
100 Ø service connections	each	$ 1,000	400	$400,000
tie in to existing	each	$ 900	20	$ 18,000
			Subtotal:	**$1,250,000**
Diversion at Ulverston and Ravine Replacement				
600 Ø pipe	m	$ 260	440	$114,400
300 Ø pipe	m	$ 220	280	$ 61,600
250 Ø pipe	m	$ 210	240	$ 50,400
manholes	each	$3,000	12	$ 36,000
remove existing structures	each	$1,000	8	$ 8,000
100 Ø service connections	each	$ 1,000	45	$ 45,000
tie-in to existing pipe	each	$ 900	16	$ 14,400
			Subtotal	**$ 329,800**
		Construction Total		$1,579,800
Engineering & Contingency (35%)				$ 553,000
			Total	**$2,132,800**

e) Cost Comparison

Costs for sewer separation are compared with those from the *Feasibility Study for Sewerage and Wastewater Disposal,* KPA Engineering Ltd. (1990), with costs adjusted to 2002 values. KPA Engineering costs were derived from A *Master Sewerage and Drainage Plan,* Ker Priestman & Associates, (1987).

Table 8.7 - Cost Comparison for Sewer Separation

	Option	Estimated Cost	KPA Cost (2002 $)
1.	a Storm Sewer Separation b Ulverston and Ravine	$ 1,616,500 445,250	$1,474,000 ----
2.	Sanitary Sewer Separation	$3,450,500	$3,349,000
3.	Upgrade Existing Combined System	$ 522,600	----

The higher comparative cost for building a new sanitary sewer system (Option 2), over building a new storm sewer network (Option 1), results from the requirement that the capacity of the existing sanitary sewer be upgraded in some sections to accommodate higher peak storm flows.

8.7 Recommendations

a) Combined Sewers

If a treatment process were selected which could accommodate the combined system flows, the capital costs of upgrades to the existing system to eliminate overflow potential (Option 3) would be less than for sewer separation. (The analysis of treatment options in Chapters 10 and 11 shows that the treatment process should not be subjected to combined flows).

The estimated total cost is $0. 53 million.

b) Storm Sewer Separation

If combined sewers are separated in Cumberland it is recommended that a new storm sewer system be built (Option 1), rather than a new sanitary sewer system (Option 2). With Option 1:

- Some existing storm infrastructure forms the basis for a new storm sewer system,
- Upgrading of the existing sanitary sewer system is not required for capacity,
- The cost is lower than building a new sanitary sewer system.
- Construction can be phased over time to progressively reduce flows.
- Implementation of full BMPs and stormwater improvements includes possibilities for further savings at the detailed design stage.

The estimated total cost is $ 2.06 million.

c) Infiltration Reduction

Inflow will be significantly reduced after separation of combined sewers, but infiltration will remain high. Extensive repair or replacement of the existing older system will be required unless the treatment process can handle the higher flows.

The repair and replacement can be phased over time to progressively reduce the infiltration in the wastewater.

The estimated total cost (2002) is $2.10 million.

9. Alternative Discharge Options

9.1 INTRODUCTION

a) Background

The Liquid Waste Management Plan, Stage 1, report identified an extensive range of discharge and treatment options. A detailed analysis for many of these alternatives was not completed as part of the Stage 1 Plan.

The summer discharge of nutrients into Maple Lake Creek has long been identified as a key impact from the liquid waste discharge, particularly downstream on the Trent River.

This report addresses the four alternative discharge options that would avoid discharge into Maple Lake Creek during the summer. Chapter 10 addresses appropriate treatment options associated with a continued discharge into the creek. Chapter 11 addresses the negative impact of diverting augmentation flows away from the Trent River in summer.

b) Alternatives Considered

The alternative discharge options include:

- Storage of flows during the summer.
- Summer discharge to land.
- Connection to the Regional trunk system at Courtenay.
- Discharge to Comox Lake

c) Methodology

The following tasks were completed:

- Review of alternatives identified in the Stage 1 Plan Section 3.15 - Capacity of Water bodies and Land to Accept Waste, and Section 3.16 - Options for Treatment.
- Review of appropriate earlier studies.
- Reference to other chapters of this Stage 2 Plan.
- Discussion of the technical, economic and social implications of each alternative.
- Updating earlier cost estimates to 2002 costs.

d) Previous Reports

Previous work was reviewed in order to provide a background for calculations.

A *Master Sewerage and Drainage Plan* was completed for the Village of Cumberland by Kerr Priestman & Associates Ltd. in April 1987, with the goal of planning sewerage and drainage system improvements.

A *Feasibility Study for Sewerage and Wastewater Disposal* was completed by KPA Engineering Ltd. in November 1990, to address specific concerns regarding the Trent River dilution capacity, sewage lagoon capacity and nutrient and coliform loading of the effluent.

In May 1992, NovaTec Consultants Inc. completed a report *Impact of Connecting Cumberland and Royston to the Comox-Strathcona Regional Collection System and Wastewater Treatment Plan*

Refer also to Chapter 6 - Environment, Chapter 7 - Design Flows, and Chapter 8 - Sewer Collection System.

9.2 ALTERNATIVES

Based on the Liquid Waste Management Plan, Stage 1, Section 3.16, four alternatives to reduce or eliminate discharge into Maple Lake Creek during the summer are considered below.

The most significant impact of the sewage effluent discharge has previously been identified as an increase in nutrients in Maple Lake Creek and in the Trent River downstream. Protection of the environment and habitat in the Trent River is considered a key focus for the LWMP process. Since the most significant impact is the potential for an algae bloom in the Trent River resulting from an elevated nutrient level, this is likely only to occur in the summer months when the water temperature is higher and the effect of solar radiation elevated. Elimination of sewage effluent discharge during the summer months has been identified previously as a potential solution.

The summer months are identified as the period when the flows are lowest (therefore concentration is highest) and the water temperature elevated. For the purpose of this chapter only, the period was considered to be June 15 to September 15 annually. (A longer sensitive period from May 1 to September 30 has been prepared for future effluent discharge to Maple Lake Creek.)

a) Summer Flow Volumes

In Chapter 7 historical flows and projected design flows were analysed. Allocations to sanitary sewage, infiltration, exfiltration and inflow were made. The analysis was intended to identify peak flows for sizing of collection and treatment components.

The monthly measured distribution of flow and allocation of components is shown on Figure 9.1. Following the derivation of flows and projections to the design population (5,000), a future monthly distribution of flows is shown in Figure 9.2.

Figure 9.1 - Annual Monitored Distribution of Flows

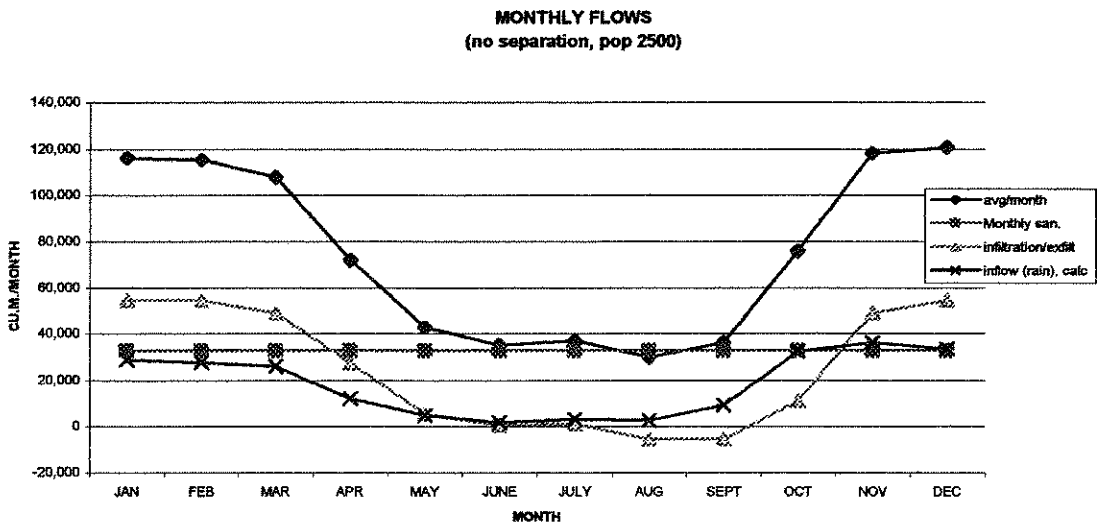
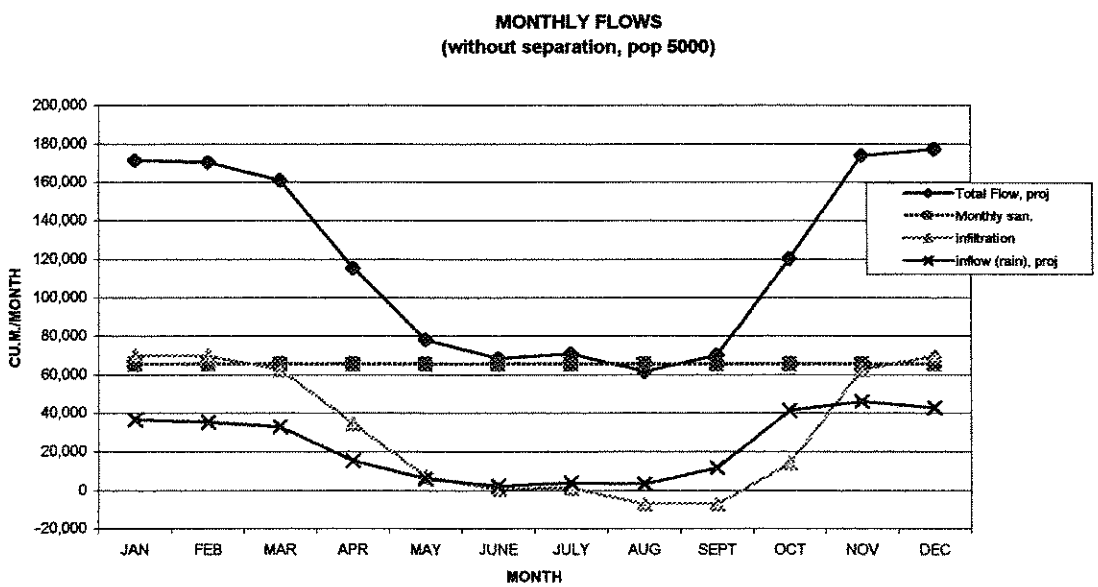


Figure 9.2 - Future Annual Distribution of Flows



The analysis in this chapter is for an "order of magnitude" total summer flow. Infiltration will be less due to lowered groundwater tables, inflow is reduced from less precipitation and elevated evapo-transpiration. No credit has been taken for the surface evaporation from storage ponds.

Although later recommendations in this plan include full sewer separation, this chapter is based on the original goal of retaining the combined sewers.

Projected storage volumes from mid-June to mid-September are shown in Table 9.1.

Table 9.1 - Projected Storage Volumes (m^3 / month)

	Population 2500			Population 5000				
	Recorded 94-01	Infiltration (est.)	Inflow (est.)	Sanitary	Infiltration	Inflow	Total	Storage
June	35,000	500	1,800	65,200	700	2,300	68,300	34,100
July	37,000	1,000	3,200	65,200	1,400	4,100	70,700	70,000
Aug.	30,000	-5,500	2,600	65,200	-7,000	3,300	61,500	61,500
Sept.	36,000	-5,500	9,100	65,200	-7,000	11,600	69,800	34,900
							Total	201,200

The projected minimum required storage volume for elimination of summer discharge is 201,200 m^3. KPA calculated a storage volume of 150,000 m^3, assuming separation of combined sewers and with a reduced population horizon.

b) Store Summer Flows

One alternative to eliminate the discharge of effluent (and nutrients) is to store all effluent during the summer period. This was Option A identified in Table 1 in LWMP Stage 1, February 2001. The advantages of this alternative include:

- All discharge of effluent and nutrients during the summer period would be eliminated together with the downstream impact.
- The overall impact of phosphorous discharge would be reduced, since it would be eliminated in summer but released during the fall when the effects of dilution are maximised, and downstream algae growth limited.
- The operational costs of this solution would be minimal, including the simple operation of control structures at the beginning and end of the storage period, together with some annual maintenance of the impoundment area.
- Storage of the effluent for up to ninety days will result in some quality improvement, particularly in TSS, BOD and coliform.

The disadvantages of this alternative include the following:

- Although the idea was first identified several years ago when the objectives may have been simpler, this alternative alone will not achieve any objectives of the MSR to improve effluent quality.
- In order to avoid storing particularly large volume in the initial impoundment period (June), and to avoid overflows and flushing towards the end of the storage period (September) it will be necessary to carry out separation of the storm and sanitary sewers.
- The total volume to be stored is large (see below) and will require a large land area.
- During particularly wet summers, there is the potential for overflow towards the end of the storage period unless large factors of safety are built into the storage volume.
- Alternative contingency plans must be prepared in case the storage volume becomes exceeded in the future.
- Storage of nutrient rich effluent in an open pond throughout the summer may result in algae bloom or other similar quality degradation. This may result in a lower quality effluent requiring discharge at the end of the storage period.
- Construction of the summer storage facility will have no effect on the water quality discharged at other times of the year. There will be no improvement in the winter effluent quality.

In order to meet all of the goals set by the MSR, additional treatment processes and potentially some additional separation of the combined sewer system will be necessary.

A potential location for this storage pond would be adjacent to Maple Lake Creek and upstream of the existing treatment process. To provide an order of magnitude comparison, the total area identified in the WetlandsPacific report, December 2002 (Volume 2), is 10.5 hectares (105,000 m^2). This area would be required to contain over a 1.9 m depth of water to provide all the storage required. Costs developed in Section 9.3 are based on the WetlandsPacific Report.

c) Summer Irrigation

The basis for this alternative is contained in the *Feasibility Study for Sewerage and Wastewater Disposal*, KPA Engineering Ltd. November 1990. The goal is to eliminate for four months the discharge of sewage effluent into Maple Lake Creek. By eliminating the discharge of nutrients during the low flow and higher temperature period of the summer, the downstream negative impacts are expected to be reduced.

The advantages of this alternative include:

- All discharge of effluent and nutrients during the summer period would be eliminated together with the downstream impact.
- The overall impact of phosphorous discharge would be reduced, since it would be eliminated from the creek in summer but not released in the fall.
- Some additional irrigation in the "shoulder seasons" would also be possible.

The disadvantages of this alternative include the following:

- Although the idea was first identified several years ago when the objectives may have been simpler, this alternative alone will not achieve any objectives of the MSR to improve effluent quality.
- In order to avoid application of large volumes it will be necessary to carry out separation of the storm and sanitary sewers.
- Irrigation requires a large area of accessible land appropriate for a high rate of surface application.
- Significant treatment process upgrading will be necessary to meet a Category 2 effluent for application with Restricted Public Access.
- During particularly wet summers, the application rate may have to be reduced and additional storage provided.
- An irrigation system will have a high operating cost, both power and labour costs.

Based on the criteria established in the KPA report for an application of 350 mm, and on the volumes developed above, the required land area will be in excess of 40 ha. All suitable land area within the present and expanded Village boundaries is privately held. Based on the investigations for the *Stormwater Management Plan*, May 2000, there are limited suitable areas. Much of the ground in the centre and south of the Village is underlain by shallow bedrock or till. Much of the ground to the north is glacial moraine with high percolation rates leading to surface water. The natural groundwater flow is eastwards from the area of Maple Lake to spring sources of domestic and irrigation water, as well as the sources for Millard, Piercy and Roy Creeks.

The Vancouver Island Health Region is not in favour of this alternative.

Costs are developed in Section 9.3 below.

d) Connection to the Regional District System

The alternative for pumping some or all of the sewage from Cumberland to the Regional System was first identified in the *Feasibility Study for Sewage and Wastewater Disposal,* KPA Engineering Ltd. November 1990. In their report the goal was to eliminate the discharge of effluent to Maple Lake Creek during the summer months. A number of scenarios were developed which included separation of the combined storm sewers, separation of the sanitary sewers from the combined area, and construction of attenuation storage. The proposed system included a pumpstation at the existing sewage treatment lagoons, a forcemain south and then east on Royston Road to the high point (approximately the existing Island Highway), a gravity main down to Royston, another pumpstation and forcemain northwards to the existing Regional District of Comox-Strathcona pumpstation near the mouth of the Courtenay River.

A report *Royston Sanitary Sewer Study Update,* Koers and Associates Engineering Ltd. July 1991, examined the service area, works required and costs for also servicing Royston through the same system.

A report *Impact of Connecting Cumberland and Royston to the Comox-Strathcona Regional Collection System and Wastewater Treatment Plant,* NovaTec Consultants Inc. May 1992, reviewed the downstream implications of a connection by Cumberland and Royston. The report confirmed that there is hydraulic capacity in the existing forcemain and pump stations, and that the treatment plant would have sufficient capacity following scheduled expansion plans. The NovaTec report identified no downstream consequences of connecting the Cumberland sewage to the regional system.

The regional sewage system is administered by the Courtenay Comox Sewage Commission. The letters patent allow only for the acceptance of sewage from incorporated municipalities. At this time, only the City of Courtenay and Town of Comox are members. As an incorporated municipality, the Village of Cumberland could be included. As there are no plans to incorporate Royston as a municipality, agreement from Courtenay and Comox and a change in the letters patent would be required before sewage from Royston could be included.

The scheme envisioned by KPA Engineering was intended to deal with the diversion of summer flows. If the system is installed with the capacity sufficient only to discharge the flows projected for June through September, the additional higher flows in the remainder of the year will continue be discharged to Maple Lake Creek.

For the purpose of this study two scenarios are developed:

- Capacity only for the summer flow diversion, and
- Sufficient pumping and pipeline capacity to divert all flows to the Regional System, together with separation of combined sewers and upgrading of sanitary sewers to reduce inflow.

The apparent advantages of connection to the Regional System include:

- Elimination of discharge of phosphorus and other nutrients to Maple Lake Creek during the summer.
- Potential elimination of the treatment plant at Cumberland.
- The potential to free up some existing land from the treatment plant to be used for other purposes

Some of potential disadvantages of connection to the Regional System include:

- High capital cost for pumping stations, forcemains and pipelines.
- High capital cost associated with reduction of inflow and infiltration as well as separation of combined sewer system.
- High operating costs from pumping stations together with ongoing maintenance and repairs.
- Direct charges from the Sewer Commission for handling and treating the sewage downstream.
- This is not considered an innovative or "green" solution.

e) Discharge to Comox Lake

An alternative discharge location to Comox Lake was identified in LWMP Stage 1 at the request of MWLAP.

Comox Lake is located approximately 4 km to the west of the Cumberland Treatment Plant. The lake serves a multiple of uses including:

- A drinking water source for the Regional District supply system to Courtenay and Comox.
- Source of water for the Puntledge River Hatchery.
- Supply of water for BC Hydro generation facility.
- Public use and recreation.

A review of the MSR Schedule 3 - Standards for Discharges to Water indicates that the standards for discharge to Comox Lake would be 45/45 BOD/TSS and that the interim effluent quality for daily flows greater than 2 times ADWF would be 130/130.

The requirements for total phosphorus (1.0 mg/ℓ) and ortho-phosphate (0.5 mg/ℓ) are based upon the *BC Approved Water Quality Guidelines* for lakes.

The advantage of a discharge to Comox Lake is that an outfall at suitable depth might create an effluent plume with an Initial Dilution Zone (IDZ) to achieve a higher level of direct impact reduction than can be achieved in Maple Lake Creek.

Since the required effluent quality is high, particularly in regards to phosphorus, there is unlikely to be any cost saving in the proposed level of treatment.

The works required to discharge to Comox Lake include:

- Upgrading of the existing treatment process to achieve the required reduction in phosphorus compounds.
- Construction of a pumpstation with multiple pumps, together with a forcemain to the high point on the route.
- Construction of a gravity main from the high point to the shore.
- Construction of an outfall pipeline to suitable depth with suitable discharge manifold.
- Storage upstream of the pumpstation to provide short-term flow balancing.
- Separation of stormwater from the combined sewer system.
- Extensive rehabilitation of the existing sanitary collection system to reduce inflows.

This alternative would require an extensive study and environmental impact assessment process. Since Comox Lake and Puntledge River system affect a large part of the population of the Comox Valley, we assume that they will all be concerned about any proposal to discharge effluent into the Lake. This would need to be addressed in an extensive public consultation process.

The Vancouver Island Health Region is not in favour of this alternative.

Discharge to Comox Lake will divert water (normal I&I component) from the Maple Lake / Trent River watershed to the Comox / Puntledge watershed. This is contrary to MWLAP policy. It would return the sanitary flow (derived from domestic waste) from Allen Lake, to the Comox watershed.

Costs for the proposed scope of works are developed in Section 9.3 below.

9.3 COST ESTIMATES

These cost estimates are based on earlier work and on cost estimates developed in the other Chapters of the LWMP Stage 2. They are Class C estimates prepared without any detailed design.

a) Store Summer Flows

Storage volume		201,000 m^3
Pond area		18.5 ha
Depth		1.1 m
Pond Construction [1]		$2,950,000
Creek Realignment [1]		$77,000
Control Structures [1]		$22,000
	Subtotal:	$3,049,000
Storm Sewer Separation [2]		$1,288,000
Engineering Design and Construction		$1,063,000
	Total:	$5,400,000

Reference: (1) *Conceptual Design and Costing of a Constructed Wetland for Cumberland*, January 2002, WetlandsPacific
(2) Chapter 8

Land costs not included.

b) Summer Irrigation

Treatment Upgrade [1] (summer flows)		$3,000,000
Holding Pond & Irrigation System [2]		$2,560,000
Storm Sewer Separation [3]		$1,288,000
	Sub total:	$6,848,000
Engineering Design and Construction		$2,392,000
	Total:	$9,240,000

Reference: (1) *Cumberland Wastewater Treatment Plant Upgrading*, March 2002, Kerr Wood Leidal
(2) *Feasibility Study for Sewerage and Wastewater Disposal*, November 1990, KPA Engineering Ltd. (x ENR index to 2002).
(3) Chapter 8

Land costs not included.

Operating costs not shown, but are expected to be high.

c) Connection to Regional District System

i) Summer Flows only

P/S, forcemain, gravity [1]		$1,170,000
P/S, forcemain (Royston) [1]		$1,267,000
Balancing storage (mods)		$100,000
	Subtotal:	$2,537,000
Engineering Design and Construction		$890,000
Regional Sewer Capital Share		$600,000
	Total:	$4,027,000

ii) Total Annual Flow

P/S, forcemain, gravity [1]		$1,450,000
P/S, forcemain, (Royston) [1]		$1,666,000
Balancing Ponds (mods)		$200,000
Storm Sewer Separation [2]		$1,288,000
	Subtotal:	$4,604,000
Engineering Design and Construction		$1,600,000
Regional Sewer Capital Share [3]		$3,800,000
	Total:	$10,004,000

Reference: (1) *Feasibility Study for Sewerage and Wastewater Disposal*, November 1990, KPA Engineering Ltd. (x ENR index to 2002).
(2) Chapter 8
(3) Based on share of un-retired capital debt proportional to share of annual volume.

Land costs not included.

Annual operating costs (pumping and Regional District fees) not shown, but high.

d) Discharge to Comox Lake

Treatment Upgrade [1]		$4,135,000
Storm Sewer Separation [2]		$1,288,000
Balancing Storage		$500,000
P/S, forcemain, gravity		$1,675,000
Outfall		$300,000
	Subtotal:	$7,898,000
Studies, Design, Construction		$2,762,000
	Total:	$10,660,000

Reference: (1) *Cumberland Wastewater Treatment Plant Upgrading*, March 2002, Kerr Wood Leidal
(2) Chapter 8

Land costs not included.

Operating costs not shown, but are expected to be high.

9.4 RECOMMENDATIONS

a) Storage of Summer Flows

Storage of summer flows is the least expensive, but achieves no improvement in water quality at other times of the year. Although prolonged storage may improve some constituents, there is a high probability of algae growth, eutrophication and very poor effluent to discharge in the fall. Separation of the combined systems may be necessary to avoid early and late overflows.

This alternative is not recommended.

b) Discharge to Land

Discharge to the land in summer eliminates phosphorous and other nutrients from Maple Lake Creek and the Trent River. The treatment upgrades for land discharge can also improve part of the flows in winter. Improvement of all winter flows is not achieved. This alternative is expensive, and may not meet the goals of the MSR for the standard of discharge throughout the year.

This alternative is not recommended.

c) Connection to the Regional System

Connection to the Regional System would eliminate phosphorus and other nutrients from Maple Lake Creek and the Trent River. If the system were used only in the summer, the capital cost would be fixed and not used in winter. If the system is used throughout the year, higher charges from Courtenay - Comox would apply and additional capacity would be required as well as separation of the combined sewers.

Although technically feasible, this is not an innovative or "green" solution. This alternative is expensive.

This alternative is not recommended.

d) Discharge to Comox Lake

Discharge to Comox Lake would eliminate phosphorous and other nutrients from Maple Lake Creek and the Trent River. The alternative requires upgrading of the treatment process to at least the standard proposed for discharge to the creek. Combined sewer separation will be required to control capital and pumping costs. The environmental and social impact of discharge to the lake is unknown and extensive studies are required. There is no reduction of nutrients to Baynes Sound. This alternative is expensive.

This alternative is not recommended.

10. Alternative Treatment Options

10.1 INTRODUCTION

a) Background

The Liquid Waste Management Plan, Stage 1, report identified an extensive range of discharge and treatment options. The treatment options include a wide range of conventional electro-mechanical processes, and the possibility of constructing a treatment wetland by modification of an existing wetland area immediately to the north of the existing treatment plant.

Individual treatment and discharge options have been evaluated in other reports (see Section 10.2 below). This chapter reviews that information to identify selection of the preferred option.

b) Design Criteria

The design service area and populations were identified in the LWMP Stage 1 report, and are based on the Official Community Plan.

Analysis of design flows, including inflow and infiltration, is included in Chapter 7. The design flow projections used for treatment process evaluations are shown on Table 7.7. Review of the downstream environmental impact of construction is included in Chapter 6. This full analysis and discussion was not available at the time of commissioning the studies, and the studies were based on Mimulus (2001).

Each of these consultants was provided with a copy of the Mimulus report, Technical Memorandum *Sanitary and Stormwater Design Flows,* LWMP Stage 1 Report Volume 1 and Volume 2, and the long-term monthly flow records.

The consultants were asked to evaluate processes and technology to achieve the discharge quality goals recommended (Mimulus, Table 7.1). In the case of electro-mechanical processes the design flows are the instantaneous future flows from the Technical Memo. In the case of the constructed treatment wetlands, instantaneous flows are handled by detention and the design flows are for peaks of duration closer to the overall residence time, (minimum 15 days at future winter flows).

10.2 ALTERNATIVES CONSIDERED

a) Basic Requirements

Each of the treatment process options was evaluated against a number of criteria including:

- Integration with the existing collection and treatment facilities.
- Ability to handle the design flows (with significant inflow).
- Ability to address the effluent criteria, particularly the summer high impact.
- The operating costs on both the short and long term basis.
- The sophistication of the technology and the level of operator qualification required to manage the process.
- Land area occupied and the suitability of the process for the site identified.
- The degree to which the process could be considered "green" and sustainable, particularly in the context of the Village OCP and the LWMP Stage 1 Report.

b) Detailed Studies

Separate reports were commission for each of the electro-mechanical group of processes and the treatment wetland process:

- Cumberland Wastewater Plant Upgrading, March 2002, Kerr Wood Leidal Associates Ltd. (Volume 2), (KWL)
- Conceptual Design and Costing of a Constructed Wetland for Cumberland BC, January 2002, WetlandsPacific (WetlandsPacific).

c) KWL Report

This report addressed the alternative electro-mechanical treatment processes suitable for the Village of Cumberland. These processes included:

- Upgrading the existing treatment process
- Sequencing Batch Reactor (SBR) and variants
- Oxidation Ditch
- Biological Nutrient Removal (BNR)
- Membrane Filtration, and
- Upflow Sludge Blanket Filtration

i) Existing Treatment Process

The existing sewage treatment process consists of a two-lagoon wastewater treatment system with an outfall discharging directly to Maple Lake Creek. The treatment plant was originally designed to handle a population of 1,500. The facility was first commissioned in 1967 and subsequently upgraded in 1971. The treatment plant consists of a sewage lift station (for flows from the north), an inlet distribution box, an aerated lagoon, a facultative stabilization pond and an outlet weir equipped with recording flow meter. Aeration is provided by means of three floating mechanical surface aerators. The wastewater flows by gravity through the process from inlet to discharge.

The existing process handles wastewater flow volumes that vary significantly due to storm flows in the combined sewers. The flows are large and highly diluted during the wet winter weather, but in summer the flow volumes are greatly reduced and the concentration of constituents increases due to the lack of dilution. The residence time in winter tends to be short, but in summer significantly longer, which provides an opportunity for improved treatment.

Improvements to the existing process included dividing the facultative pond into three cells for better partial mixed plug flow, increasing the number of aerators, increasing the depth of the ponds from the existing 1.5 m up to approximately 4.5 m deep, or increasing the surface area of the lagoons available. Projections for the performances of these various configurations are shown on graphs in the report.

It was concluded that it is not viable to increase this type of treatment process to achieve a 10/10 effluent. Phosphorous removal will be minimal.

ii) Sequencing Batch Reactor (SBR)

This is a conventional process used in a number of other communities on Vancouver Island. The requirements of the infrastructure for this process are included in the report.

The process is able to tolerate variable hydraulic and organic loads. Mixed liquor solids are not washed out by hydraulic surges and each influent liquid batch is diluted with part of the contents from previous cycle, thus evening out some of the organic load variations.

Of the three most common forms of Activated Sludge Process, the SBR process was considered to be the most suitable treatment option for the proposed Cumberland application. This was based on the having the lowest capital cost and consistently producing a high quality effluent. The SBR process also has the ability to remove phosphorous using a chemical precipitation within the SBR reactor to achieve a concentration in the effluent of 1.0 mg/ℓ. To achieve lower levels of phosphorous discharge, a tertiary treatment step will be required. This might include additional chemical precipitation together with sand filtration. These components will add significantly to the O&M costs associated with chemical usage and biosolids handling, as well as increasing the operator skills required to control the system for optimum performance.

iii) Membrane Filtration

Membrane filtration is rapidly becoming popular in both water supply and wastewater treatment processes. The technology now exists to produce economically membranes capable of filtering anywhere down to molecular level. Membranes are typically produced as thin straws in bundles and are available from a number of large, well-established manufacturers.

The micro-filtration membranes are typically submerged in an aeration tank in direct contact with a suspended biomass. For municipal applications, the micro-filter typically has a 0.1 micron pore size that ensures that no particulate matter is discharged in the effluent. Any phosphorus or other compounds precipitated during the chemical coagulation process are also removed without the potential of minor carry-over of floc. The treated water is drawn by vacuum through the hollow fibre membranes and discharged.

The process of constantly cleaning the membranes is complex, and frequently requires removal of banks of elements for mechanical washing. This factor tends to increase the cost of the membrane process, by requiring significant redundancy to allow for the elements out of service for cleaning at any one time. The process is typically concentrated, compact and effective.

The membrane filtration process, using chemical phosphorous removal, can achieve the specified phosphorous discharge limits of 1.0 mg/ℓ in the winter and 0.1 mg/ℓ in the summer.

The membrane process is typically higher in capital cost, and much higher in power consumption and operating costs (which include an allowance for replacement of membranes every few years).

iv) Other Treatment Processes

Other treatment processes outlined above were also considered, but considered less favourable for a number of different reasons. Although the advantages and disadvantages of each were enumerated, these processes were not carried forward for detailed analysis of capital and operating costs.

v) Process Flow Equalization

As the projected flows into the treatment process vary widely in response to inflow and storm surges, it is necessary to introduce some form of flow equalization. The recommended equalization for both the SBR and Membrane Filtration processes would use the existing aerated and facultative lagoons. These would be used to accommodate the excess flows above design values, and the storage volume would be re-pumped into the inlet stream as the peak flows subsided. The appropriate costs for modifications to and upgrading the existing lagoons are included in Section 10.3 following.

In view of the limited cost to modifying the lagoons to provide the required flow equalization, the alternative strategy of reducing inflow volumes by upgrading the collection system is not economic. The costs of completing the sewer separation to eliminate inflow and storm surges were addressed in Chapter 8.

vi) Disinfection

Chlorine based disinfection systems are no longer popular due to the requirement for de-chlorination before discharge and the probability of by-products in the effluent stream.

Ultra-violet (UV) disinfection is an established technology that can effectively disinfect the effluent. Potential problems can arise from coating of the tubes as a result of the chemicals used for coagulation, and with the need for a low turbidity effluent.

With the requirement established for a 10/10 effluent, UV is the recommended form of disinfection.

d) WetlandsPacific Report

This report addresses the effectiveness of using a Constructed Treatment Wetland in series with the existing lagoon system to produce a high quality effluent for discharge to Maple Lake Creek. The report reviews the earlier work *A Constructed Wetland for Stormwater Management, Tertiary Wastewater Treatment, and Low Flow Stream Augmentation - Feasibility Study*, October 1998 by CK Ventures et al and updates the conclusions and expands on the detailed science involved.

The proposed constructed wetlands contain both shallow sections with emergent vegetation and deeper sections of open water. This type of wetland closely mimics nature and provides a variety of wildlife habitat.

i) Treatment Process

The proposed treatment process includes a number of individual cells. The effluent can be routed successively through all four cells in series or through shorter paths to suit operational requirements when necessary. The first two cells are intended to reduce the suspended solids, BOD, coliform bacteria, nitrogen compounds, and heavy metals. The form of these cells will be sections of shallow water with emergent vegetation and deeper sections of open water. The remaining two treatment cells are intended to complete the reduction of soluble phosphorous compounds. The treatment process is one of using natural processes to the maximum extent practical, and by accommodating short term variations in water depth will effectively handle the wide range of flows projected.

ii) Configuration of Layout

The proposed layout of the cells generally follows the 1998 report and recommendations, and is shown on WetlandsPacific Figure 5. Since publishing the report in 2001, continuing discussions have amended the available area as shown on Figure 6.1 (Appendix C). A supplementary report on the projected performance of the wetlands (December 2002) is discussed in Chapter 11.

The layout requires that the natural existing southerly flow of water through the fen and around the section of shore pines be maintained. Provision is made to accommodate separate stormwater flows from Mill Street when the silt loading would be particularly beneficial to one or more of the cells. Silt can plan an active role in binding phosphorous permanently into the pond sediment. Some of the earlier provisions in the 1998 report for treatment of stormwater have been eliminated in the interest of reducing any environmental impact and damage.

The existing Maple Lake Creek alignment is purely artificial, and reflects the drainage works undertaken early in the last century to create arable agricultural land. The existing creek between Cumberland and Royston roads takes the form of a linear open ditch that has been created by excavation and maintained by dredging.

The WetlandsPacific report (January 2002) recommended relocation and reconstruction of the creek to the east. Subsequent review and discussion has shown little support for this. As discussed in Chapter 6, there is a requirement to maintain the hydraulic regime in the sensitive fen/bog area. The revised location and layout (Figure 6.1) retains Maple Lake Creek in the existing west channel.

iii) Phosphorous Reduction

The report contains extensive discussion on the effect of wetlands on phosphorous in the effluent. Basically two mechanisms are identified affecting the concentration of phosphorous in the final effluent.

Wetlands retain and secrete phosphorous (particularly organic orthophosphates) according to a complex array of climatological and biological factors. The vegetation in the wetlands is expected to take up phosphorous during the active growing season, but release it during the late fall and winter during the natural die-off of vegetation. This seasonality results in a reduced phosphorous discharge during the summer when the impact on Maple Lake Creek would be the most severe.

The other mechanism affecting the total phosphorous concentration is a net retention of phosphorous in the wetland. This is assumed to take place in the permanent root structure of the plants and by adsorption onto the plant structure and bottom sediments. References are cited for the rate at which phosphorous is retained in the wetlands.

Review and discussion, (refer to Chapter 6), identified orthophosphates as the target constituent in the discharge. Although the discharge of total phosphorous throughout the year is not considered important, the release of orthophosphate should be limited to 0.10 mg/ℓ (100 μg/mℓ) between May 1 and September 30. A supplementary analysis of the wetland performance was completed (WetlandsPacific, December 2002) and is discussed in Chapter 11.

iv) Disinfection

At the existing discharge point from the settlement lagoon to Maple Lake Creek, the fecal coliform concentrations can be very high. In the proposed wetland design, the lagoon discharge will be directed through the wetland cells. The future minimum winter retention time is 15 days and during the summer up to 31 days. These retention times will result in a significant die-off of all human pathogens, in particular the indicator fecal coliform. By the point of final discharge to Maple Lake Creek, it is expected that the indicated coliform levels will be within target values set in the MSR for reclaimed water for stream flow augmentation.

Until disinfection is added to the process stream, sampling for viruses should be carried out during the period when discharge is classified as "reclaimed water". The results of this sampling must be acceptable to the local health authority at all times.

The wetlands, however, will be home to a host of other animals and in particular waterfowl. These will contribute their own contaminants to the water and may show significant coliform counts at the point of discharge. In effect the wetland will have exchanged human pathogens for waterfowl pathogens. Techniques are available to analyse these specific pathogens encountered and to attribute their source appropriately. Consideration should be given to undertaking this task seasonally to confirm that no human pathogens from the sewage are reaching Maple Lake Creek.

Should disinfection of the final effluent be required, UV would be installed as recommended above in c) vi).

v) Additional Provisions

It is proposed to construct the entire treatment wetland immediately for the horizon design population. This will provide a considerable conservative factor of safety between the capacity and the design flows. The initial wetland will be constructed with immature vegetation, and will take some time to grow in and stabilize. After the first growing season it is expected that there will be significant water quality improvement and the final effluent discharge may even meet the design goals. The final effluent quality will improve dramatically over the first few years as the wetlands establish themselves. Phosphorous uptake will be high during the early years until equilibrium is reached.

As the design sewage flow increases with increasing population towards the OCP horizon, the final effluent quality may degrade slightly but will still remain at, or better than the required design limits.

As phosphorous has been identified as a key component in the discharge, and as this is the constituent with the highest treatment process uncertainty, it is projected that present and future phosphorous goals will not be achieved by the wetland alone. It will be necessary to add chemical injection for precipitation of additional phosphorous. This is further discussed in Chapter 11.

The MSR requirements for reclaimed water include provisions for alternative methods of disposal. As the treatment process requires significant duplication and redundancy (i.e. 4 aerators, standby power etc.), and the bulk of the process is passive and gravity driven, no alternative method of disposal (other than the discharge at Maple Lake Creek) is proposed.

Since the discharge from the facultative lagoon is to a Treatment Wetland, and since future control arrangements will allow either the aerated or facultative lagoons to be bypassed if necessary for a short period, duplication of these lagoons should not be required.

10.3 COST ESTIMATES

Preliminary, Class C, cost estimates were completed. The costs include the necessary works to modify or replace the existing treatment process to meet the stated effluent quality. The details of each cost estimate, the scope of works proposed and the quality of effluent achieved are detailed in the individual reports referenced (see Volume 2).

An allowance for engineering (including studies and design) and contingency is included. Costs do not include municipal financing, administration or legal costs. As all lands required for the construction are owned by the municipality, there are no costs included for land value or acquisitions. On the common basis for cost estimates used in Stage 2 of the LWMP, present day costs for 2002 are used for comparison.

These costs are based on KWL (March 2002) and WetlandsPacific (revised September 2002), as well as an independent assessment for costs not explicitly covered in each of these reports.

a) Option 1 - Sequencing Batch Reactor (SBR)

The proposed works include modification to the existing lagoons for use in flow balancing, the treatment process, sludge handling facilities, chemical additions, final filtration, disinfection, buildings and support services.

Site preparation, modify lagoons	$ 471,000
Head works	$ 154,000
Treatment process	$1,628,000
Chemical precipitation, tertiary filters	$ 324,000
Sludge / biosolids handling	$ 719,000
UV disinfection equipment	$ 80,000
Process and administration buildings, labs	$ 600,000
Power supply	$ 161,000
Construction Total:	$4,137,000
Engineering and Contingency (35%)	$1,448,000
Total:	**$5,585,000**

b) Option 2 - Membrane Filtration

The proposed works include modification to the existing lagoons for use in flow balancing, the treatment process, sludge handling facilities, chemical additions, disinfection, buildings and support services.

Site preparation, modify lagoons	$ 578,000
Head works	$ 154,000
Treatment process	$3,634,000
Chemical precipitation	$ 100,000
Sludge / biosolids handling	$ 719,000
UV disinfection equipment	$ 80,000
Process and administration buildings, labs	$ 600,000
Power supply	$ 161,000
Construction Total:	$6,026,000
Engineering and Contingency (35%)	$2,109,000
Total:	**$8,135,000**

c) Option 3 - Constructed Treatment Wetlands

The proposed works include construction of wetlands (by excavation and berm construction), planting, flow control structures, and public access controls.

Excavation and berm construction	$2,992,000
Supply and place plants	$ 375,000
Plant management (initial growth period)	$ 120,000
Pumpstation and aeration upgrades	$ 200,000
Flow control structures	$ 50,000
Access facilities and landscaping	$ 265,000
Initial performance management and commissioning	$ 462,000
Construction Total:	$ 4,464,000
Detailed Design:	$ 780,000
Contingency (15%):	$ 786,000
Total:	**$ 6,030,000**

For the additional phosphorous removal required, the following costs apply:

Chemical precipitation equipment	$100,000
Building and power supply	$ 75,000
Construction Total:	$175,000
Engineering and Contingency (25%):	$ 44,000
Total:	**$219,000**

In the event that disinfection of the wetland effluent, is required, the following costs would apply:

UV Disinfection	$ 80,000
Enclosure and power supply	$ 30,000
Construction Total:	$110,000
Engineering and Contingency(35%):	$ 38,000
Total:	**$148,000**

d) Operational Costs

The annual operating costs for each of the three processes are significantly different. In the case of Options 1 and 2 there will be power and chemical costs.

The allowance for chemicals in Option 3 assumes only a seasonal summer use, and that the dose is only required to precipitate the residual phosphate after the wetland treatment. The biosolids management is limited to the results of chemical addition, removal of build-up in the lagoons and wetlands is amortised over a 25-year period.

In the case of Option 2 there are additional significant cost of regular membrane replacement. The number and technical skill of the staff required is different for each process, with Option 3 requiring the lowest manpower levels.

Table 10.1 - Annual operation and maintenance costs:

	Option 1 SBR	Option 2 Membrane	Option 3 Wetland
Equipment maintenance and repair	$ 45,500	$136,000	$10,000
Chemicals	$ 20,000	$ 15,000	$5,000
Power	$ 51,500	$114,000	$5,000
Operators	$ 90,000	$ 90,000	$60,000
Laboratory and site maintenance	$ 60,000	$ 60,000	$35,000
Biosolids management	$162,000	$162,000	$3,000
Annual Total	**$429,000**	**$577,000**	**$118,000**

10.4 DISCUSSION

Each of the three options was developed to handle the same design flows of sewage and to target similar effluent criteria.

In the case of Options 1 and 2, the existing lagoon system will be converted to provide flow balancing for peak storm and inflow conditions. This alternative was considered to be much less expensive than eliminating these flows from the sewage flow (Refer to KWL Section 6.3 and Chapter 8, 8.4 b).

The target effluent quality levels were set out in Table 7.1 of the Mimulus report. All processes are expected to meet the criteria for TSS 10 mg/ℓ and BOD_5 10 mg/ℓ.

With disinfection, Options 1 and 2 will have fecal coliform less than 2.2 / 100 ml. In the case of Option 3 the residence times under all flow conditions are expected to reduce or eliminate the human fecal coliform from the sewage collection system. Due to the available access for wildlife and waterfowl, the fecal coliform from these sources may be significant. This is a normal condition in natural wetlands. It is proposed that disinfection may not be necessary for the wetland effluent. The initial monitoring programme will analyse the fecal coliform on a regular basis. If results are high, a detailed analysis can be completed to identify the source of coliform and to identify other pathogens. If these are found to originate from the municipal sewage collection system, disinfection should be installed.

With chemical addition, both Options 1 and 2 will achieve a total phosphorous level in the discharge of 1.0 mg/ℓ. With appropriate design and chemical addition, Option 2 (membrane) can achieve 0.1 mg/ℓ during the summer. With further chemical addition and filtration, Option 1 (SBR) can achieve 0.1 mg/ℓ in the summer.

The function of the Treatment Wetlands (Option 3) is natural, and will tend to abstract phosphorous during the growing season and release it during the fall and winter dieback seasons. This will reduce the phosphorous during the warmer summer months when the impact downstream is highest. There is also a permanent removal of phosphorous locked up in the plant material and bottom sediments. A chemical precipitation stage can be added to the wetland system to precipitate additional phosphorous if required in the future. Refer to Chapter 11 for further detailed discussion.

Although the capital costs for Option 3 are higher than for Option 2, the much lower O&M costs achieve a cost balance within three years.

The annual O&M costs for Options 1 and 2 both exceed the budget available to the Village from property taxes and user rates.

10.5 RECOMMENDATIONS

Based on the studies completed to date and the supplementary reports prepared, it is recommended that the Village of Cumberland should:

a) Adopt the Constructed Treatment Wetlands (Option 3) as the preferred treatment process.

b) Proceed with design and approval of the works outlined in the WetlandsPacific report.

c) Monitor and review the impact of the Constructed Treatment Wetlands on Maple Lake Creek and the Trent River over the first 5 years of operation.

d) Develop a pilot plant for the addition of chemicals for phosphorous precipitation.

e) After 5 years of operation, review with Ministry of Water, Land and Air Protection the need for effluent disinfection.

11. Proposed Treatment Process

11.1 Constructed Treatment Wetlands

In Chapter 10 a broad range of possible treatment processes was evaluated for performance and cost. The final recommendation is to use the Constructed Treatment Wetlands as the final stages in a process beginning with the existing aerated lagoon. The evaluation in Chapter 10 was based on the original performance goals and land area identified in 2001. Further detail of the process and performance follows.

11.2 Receiving Water Criteria

The original assessment of treatment processes was based on the recommendations in Mimulus (2001), Table 7.1. Subsequent analysis and discussion, Chapter 6, has identified orthophosphate discharge in the summer as the key constituent. The recommendation is for the effluent not to exceed 100 µg/ℓ (0.10 mg/ℓ) of orthophosphate between May 1st and September 30th in each year. These dates should be reviewed as further summer monitoring results become available. No other limits on total phosphorous throughout the year, or orthophosphate during the winter, need to be set.

The BC Approved Water Quality Guidelines (WQG) sets out appropriate values for all other constituents likely to be found in the effluent discharge. It is proposed that the criteria for Aquatic Life be applied to the discharge. Phosphorous (in any form) is not explicitly identified, but the impact is monitored as chlorophyll *a* in the receiving environment. As this is not a measurable component of the effluent, orthophosphate limits are recommended above, and chlorophyll *a* will be measured in the Trent River downstream.

Liquid waste discharges in BC are required to comply with the MSR. Since the base flows in Maple Lake Creek are low, there will be less than 10:1 dilution most of the time. The provisions of Schedule 3 do not directly apply.

One of the goals of the LWMP Guidelines is to develop beneficial re-use opportunities for effluent where possible. Where dilution is not available, the discharge may be considered as Reclaimed Water and used for streamflow augmentation. The MSR includes conditions in Section 10 and Schedule 2 that must be met before the effluent can be considered for re-use as Reclaimed Water. The *Code of Practice for the Use of Reclaimed Water*, MELP, 2001, also provides guidance and requirements.

Permitted uses are divided into two categories depending on the level of public access, and effluent standards are set for each category. The following table summarises the permitted uses applicable to discharges and the required standards:

Table 11.1 - Reclaimed Water Standards

Public Access:	Unrestricted (Category 1)	Restricted (Category 2)
Water Use:	Stream flow Augmentation	Wetlands
BOD_5	10 mg/ℓ	45 mg/ℓ
Turbidity	2 NTU	45 mg/ℓ (or 60)[(1)]
Fecal Coliform	2.2 / 100 ml	200 / 100 ml (or 1,000)[(2)]
Treatment	secondary	secondary
Chemical Addition	yes	----
Filtration (or 60 day storage)	yes	----
Disinfection	yes	yes
Emergency Storage (20 days)	yes	----

Note: (1) Effluent from lagoon system.
(2) Wetlands with no diving, swimming or wading.

Discharge from the existing lagoon system typically is at 15 - 20 mg/ℓ BOD_5, 20 - 40 mg/ℓ TSS and 2,000 - 5,000 / 100 ml fecal coliform (although less than 500 in summer). These values are occasionally exceeded, and further deterioration is expected as the flows and loading increase towards the design population and service area (see further discussion below). The effluent quality is already close to the standard for discharge to a natural wetland.

The existing discharge from the lagoons will be directed to the Constructed Treatment Wetlands. These will significantly reduce BOD, TSS and Fecal Coliform. During the summer months, May to September, the orthophosphate will also be significantly reduced.

The final discharge to Maple Lake Creek will meet most of the standards for Category 1 Reclaimed Water (Unrestricted Public Access). Background levels of TSS measured in Maple Lake Creek below Cumberland Road ranged between 6.2 and 56 mg/ℓ in June - September 2001. Turbidity levels in the discharge from a wetland are unlikely to be as low as the 2 NTU standard. The standard for this application should be to meet or exceed the existing upstream turbidity values.

The MSR criteria for Reclaimed Water were developed in anticipation of using conventional electromechanical treatment processes. The goal is to remove harmful constituents from the wastewater before discharge to the environment. The regulation (see Table 11.1 above) requires chemical addition and filtration to achieve the goals, and measures the effectiveness of this with a very low turbidity of 2 NTU. The Constructed Treatment Wetland intends to meet the objectives by natural means without chemical addition or mechanical filtration. A maximum TSS of 5 mg/ℓ or the background level in Maple Lake Creek (whichever is greater) should be achieved. Turbidity levels will be low, and a maximum 8 NTU is recommended.

The issue of fecal coliform and the requirement for disinfection are discussed above. Coliform levels should be set to preclude any sewage contamination exceeding the 2.2 / 100 ml level. If monitoring and analysis shows that the Constructed Treatment Wetlands meets this reliably, disinfection should not be required.

Emergency storage in excess of 20 days is available in the summer, but not in the high rainfall months. Specific storage requirements and operational plans should be developed for the final design. Final discharge from the Constructed Treatment Wetland is expected to meet appropriate goals for Streamflow Augmentation, subject to evaluation over the initial 5-year commissioning period.

Public access to the water will be limited to avoid any likely contact with water in the wetlands or streams. The access limitations will apply between Cumberland Road and Royston Road, as these are private lands owned by the Village. Although access on trails and viewing platforms through the area will be encouraged, the public will be restricted from direct contact with the water, and warning information signs will be posted at all entry points.

Table 11.2 - Recommend Effluent Quality Criteria

Item	Value (mg/ℓ)
BOD_5	10
TSS	5 (30 day mean) 10 maximum
Turbidity	8 NTU (maximum)
Fecal Coliform	2.2 / 100 ml (human origin)
orthophosphate	0.1 May to September
total phosphorous	1.0 May to September
Nitrate (1)	40 average. 200 maximum
Nitrite (1)	0.02 average, 0.06 maximum
Ammonia (2)	approx. 1.3 (30 day), approx. 18.0 max.

Notes: (1) BC Approved Water Quality Guidelines, Table 3
(2) BC Approved Water Quality Guidelines, Tables 4 and 5.

The requirements for sampling, analysis, and reporting of test results will follow the requirements of the MSR.

11.3 Construction Area

The original wetlands concept, WetlandsPacific, January 2002, was based on earlier reports and Mimulus 2001 assessment. Subsequent evaluation and discussion with CWS resulted in a new definition of the area available for construction. The revised area is shown on Figure 6.1 (Appendix C), and used in the supplementary WetlandsPacific report, December 2002.

As discussed above, the original report included relocation of Maple Lake Creek to the east. With the need to protect the hydraulic regime in the sensitive fen/bog area, and the lack of support for creek relocation, this element has been deleted from the plan.

Discussion below (Chapter 12) shows the opportunities for summer low flow augmentation of the Trent River. The proposed Constructed Treatment Wetland does not include any specific storage capacity beyond the freeboard required to handle winter peak flows.

11.4 Design Flows

Detailed wastewater design flows are developed in Chapter 7. These include the storm flows from the existing combined sewer area and the high infiltration component from the entire existing system. These flows were used for the treatment process evaluation in Chapter 10.

As the existing lagoon system will be retained as part of the treatment process, further analysis of the historical effluent flows records was undertaken. These design flows for existing conditions are based on numerical analysis of the monthly totals 1994-2001 and observation of the weekly chart records 1998 - 2001. Stormwater inflows experienced by the existing combined system, with high infiltration, are included for "Existing Conditions". Peak flows are shown on a 24-hour basis.

"Future Conditions" are projected, in accordance with Chapter 7, to the ultimate design population of 5,000. These are based on increased population, increased service area and elimination of stormwater from the existing combined system. Infiltration in the existing 120 ha service area is reduced to 10 m^3/ha/day as a result of extensive replacement recommended in Chapter 8.

Older sections of the Village have high I&I values. Chapter 13 recommends reconstruction of these sanitary sewers to reduce infiltration and eliminate inflow as part of the Capital Works Programme. Storm connections will be eliminated and inflow will be significantly reduced. The effect of this programme has been included in the following flow projections, and will result in lower future peak design flows.

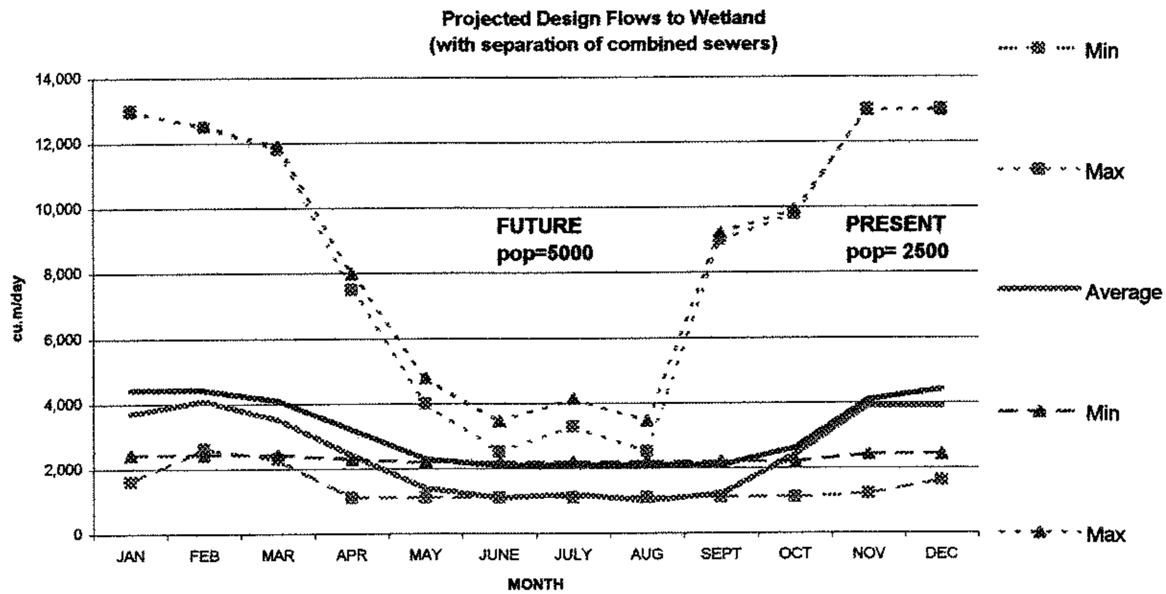
The effect of stormwater inflow elimination by sewer separation offsets the increased flow from population expansion. The hydraulic loading on the aerated and facultative lagoons remains unchanged.

In addition to the replacement recommended in Chapter 13, any other repair or replacement of sanitary sewers should include elimination of direct storm inflow connections.

Table 11.3 - Design Flows to Wetland

Existing conditions (2002), with combined sewers						
	cubic meters / month			cubic meters / day		
	Average	Max	Min	Average	Max	Min
JAN	116,052	403,000	49,600	3,700	13,000	1,600
FEB	115,146	375,000	78,000	4,100	12,500	2,600
MAR	107,778	365,800	71,300	3,500	11,800	2,300
APR	72,037	225,000	33,000	2,400	7,500	1,100
MAY	42,804	124,000	34,100	1,400	4,000	1,100
JUNE	35,051	77,500	34,100	1,100	2,500	1,100
JULY	37,019	101,525	34,100	1,200	3,275	1,100
AUG	35,274	77,500	34,100	1,100	2,500	1,100
SEPT	41,772	270,000	33,000	1,400	9,000	1,100
OCT	75,946	303,800	34,100	2,400	9,800	1,100
NOV	118,108	390,000	36,000	3,900	13,000	1,200
DEC	120,762	403,000	49,600	3,900	13,000	1,600
Future conditions (pop. 5000), combined sewers separated						
JAN	134,880	389,333	72,195	4,400	12,978	2,400
FEB	134,880	376,000	72,195	4,400	12,533	2,400
MAR	127,915	357,333	71,499	4,100	11,911	2,400
APR	100,055	239,667	68,713	3,200	7,989	2,300
MAY	72,195	143,333	65,927	2,300	4,778	2,200
JUNE	65,927	103,333	65,300	2,100	3,444	2,200
JULY	66,623	124,000	65,369	2,100	4,133	2,200
AUG	65,230	103,333	65,230	2.100	3,444	2,200
SEPT	65,230	276,667	65,230	2.100	9,222	2,200
OCT	79,160	298,000	66,623	2,600	9,933	2,200
NOV	127,915	389,333	71,499	4,100	12,978	2,400
DEC	134,880	389,333	72,195	4,400	12,978	2,400

Figure 11.1 - Projected Design Flows to Wetland
(no separation of combined sewers)



11.5 Treatment Process

As outlined above, the proposed treatment process includes use of the existing process elements with a new Constructed Treatment Wetland (CTW) following. Final discharge of effluent to Maple Lake Creek will be from the end of the CTW.

The existing aerated/facultative lagoon system works well and requires little supervision or maintenance. As identified in KWL, March 2002, there are a number of improvements that can be implemented to maintain performance with increased flows. As part of the initial capital improvement, a new aerator will be added and minor improvements to the inlet/outlet works made. The discharge from the facultative lagoon will be relocated from Maple Lake Creek to the first CTW cell.

If future quality monitoring indicates that improvements are required, the volume of the facultative lagoon can be increased by deepening.

The sanitary mains from the south feed the aerated lagoon by gravity. The flow from the north is pumped into the head works. The capital works programme, Chapter 13, includes improvements to the headwork, refurbishing the pumpstation and the addition of an emergency generator.

The existing aerated lagoon has a surface area of 8,400 m^2 and an average depth of 1.6 m. The facultative lagoon has a surface area of 24,650 m^2 and an average depth of 1.45 m. Based on these dimensions, Table 11.5 shows the existing and future hydraulic retention times (HRT).

Table 11.4 - Average Hydraulic Retention Times for Lagoons

	Existing Conditions (2002)			Future Conditions (pop = 5000)		
	Aerated	Facultative	Total	Aerated	Facultative	Total
JAN	3.6	9.7	13.3	3.1	8.1	11.2
FEB	3.3	8.7	12.0	3.1	8.1	11.2
MAR	3.8	10.2	14.1	3.3	8.7	12.0
APR	5.6	14.9	20.5	4.2	11.2	15.4
MAY	9.6	25.5	35.1	5.8	15.5	21.4
JUNE	12.2	32.5	44.7	6.4	17.0	23.4
JULY	11.2	29.8	41.0	6.4	17.0	23.4
AUG	13.4	35.7	49.2	6.4	17.0	23.4
SEPT	11.2	29.8	41.0	6.4	17.0	23.4
OCT	5.6	14.9	20.5	5.2	13.7	18.9
NOV	3.4	9.2	12.6	3.3	8.7	12.0
DEC	3.4	9.2	12.6	3.1	8.1	11.2

11.6 Input Quality to Constructed Treatment Wetlands

In order to define the applied loading on the CTW and prepare projections for the final effluent, the expected output from the lagoons was defined.

Lagoon effluent records for the last 5 years 1997 to 2002 were reviewed and data points plotted. For each parameter, an envelope was developed which enclosed all data points (except occasional isolated extreme values). This envelope was set as the worst-case condition on a monthly basis. The projected values for the existing treatment process and present flow regime are shown below.

Table 11.5 - Existing Lagoon Effluent Quality (maximum values)

Existing conditions (2002)									
	mg/l		mpn/100	mg/l					
	BOD	TSS	Fecal	Ortho-p	phosphate	Nitrate	Nitrite	Ammonia
JAN	15	20	5000	1.00	1.50	0.50	0.20	8
FEB	20	30	5000	1.25	1.75	0.40	0.10	7
MAR	25	30	4000	1.50	2.25	0.30	0.09	8
APR	25	35	2000	2.00	2.75	0.20	0.05	10
MAY	27	45	500	2.25	3.25	0.10	0.05	12
JUNE	15	40	500	2.25	3.10	0.10	0.05	14
JULY	20	40	500	2.25	3.00	0.10	0.10	15
AUG	20	40	500	2.50	2.75	0.10	0.15	16
SEPT	20	40	3000	2.50	2.75	0.10	0.20	16
OCT	17	50	4000	1.75	2.50	0.25	0.20	14
NOV	15	30	10000	1.25	2.00	0.50	0.20	10
DEC	15	25	10000	1.00	1.75	0.60	0.20	6

Future projections were made for increased sanitary loading proportional to the design population, with increased infiltration as developed in Chapter 7 and above, and with the existing storm inflow eliminated. Although some improvement from the additional aerator is assumed, the performance of the aerated / facultative lagoons is projected to deteriorate approximately 20% with increased loading. A comparative check for performance under intermediate flows was available from present condition winter flow values.

Table 11.6 - Future Lagoon Effluent Quality

Future conditions (pop. 5000)								
	mg/l		mpn/100	mg/l				
	BOD	TSS	Fecal	Ortho-p	phosphate	Nitrate	Nitrite	Ammonia
JAN	31	41	10,300	1.90	2.80	1.03	0.41	15
FEB	41	61	10,200	2.30	3.30	0.82	0.20	13
MAR	50	61	81,000	2.80	4.20	0.61	0.18	15
APR	43	60	3000	3.20	4.30	0.35	0.09	16
MAY	38	64	2000	2.90	4.20	0.14	0.07	16
JUNE	19	51	2000	2.60	3.60	0.13	0.06	16
JULY	27	53	2000	2.70	3.70	0.13	0.13	18
AUG	22	44	2000	2.50	2.80	0.11	0.16	16
SEPT	27	53	4000	3.10	3.40	0.13	0.27	20
OCT	39	115	9,200	3.70	5.30	0.57	0.46	29
NOV	33	66	22,100	2.50	4.10	1.11	0.44	20
DEC	32	54	21,500	2.00	3.40	1.29	0.43	12

11.7 Projected Effluent Quality

Design flows and lagoon effluent parameters were provided to WetlandsPacific. The approved area available for the CTW was also provided. A revised layout for the wetlands was developed, and a new performance model created. The focus of the analysis was to reduce orthophosphate discharge as identified in Chapter 6 above.

The report *Selected Water Quality Projections in the Discharge of Cumberland's Proposed Constructed Treatment Wetland* (Draft) November 2002, discusses the processes for reduction or removal of key constituents. It provides detailed information on phosphorous reduction, as well as the limitations in achieving the very low values recommended in Table 11.2.

From a mathematical model, substantially based on the US EPA North American Wetlands Data Base and specific performance results at Arcata Marsh, final seasonal discharge values are projected. (See Table 11.6)

Table 11.7 - Future Effluent Quality from Wetland

Future conditions (pop. 5000)					
	mg/l		mpn/100	mg/l	
	BOD	TSS	Fecal	Ortho-phosphate	Total Nitrogen
JAN	4.9	3.1	< 2.2		1.70
FEB	6.3	3.1	< 2.2		1.50
MAR	6.0	3.1	< 2.2		1.50
APR	4.0	3.1	< 2.2		1.00
MAY	3.3	3.1	< 2.2	0.60	< 1
JUNE	3.1	3.1	< 2.2	0.30	< 1
JULY	3.2	3.1	< 2.2	0.60	< 1
AUG	3.1	3.1	< 2.2	1.10	< 1
SEPT	3.2	3.1	< 2.2	1.50	< 1
OCT	4.1	3.1	< 2.2	1.50	1.40
NOV	5.0	3.1	< 2.2		1.80
DEC	5.1	3.1	< 2.2		1.50

With the exception of orthophosphate, these projections meet the target values. The balance between Nitrogen forms is discussed in WetlandsPacific, December 2002 (Volume 2).

To meet the target for phosphorous it will be necessary to implement additional measures. The following alternatives will each reduce or remove phosphorous from the wastewater:

- Source Control - this would include an education programme to: reduce the use of household chemicals high in phosphorous and use alternatives; reduce the use of high phosphorous fertilisers that may end up in the wastewater through infiltration and inflow.
- Limna Harvesting - this would include proactive and frequent removal of floating vegetation (duckweed etc.) from the surface of the lagoons and wetlands. The removed vegetation is high in phosphorous and may be composted on-site, allowed to release phosphorous in winter or trucked to the Regional composting site at Pigeon Lake.

- Chemical Precipitation - this would include the injection of appropriate chemicals into the wastewater to precipitate phosphorous compounds. Alternative points in the process train include: after the aerated lagoon with removal of the precipitate with the sludge in the settling lagoon; before the first wetland with provision for monitoring and removal of precipitate build-up in the wetland cell; after the last wetland cell when the remaining mass of phosphorous is lowest, but this will require construction of a zone to trap the precipitate for removal.
- Cationic Receptor - this technique includes flowing the effluent through a suitable granular medium to which the active phosphorous adsorbs. Although this has been applied in other situations, further work is required to evaluate the volumes required, appropriate flow rates and regeneration techniques.

Both Source Control and Limna Harvesting should be implemented immediately, and the effectiveness monitored by continued analysis of lagoon effluent. Source Control is a long-term commitment that will take many years to become truly effective.

The wetland is expected to experience high phosphorous retention over the first few years until an equilibrium is established with the substrate and vegetation. Pilot testing for Chemical Precipitation and Cation Receptor techniques should be started. The results of pilot testing will identify the best location and details required. The capital costs for construction of the permanent facilities should be included in the initial project costs.

12. Summer Low Flow Augmentation

12.1 INTRODUCTION

a) Background

The LWMP, Stage 1, report identified the possible benefit of considering the effluent discharge for use in summer low flow augmentation of Maple Lake Creek, and consequently the Trent River. A more detailed review and analysis was identified as one of the tasks for the Stage 2 Plan.

This chapter addresses the impact of low flow augmentation from a volumetric perspective. It does not address the water quality requirements, as these are reviewed in Chapters 6 and 11.

b) Alternatives Considered

The alternative low flow augmentation options considered in this study include:

- The effect of direct "flow through" discharge.
- The effect of additional storage provided within the Constructed Treatment Wetlands.
- The effect of constructing or providing additional storage volume.

c) Methodology

The following tasks were completed:

- Review of the limited flow records available for the Trent River.
- Review of the compiled monthly flow records for the Village of Cumberland effluent discharge.
- Review of selected weekly flow chart records during summer months for effluent discharge.
- The analysis of design flows in Chapter 7, and available summer flows in Chapter 9.

d) Previous Reports

Previous work was reviewed in order to provide a background for calculations.

A *Feasibility Study for Sewerage and Wastewater Disposal* KPA Engineering Ltd., November 1990, addressed specific concerns regarding the Trent River dilution capacity, sewage lagoon capacity and nutrient and coliform loading of the effluent.

A Constructed Wetland for Stormwater Management, Tertiary Wastewater Treatment and Low Flow Stream Augmentation - Feasibility Study Final Report, CK Ventures Ltd., October 1998, identified the possibility of using additional wetland storage for stream flow augmentation.

A *Conceptual Design and Costing of a Constructed Wetland for Cumberland* WetlandsPacific, January 2002, confirmed the concept of the Constructed Wetland and proposed effluent quality goals.

12.2 AVAILABLE FLOWS

a) Trent River

Extensive analysis on the available and required flows in the Trent River is included in the *Nile Creek to Trent River Water Allocation Plan,* MELP, January 1995. A copy of this plan is included in LWMP Stage 1, Volume 2. The following information is summarized from the Water Allocation Plan:

- Precipitation in the region is low during the summer months and high during the winter months.
- Lack of precipitation in the summer months, coupled with high evaporation rates and the rain shadow effect tends to create an annual moisture deficit.
- The Trent River catchment is shown as 66.9 km2, however the plan does not show the watershed extending to include the Maple Lake Creek catchment (see below).
- Water survey of Canada Hydrometric Discharge information for the Trent River is only available between 1971 and 1976. The discharge rate for the Trent River during this period is recorded at only approximately 25% of that recorded for the other rivers. The only explanation provided is that the Trent River lacks supporting aquifers and wetlands that are present in the other river catchments.
- The Trent River shows mean monthly discharge (MMD) less than 10% of the mean annual discharge (MAD) during July, August and September.
- The seven-day average low flows occur predominantly in August or September, with rare occurrences in July or October. The seven-day average low flow projections for Trent River are extremely low at approximately 10% of MMD.
- For the Trent River, the MMD in August falls below 5% of MAD. The MELP in-stream fisheries requirements indicate that less than 5% MAD will result in severely degraded spawning and rearing habitat. Where fish are present, the minimum flow required to sustain fisheries resource for poor spawning and rearing habitat is 5 - 10% of the MAD.

b) Maple Lake Creek

Maple Lake Creek watershed lies to the north of and is tributary to the Trent River. Details of the catchment and characteristics were identified in the *Stormwater Management Plan,* Anderson Civil Engineering, May 2000:

- The majority of the 11.5 km^2 catchment for Maple Lake Creek lies within the boundaries of the Village of Cumberland (2002).
- Maple Lake Creek flows from the headwaters in Maple Lake north of Cumberland a distance of approximately 4.5 km to the confluence with the Trent River.
- The confluence is located 4 km upstream from the mouth of the Trent River.
- The southern upland catchment is steep with shallow surficial deposits over bedrock. The characteristics of this catchment and the balance of the Maple Lake Creek watershed downstream of the Municipal boundary are similar to the Trent River watershed.
- The Village of Cumberland is the only urban developed area within the creek watershed.
- The northern upland area is almost exclusively glacial deposit. These are deep in places and include extensive areas of open water, which may reflect the water table in the granular materials below. This area represents a significant storage capacity that provides a year-round flow to Maple Lake Creek, as well as sustaining springs in the headwaters of Roy Creek and Millard Creek to the east.
- The flow from the open water areas adjacent to Maple Lake is in a southerly direction under Cumberland Road. Although part of the flow is exposed in open ditches, it is believed that a large part of the flow is subsurface through the gravel deposits.
- The subsurface flow under Cumberland Road contributes significantly to the wetlands and fens south of Cumberland Road and north of the existing sewage treatment lagoons.
- No direct flow measurement has been made of the flows in Maple Lake Creek and all assessments are subjective.
- The flow from Maple Lake Creek in the open channel upstream of the sewage treatment lagoons is sustained in summer, and does not respond rapidly or significantly to winter storm flows.

c) Effluent Discharge

Projected design flows for the effluent were developed in Chapter 7. These provided specific flow guidelines to be used in future design and for detailed design of the treatment process.

These flows were projected on a monthly basis in Chapter 9 to identify the volumes that would require discharge during the summer months if all flow was diverted from Maple Lake Creek. Although more detailed flows are developed in Chapter 11, the Chapter 9 flows are used for simplicity in the following analysis.

12.3 AUGMENTATION ALTERNATIVES

There are three basic alternatives available for flow augmentation of Maple Lake Creek using the municipal effluent discharge. Any flows used for stream flow augmentation should meet the MSR requirements for Reclaimed Water Standards Category 1. (Refer to Chapter 11.) The alternatives for stream flow augmentation include:

- Direct augmentation without storage using the available flow of effluent.
- Supplementing the flow of effluent with draw down of available storage in Constructed Treatment Wetland Cells.
- Augmentation of direct effluent flow and draw down of Wetland Cells with additional storage specifically constructed and impounded for the purpose of summer stream flow augmentation.

The projected mean monthly discharges (MMD) for the Trent River are shown below in Table 12.1. This table is based on flows projected in the *Nile Creek to Trent River Water Allocation Plan*, 1995. The low flows in May to September are based on the very short period of gauging between 1971 and 1976. Trent River shows particularly low flows in relation to its catchment when compared to other adjacent rivers to the south. This is discussed in the Water Allocation Plan.

Seven-day average low flows are also given for the period 1971 to 1976, and range between 0.5% and 58% of the mean monthly low flow. The flow augmentation with effluent will have a larger impact on maintaining the seven-day average low flows, than on the monthly low flows.

Although the flows are derived form all data 1971-1976, it should be noted that 1976 was not typical. Generally it was a very low flow year, although the summer flows were much higher than usual. An alternate analysis, or longer records, might show lower than average summer flows. The contribution from effluent discharge would be even more significant.

Table 12.1 - Trent River Mean Monthly and Mean Annual Discharge (1)

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	MAD
7279 (2)	7022	6080	3480	3730	1410	420	199	324	5010	7665	8221	4282
18.9 (3)	18.2	15.8	9.0	9.7	3.7	1.1	0.5	0.8	13.0	19.9	21.3	11.1
Percent of MAD					33%	9.8%	4.6%	7.6%				
Volume deficit to 10% MAD						0.02	0.59	0.27		$x10^6\ m^3/mo$		
Total Volume deficit (July - Sept)								0.89		$x10^6\ m^3$		($885,427\ m^3$)

Note: (1) from *Nile Creek to Trent River - Water Allocation Plan,* MELP, 1995
(2) ℓ/s
(3) $x10^6\ m^3/mo$

a) Direct Augmentation

The projected effluent flows for the existing and future conditions, as previously derived, are shown on Table 12.2 (for the period June to September).

The established goal for east Vancouver Island rivers to maintain fish habitat is to have a minimum flow of 10% Mean Annual Discharge. These figures are shown for the Trent River on Table 12.2. The critical period of deficit is the month of August.

The table shows that the direct discharge of effluent will provide approximately 10% of the flow deficit in the Trent River. At that time, the effluent will constitute approximately 12% of the total flow in the Trent. This flow is obviously important to the Trent, although not sufficient to raise the base flow to an adequate level for fish rearing. The discharge of effluent to Maple Lake Creek and thence the Trent River conveys a positive benefit on the flow regime in the Trent.

Table 12.2 - Flow Augmentation from Projected Effluent Flows

	June	July	August	Sept	
Existing conditions	35,000	37,000	30,000	38,000	m^3/mo
Future conditions	66,000	67,000	65,000	65,000	m^3/mo
Volume deficit in Trent River to 10% MAD	0	21,254	594,086	270,086	m^3/mo
Percent Deficit made up by effluent:					
Existing conditions		100.0%	5.0%	14.1%	
Future conditions		100.0%	10.9 %	24.1 %	
Effluent as percent of Trent monthly low flow					
Existing conditions		3.4%	5.8%	4.5%	
Future conditions		6.2 %	12.6 %	7.7 %	

b) Draw Down of Available Storage

If the Constructed Treatment Wetlands Cells are constructed as recommended in WetlandsPacific, January 2002, additional active storage can be available.

The following Table 12.3 is based on an effective surface area of90,000 m^2 for Cells A, B, C and D. With an active draw down of 0.5 m, the available storage is 45,000 m^3. As there may be up to an additional 0.3 m of evapo-transpiration, the total design draw down range may be as great as 0.8 m.

Applying this available storage for release during the month of August only can provide an additional 8.5% of the deficit in the Trent River. At that time the draw down release will constitute approximately 9.7% of the flow in the Trent. There will still remain 91% of the deficit in the August Mean Monthly Flow in the Trent River.

The impact of a 0.5 m draw down in the cells has not been assessed for its impact on the plants growing in the wetland. The water level would need to be progressively raised during the months up to the end of July, and then dropped throughout the month of August. The effect of these water level changes on the plants, and their effectiveness in continuing to treat the effluent (particularly the removal of phosphorous) has not been assessed.

Additional impoundment, and subsequent release, of this additional water has a beneficial effect downstream in the Trent River, provided the operational changes do not adversely impact the water quality released.

It is not considered practical to provide for any additional draw down depth in the wetlands without considerable additional construction and cost increase.

Table 12.3 - Flow Augmentation from storage in Wetland Cells

	June	July	August	Sept	October	
Projected Existing Effluent Flows	35,000	37,000	30,000	36,000		m^3/mo
Projected Future Effluent Flows	66,000	67,000	65,000	65,000		m^3/mo
Monthly volume deficit in Trent River to 10% MAD	0	21,254	594,100	270,100	0	m^3/mo
Monthly volume Deficit remaining after effluent:						
Existing conditions		0	564,100	232,100	0	m^3/mo
Future conditions			529,100	205,000		m^3/mo
Volume of storage in wetlands (0.5m draw down)			45,000			m^3
Percent Deficit made up by Storage Release			8.5%			
Percent Trent flow made up by Storage release			9.7%			
Volume Deficit remaining:						
Existing conditions		0	514,100	232,100	0	m^3/mo
Future conditions		0	484,100	205,100	0	m^3/mo

c) Additional Storage Volumes

The alternatives above have provided for stream flow augmentation without the construction of any additional facilities. If additional design and construction were applied to the Constructed Treatment Wetland Cells (subject to being biologically acceptable) then the depth of draw down could be increased. If additional cells, such as Cells E and F were constructed with the express purpose of permitting additional draw down, further storage could be provided. All of these would incur additional costs.

To provide the total storage required to augment the Trent River to the minimum 10% MAD would require an active storage depth of 5.1 m over the entire area proposed for the Constructed Treatment Wetlands. Since the proposed area represents the maximum that should be impacted by construction, and it is obviously not practical to provide an active draw down as deep as 5 m, it will not be practical to provide the total flow deficiency in the Trent River. This was never a goal of the LWMP.

12.4 COST ESTIMATES

These cost estimates are based on earlier reports and on cost estimates developed in other chapters. They are Class C estimates prepared without any detailed design.

a) Direct Augmentation

There is no additional cost for providing flow augmentation by direct discharge of the effluent.

b) Draw Down of Available Storage

Provided there is no biological impact on the performance of the Constructed Treatment Wetland by operating Cells A, B, C and D to provide 0.5 m of active storage (plus evapo-transpiration allowance) then this flow augmentation can be provided at no additional capital cost. There will be some operational costs to manipulate the flow control structures to impound and release the flow.

c) Additional Storage Volumes

The cost to provide additional active storage by construction of additional works would depend upon further design development of the concepts. Assuming that additional storage is provided only by additional active depth in Cell E, anticipated costs are:

Construction Costs	$700,000
Engineering and Contingency (35%)	$244,000
Total Capital Cost:	**$944,000**

To provide this additional storage would require external funding from an agency that considers the benefit is worth the cost.

12.5 RECOMMENDATIONS

Direct augmentation by discharge of effluent into Maple Lake Creek and thence into Trent River appears to have a small but significant benefit in sustaining low flows, particularly during August. Provided the quality of discharge does not cause an adverse impact downstream, augmentation by this discharge should continue.

Manipulation of the active storage volume in the Constructed Treatment Wetlands Cells can provide an additional significant storage volume. Provided manipulation of the water level over a range of 0.5 and 0.8 m does not impact on the plants required for water quality treatment, manipulation of the active storage should be implemented in August to sustain low flows in the Trent River.

Since the cost of providing additional active storage or special storage in additional cells is considerable, this storage should only be constructed if additional external funding is provided for the total cost.

13. Construction Schedule

13.1 Introduction

Goals for the Liquid Waste Management Plan have been developed through the Stage 1 and Stage 2 study process. These include:

- Extending sanitary service to most of the urban village.
- Constructing a treatment process to reduce effluent discharge impact on the receiving environment.
- Separating the existing combined sewer system, and upgrading sections of deficient pipework to eliminate CSO potential and infiltration.

The costs and timetable for implementing the specific projects identified in the LWMP are detailed below.

13.2 Service Areas Extension

The LWMP, Stage 1 identified areas that were currently serviced by on-site disposal systems. (Refer to LWMP Stage 1, Figure 3.) The Stage 2 Plan includes provision for extending the collection system to service areas in the southeast of the Village. This area includes properties on Union Avenue and seasonally flooded properties south of Dunsmuir Avenue.

The works required to service this area include:

- 350 m of 200 mm dia. gravity main on Union Road north of Dunsmuir Avenue.
- 100 m of 200 mm dia. gravity main on Dunsmuir Avenue west of Union Road.
- 600 m of 200 mm dia. gravity main on Dunsmuir Avenue west of Maple Lake Creek.
- 140 m of 100 mm dia. forcemain on Dunsmuir Avenue.
- 350 m of 100 mm dia. forcemain on Ulverston Avenue.
- Sewage pumpstation on Dunsmuir Avenue near Maple Lake Creek.

Estimated Cost:	$384,640
Engineering & Contingencies 35%:	$134,660
Total Project Cost:	$519,300

These works are scheduled for construction in 2006.

13.3 Collection System Upgrades

In Chapter 8, alternatives were developed for separating the combined sewer service areas, and for upgrading the existing system to reduce infiltration. In Chapter 10 a Constructed Treatment Wetland is recommended for addition to the existing treatment works. Separation of the combined sewers is required to reduce the future hydraulic loading on the existing lagoon system.

To avoid the possibility of future Combined Sewer Overflows (CSO) and reduce infiltration it is necessary to upgrade sections of the existing collection system as outlined in Table 8.6 and shown on Figure 8.3 (Appendix C).

13.3.1 Sewer extension on Ulverston Ave, Fourth St. to Cumbria Woods

This work is required to intercept and divert existing sanitary sewers at the upstream end and discharge into the new sewer main being constructed as part of the Cumbria Woods project. This will take advantage of the work being constructed by others downstream, and will play a significant role in diverting upstream flows from the aging systems in the "ravine" (Refer to Item 13.3.2 below.) Detailed costs are shown on Table 8.6.

Estimated Cost:	$ 158,900
Engineering & Contingencies 35%:	$ 55,600
Total Project Cost:	$ 214,500

These works are scheduled for construction in 2004.

13.3.2 Replacement and Diversions on the "Ravine"

The original "ravine" in Cumberland runs north / south parallel to and between Fourth and Fifth Streets. The existing pipes are generally duplicate mains of uncertain vintage or quality. Based on flow calibrations, the pipes are believed to suffer severely from infiltration, and consequently exfiltration in the dry season. Downstream sections have insufficient capacity to carry the design flows and may be susceptible to CSO's.

The flow into the north end of this system at Windermere Avenue will be diverted north into the new 600 mm dia. (See Item 13.3.1 above). The remaining very old pipes and under-capacity sections should be replaced with new mains. Because of the nature of the ground, the new alignment must follow approximately the existing route through private properties. Alternative replacement can be by open trenched excavation or one of a number of trenchless technologies. It is assumed that the most economical technique will be used in each section, but an allowance has been made for the higher cost of working either on or under private property. Detailed costs are shown on Table 8.6.

Estimated Cost:	$170,900
Engineering & Contingencies 35%:	$ 59,800
Total Project Cost:	$230,700

These works are scheduled for construction in 2005.

13.3.3 Combined Sewer Separation

To reduce inflow to the treatment process, separation of the existing combined sewer system is required. Refer to Chapter 8. Construction of new storm sewers is recommended. Detailed costs are shown on Table 8.2

Total Construction Cost	$1,197,350
Engineering and Contingency 35%	$ 419,150
Total Construction Cost	$1,616,500

Design and construction of these works should be spread out and is scheduled for 2004 through 2013. The programme should complete improvements to match increasing design populations, and avoid exceeding the treatment process design flows.

The first sections should include areas contributing upstream of the potential CSO at Derwent Avenue, and in the area of the "ravine" to match construction of sanitary sewer improvements.

13.3.4 Upgrade to Reduce Infiltration and Exfiltration

Some sanitary sewers in the oldest part of town date back to the turn of the twentieth century. While they represented a significant improvement on the open ditches and privies of the day, they no longer meet the requirements of the twenty-first century. Based on the preliminary studies for the LWMP Stage 1, these pipes are identified as posing a significant environmental hazard from exfiltration and causing significant overload on the treatment process due to infiltration in the wet weather season.

This area is generally bounded by Egremont Road to the west, Ulverston Avenue to the north, Seventh Street to the east and Keswick Avenue to the south. Refer to Figure 8.3, (Appendix C).

Detailed analysis identified the principal deficiencies in the older part of town and assessed the detailed impact of replacing these pipes. The appropriate technique for replacing will depend upon each section of pipe, but may include trenchless technology (such as pipe lining or pipe bursting for in-place replacement) or a direct open cut replacement either on the original alignment or on a better alignment to service the properties. All sewers will provide service to each adjacent property. A number of small duplicate or parallel branches will be eliminated. Detailed costs are shown on Table 8.6.

Total Construction Cost:	$ 1,250,000
Engineering & Contingency 35%:	$ 437,500
Total Construction Cost:	$ 1,687,500

This project is extensive and construction will impact a large part of the older village. Design and construction for these works should be spread out and is scheduled for 2007 through 2020. The programme should complete improvements to match increasing design population, and avoid exceeding the treatment process design flows.

13.4 Treatment Systems

In Chapter 10, alternative treatment processes were reviewed, and the Constructed Treatment Wetland was recommended.

Costs for the process were based on the WetlandsPacific report (January 2002). Subsequent revision (September 2002) included additional allowance for biota supply, weir control structures, and upgrading the existing lift station and lagoon aerators. The cost of relocating Maple Lake Creek was deleted. Costs are included for disinfection and special phosphorous removal, as these may be required to meet the criteria established in Chapter 11.

Estimated costs from Chapter 10 include:

Wetland construction		$2,992,000
Plants and plant management		$ 495,000
Flow control and access facilities		$ 315,000
Pumpstation and lagoon upgrades		$ 200,000
Disinfection		$ 110,000
Chemical precipitation		$ 175,000
Commissioning and testing		$ 462,000
Detailed design		$ 822,000
Contingency (15%)		$ 826,000
	Total Treatment Improvements	$6,397,000

These works are scheduled for design construction from 2003 through 2006.

13.5 LWMP Stage 3

Completion of the Liquid Waste Management Plan through Stage 3 requires detailed documentation, designs and draft regulations (Bylaws). The detailed design costs for individual capital projects are included with each project.

As part of the Federal grant process for CBCIP, studies and reports are required to satisfy appropriate authorities under the Canada Environmental Assessment (CEA) Act. These are particularly required for the Constructed Treatment Wetland, but are not included in the design / construction costs above.

Data collection, as recommended in Chapter 20, to provide data for preliminary design, and to set baseline values for process performance evaluation, is also required, but not included in these costs.

Estimated prime consultant fees for LWMP Stage 3	$ 75,000
Estimated specialist subconsultants	$ 75,000
Total Estimated Fee:	$150,000

Table 13.1 - Construction Costs and Schedule

Item	Description	2003	2004	2005	2006	2007 - 2013	2014 - 2020	Total
1	Extend service area on Union Road and Dunsmuir Avenue				519,300			519,300
2	Ulverston Avenue diversion and "Ravine" upgrade		214,500	230,700				445,200
3	Storm Sewers for combined sewer separation		350,000	350,000	350,000	566,500		1,616,500
4	Upgrade Collection System for Infiltration and Exfiltration					787,500	900,000	1,687,500
5	Constructed Treatment Wetland	472,000	4,960,000	487,000	478,000			6,397,000
6	LWMP Stage 3 studies	100,000	50,000					150,000
	Total	572,000	5,574,500	1,067,700	1,347,300	1,354,000	900,000	
							Total Implementation Cost	**$10,815,500**

14. Source Control Bylaw

14.1 Background

The Village of Cumberland has the advantage of currently having only one industrial discharge (hospital laundry) and a single commercial district of four continuous blocks on Dunsmuir Avenue. This relatively small amount of non-residential development allows the introduction of a source control bylaw for any new development while concurrently having high confidence that existing, non-residential sources can be monitored easily and violators discovered.

The objective of the source control bylaw is to avoid non-domestic waste and other deleterious substances from entering the collection system, and subsequently reaching the treatment system. The impact of these wastes on the treatment system could cause degradation in the effluent discharge quality.

The detection of source control violation will be through sampling at the five existing sewer manholes where the approximately 70 businesses of the commercial district enter the major sewer system trunks.

14.2 Proposed Bylaw

The Village will enact a municipal bylaw seeking responsible waste management at the source rather than constructing interceptor devices within the sewer collection system at public expense. The municipal bylaw will be largely based upon the Greater Vancouver Sewerage and Drainage District Sewer Use Bylaw (revised 2002). This bylaw has been through a rigorous public review process in Greater Vancouver and is considered to be logical, thorough and achievable.

15. Biosolids Management

15.1 Accumulation

The accumulation of biosolids in the lagoons is very slow. Historically cleaning has only been required every 15 to 20 years, and this is similar to other facilities on Vancouver Island.

The accumulation of sediment, mostly as peat, in the Wetlands is projected at only a few millimetres per year. The projection for any possible localized excavation is over 25 years. The addition of chemicals for phosphorous precipitation in summer will generate a much faster localized accumulation.

15.2 Disposal

As identified in the LWMP Stage 1 Plan, biosolids will be delivered to the Regional processing facility at Pigeon Lake for processing in accordance with the OMR.

16. Hospital Laundry Source

16.1 Impact of Flows

The Cumberland Regional Hospital Laundry Service (CRHLS) provides cleaning services to a large number of health care facilities on Vancouver Island, and as such is the largest water consumer in Cumberland with an average annual consumption of 55,000 m^3. The total average annual consumption of water in the joint Cumberland and Royston water supply system is 1,320,000 m^3/year. Therefore the CRHLS represents only about 4% of the total municipal water consumption.

The CRHLS consumption results in approximately 45,500 m^3/year of sewage discharge after process losses, which is about 5% of the total annual municipal effluent discharge.

16.2 Impact of Quality

The laundry is currently the only industrial discharge in Cumberland and it does not use detergents with chlorine or phosphates. The phosphorous present in the laundry discharge is lower than that found in the domestic sewage entering the sewage lagoon. There is a high degree of confidence in the quality of effluent from the CRHLS as it maximizes recycling the detergents for operational cost efficiencies. The CRHLS and its chemist have committed to meet with the Village as necessary during the LWMP Stage 3 design phase to provide detailed information on the effluent.

16.3 Future Expansion

Although expansion of the CRHLS is not foreseen in light of current health care facility downsizing across British Columbia, the laundry could double capacity by starting a second shift. This operational change would not require approval from the municipality. The sanitary design flows (refer to Chapter 6 b) ii)) plan for an increased effluent quantity appropriate for a two shift operation.

17. Public and First Nation Consultation

17.1 Public Consultation

There has been extensive public consultation throughout Stage 1 and Stage 2 of the LWMP, as well as the Official Community Plan process leading up to the LWMP process, and this will continue as appropriate.

The most recent public meeting was organized by the LWMP Public Advisory Group and was held on September 19th, 2002. The meeting confirmed the support of those present for the plan as presented, including improvements to the collection system, the proposed treatment method and both capital and operating funding requirements.

Copies of the meeting agenda, the consultant presentation and the audience response forms are included in Appendix A.

17.2 First Nations

Although invited to participate throughout the Public and Technical review processes of Stage 2, the Comox Indian Band has not responded directly or participated in consultations. Copies of the Technical Memoranda were sent to the band for their information and review. A copy of the draft Final LWMP Stage 2 has also been sent.

18. Funding Plan

18.1 Overall Costs

Implementation of the Liquid Waste Management Plan is projected to have a capital cost of $10,815,500 (refer to Chapter 13). The annual operating cost thereafter will be approximately $ 118,000 (refer to Table 10.1). These costs represent a very substantial investment for the Village in light of its average annual total tax levy of only $1,700,000 (2002).

18.2 Implications of Grant Funding

The implementation of this LWMP hinges on the Village of Cumberland receiving external funding assistance. The total municipal borrowing power is limited by the available tax base. This limit will be reached, or exceeded, to achieve the municipal contribution of one-third ($ 3.6 million) of the projected cost. The Village has submitted a funding application to the Canada – British Columbia Infrastructure Program (CBCIP) and has been advised that the application is considered strong. The strength of the application is based upon the proposed treatment by Constructed Treatment Wetland clearly meeting the program objectives of using innovative technology and green infrastructure while having a high applicability for other municipalities.

18.3 Cost to Taxpayers

Based on alternative plan implementation costs, and using scenarios with and without a support funding grant, the annual cost to taxpayers is shown in Table 18.1. This table was presented at the Public Meeting on September 19, 2002.

Table 18.1 - Project Funding Costs

	ESTIMATE A		ESTIMATE B	
	with grant	without	with grant	without
Estimated Total Project Cost	$8,000,000	$8,000,000	$9,000,000	$9,000,000
Cost to Cumberland with Federal/Provincial grant	$2,666,700		$3,000,000	
Cost to Cumberland without Federal/Provincial grant		$8,000,000		$9,000,000
Subtract municipal reserves (approx. $438,488)	$2,228,200	$7,561,500	$2,561,500	$8,561,500
MFA loan principal and interest over 25 years	$4,565,520	$15,681,150	$5,249,878	$17,754,961
Annual debt payment	$182,619	$637,245	$209,994	$710,197
Capital cost per household (based on 991 households)	$184	$643	$212	$717
Additional annual operating cost per household ($100)	$100	$100	$100	$100
2002 average annual sewer frontage tax and sewer rate	$128	$128	$128	$128
Total annual cost per household	**$412**	**$871**	**$440**	**$945**

19. Stormwater Management Planning

19.1 Stormwater Background

This LWMP has taken a watershed-based approach and as such has accumulated extensive knowledge of the natural watershed, and its three sub-watersheds, within which the Village is located. Anderson Civil Engineering (LWMP Stage 1, Volume 2 K) completed extensive watershed modelling and ground truthing for the northern and southern sub-watersheds and included this work in the stormwater model. (Refer to Chapter 7). The northern sub-watershed is almost completely undeveloped at present, but the Cumberland OCP calls for extensive residential development in the future. The southern sub-watershed is a mix of managed forestland and completed urban development and as such will change little in the future.

19.2 Implementation Plan

The Small Town Initiative of the University of British Columbia has recently completed a municipal stormwater management plan for the urban area that will, among other objectives, reduce peak stormwater flows in the developed portions of the Village. The LWMP does not include the implementation of the stormwater plan, as that will be largely achieved through municipal road and right-of-way capital work, and it will occur in future years.

Storm flows developed in Chapter 7, and projected design flows have assumed that the BMPs of the stormwater plan will be implemented.

20. Water Quality Sampling Programme

20.1 Background

The sampling programme is driven by the need to collect background data on the existing water quality and the seasonal variations so that this will provide a benchmark for evaluation of future improvements.

The programme is based on earlier recommendations in the Stormwater Management Plan, Anderson Civil Engineering, May 2000, discussions and recommendations from Professor Will Marsh in 2001, and recommendations by Mimulus Biological Consultants, September 2001.

This sampling programme is in addition to sanitary effluent sampling recommended or required under other protocols. It does not replace any sampling and analysis required for Environmental Impact Studies or recommended in these EIS.

20.2 Locations

Sampling has been carried out by the Village of Cumberland and the MWLAP (formerly MELP) at a few sites for a number of years. These sites are included in the list recommended under this programme. The sites identified and recommended by Mimulus are included, as well as the additional sites identified with Professor Will Marsh in the northern and southern stormwater areas. Sites identified by MWLAP for monitoring the Trent River have been included. There was some overlap in the groups of sites, and these have been consolidated into a single numbered set. Particular sampling requirements identified by WetlandsPacific have also been included in these recommendations. Individual sites are identified on Figure 19.1 (refer to Appendix C). A brief description and identifier for the location of each site is included in Table 19.1 following.

20.3 Analysis

The parameters recommended for analysis at each site are intended to identify the constituents that are likely to occur now or in the future. Of particular interest are parameters that will be improved by the implementation of BMPs for stormwater, and those that will be changed by improvements to the sewage effluent. The analysis programme is intended to complete a full spectrum analysis on all water samples at infrequent intervals, and to analyse more frequently for those parameters that will change rapidly over time or may be good indicators. Both phosphorus and chlorophyll *a* are particularly required over the next twelve months to establish base values before construction of the Constructed Treatment Wetland.

Individual sets of analyses are identified on Table 19.2 attached, together with the sample size and any particular requirements for the containers, handling or shipping.

The schedule for sampling and analysis at each site is detailed on Table 19.3, attached. A full spectrum analysis (A) is scheduled for each site annually.

Site 2 (Beaver Dam) will be eliminated by construction of the Treatment Wetlands. Site 1 will assume responsibility for monitoring the upstream natural receiving waters. The increased sampling frequency at Site 2 is intended to confirm the natural variation in chemistry, in particular phosphorus, before construction of the Wetlands.

Analysis detection limits should be:

- metals to ICPMS metals package standards,
- nutrients (phosphorous and nitrogen compounds) to 0.002 mg/ℓ, orthophosphate to 0.0001 mg/ℓ, and
- ammonia to 0.005 mg/ℓ.

20.4 Recommendations

Background water quality sampling should be continued over the long term to confirm the reducing impact of the Village of Cumberland on the surrounding environment.

Table 20.1 - Sampling Site Details

Site #	Near[1] Mimulus	MWLAP #	Name / Alias	Location
1	1		Maple Lake	Maple Lake creek 100 to 180m north of culvert under Cumberland Road
2		140120	Beaver Dam	Maple Lake creek at beaver dam 25m upstream of lagoon discharge
3			Access behind BMX	Upstream of Culvert under logging road access
4	2	140122	Royston Road	Maple Lake Creek downstream of Royston Road
5		(140123)	Island Highway	Maple Lake Creek upstream of the Inland Island Highway culvert
6 [2]	3	140124	Maple Creek Upstream	Maple Lake Creek approximately 100m above Trent River, historical Village monitoring point
7 [2]	4	127582	Trent below confluence	Trent River approximately 100m below Maple Lake Creek, historical Village monitoring point
8 [2]	5	127581	Trent above confluence	Trent River approximately 200m above Maple Lake Creek, historical Village monitoring point
9			Railway	Outlet from southern creek across old rail grade, site of old wood culvert
10			Southern Uplands	Creek flowing from south
11			Second Street	Outlet from urban storm drainage system
12	7		Northern Upland	Inlet to Maple Lake from Trib1, north west of Hope Street
13			Trent River below confluence	Trent River approximately 400 m below Maple Lake Creek
14			Lower Trent River	Trent River approximately 2,000 m below Maple Lake Creek (1,000 m above E&N)
15			E&N Railway	At E&N crossing

Note: (1) Sample site Mimulus, November 2001, Figure 5.1.
(2) Access to Sites 6, 7 and 8 in winter is difficult. Sample only when safe to do so.

Table20.2 - Analysis Requirements

Parameter		Sample Type			
		A Benchmark	B River	C Urban	D Uplands
Alkalinity	mg/ℓ	X			
TDS	mg/ℓ	X		X	
Tot Suspended Solids	mg/ℓ	X	X	X	X
Turbidity	NTU's	X		X	X
BOD 5 day	mg/ℓ	X	X	X	
Conductivity	uS/cm	X	X	X	X
Dissolved Oxygen	mg/ℓ	X	X	X	X
Hardness	mg/ℓ	X			
Oil & Grease		X			
Metals:					
Aluminium	mg/ℓ	X			
Antimony	mg/ℓ	X			
Arsenic	mg/ℓ				
Barium	mg/ℓ	X			
Beryllium	mg/ℓ	X			
Bismuth	mg/ℓ	X			
Boron	mg/ℓ	X			
Cadmium	mg/ℓ				
Calcium	mg/ℓ	X			
Chromium	mg/ℓ	X			
Cobalt	mg/ℓ	X			
Copper	mg/ℓ	X			
Iron	mg/ℓ	X			
Lead	mg/ℓ				
Lithium	mg/ℓ	X			
Magnesium	mg/ℓ	X			
Manganese	mg/ℓ	X			
Mercury	mg/ℓ				
Molybdenum	mg/ℓ	X			
Nickel	mg/ℓ	X			
Phosphorous	mg/ℓ	X			
Potassium	mg/ℓ	X			
Selenium	mg/ℓ				
Silicon	mg/ℓ	X			
Silver	mg/ℓ	X			
Sodium	mg/ℓ	X			
Strontium	mg/ℓ	X			
Thallium	mg/ℓ	X			
Tin	mg/ℓ	X			
Titanium	mg/ℓ	X			
Vanadium	mg/ℓ	X			
Zinc	mg/ℓ	X			
Ammonium (N)	mg/ℓ	X	X		
Nitrite (N)	mg/ℓ	X	X	X	X
Nitrate(N)	mg/ℓ	X	X	X	X
Total Kjeldahl Nitrogen	mg/ℓ	X	X	X	X
Ortho-P	mg/ℓ	X	X	X	X
Total P	mg/ℓ	X	X	X	X
Chlorophyll-a (2)	mg/m^2		X		
pH	pH units	X	X	X	X
Surfactants	as LAS, mg/ℓ	X			
Total Chlorine (3)	mg/ℓ	X			
Total Coliform (4)	CFU/100mℓ	X	X	X	X
Faecal Coliform	CFU/100mℓ	X	X	X	X
Chloride	mg/ℓ	X		X	

Notes:
(1) Minimum Sample Size 1500 mℓ
(2) Chlorophyll requires separate sampling onsite (May to November only)
(3) Total Chlorine not available from lab. Measure onsite
(4) Total / Faecal coliform require 400mℓ in special containers

Table20.3(a) - Schedule for Sampling (2002)

Site #		2002 Sept	Oct	Nov	Dec
1	Maple Lake	A	D D	D D	
2	Beaver Dam	A B	B B A	B B B	B
3	Access behind BMX	A		C	
4	Royston Road	A	B	B	B
5	Island Highway	A		B	
6	Maple Creek Upstream	A	B		B
7	Trent below confluence	A	B		B
8	Trent above confluence	A	B		B
9	Railway	A		C	
10	Southern Uplands	A		D	
11	Second Street	A		C	
12	Northern Upland	A		D	

Table20.3(b) - Schedule for Sampling (2003)

Site #		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
		2003											
1	Maple Lake	D	D	D	D	A	D	D	D	D D	D D	D	D D
2	Beaver Dam	B	B	B	B B B	B A B	B B	B B	B B	B B	B B	D B	B B
3	Access behind BMX		C			A			C			A	
4	Royston Road	B	B	B	B	A	B	B B	B B	B D	B B	A B	B
5	Island Highway	B		B		A		B		B		A	
6	Maple Creek Upstream		B	B	B	A		B		D	B	A	B
7	Trent below confluence		B	B	B	A B	B	B	B	B	B	A	B
8	Trent above confluence		B	B	B	A		B		B	B		B
9	Railway		C			A						C	
10	Southern Uplands		D			A						D	
11	Second Street		C			A						C	
12	Northern Upland		D			A						D	
13	Trent below confluence		D		B	A B	B	B	B	B	B	A	D
14	Lower Trent				B	A B	B	B	B	B	B	A	
15	E&N Railway		D		B	A B	B	B	B	B	B	A	D

Table 20.3(c) - Schedule for Sampling (2004 and following)

Site #		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
		2004											
1	Maple Lake	D	D	D	D D	A D	D	D	D	D D	D D	D	D
2	Beaver Dam	D D	D D	D D	D D	A	—	—	—	—	—	—	—
3	Access behind BMX	C											
4	Royston Road	D		D	D	A	D	D D	D D	D D	D D		D
5	Island Highway	D				A			D			D	
6	Maple Creek Upstream	D		D	B	A			D	D	D	D	
7	Trent below confluence	D		D		A	B	B	B	B	B	D	
8	Trent above confluence	D		D		A B	B	B	B	B	D	D	
9	Railway		C			A			C			C	
10	Southern Uplands		D			A			D			D	
11	Second Street		C			A			C			C	
12	Northern Upland		D			A			D			D	
13	Trent below confluence	D		D		A B	B	B	B	B	B	D	
14	Lower Trent					A B	B	B	B	B	B		
15	E&N Railway	D		D		A B	B	B	B	B	B	D	

21. Operational Certificate

As required by the *Guideline for Developing a Liquid Waste Management Plan*, August 1992, this section includes a draft operational certificate identifying the requirements to be included in the final Operational Certificate for the treatment process. The certificate includes the standard clauses typically used by MWLAP, as well as specific details of the proposed discharge limits and monitoring and reporting programme

DRAFT OPERATIONAL CERTIFICATE

Under the Provisions of the Waste Management Act

Village of Cumberland

PO Box 340, 2673 Dunsmuir Avenue

Cumberland, British Columbia

V0R 1S0

is authorised to discharge effluent to Maple Lake Creek from a municipal sewage system located in Cumberland, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Waste Management Act* and may result in prosecution.

This operational certificate supersedes and amends all previous versions of operational certificate PE-00197, issue under Part 3 Section 18 of the *Waste Management Act.*

1. AUTHORISED DISCHARGES

1.1 This subsection applies to the discharge of effluent to the Maple Lake Creek from a MUNICIPAL SEWAGE TREATMENT FACILITY. The site reference number for this discharge is __________.

1.1.1 The maximum authorised daily rate of discharge is 13,000 m^3/d.

1.1.2 After June 30, 2006 the maximum authorised concentration of orthophosphate that may be discharge to Maple Lake Creek from May 1 to September 30 (inclusive) each year is 0.10 mg/L.

1.1.3 The characteristics of the discharge shall not exceed:

5-day Biochemical Oxygen Demand	- 10 mg/L
Total Suspended Solids	- 10 mg/L
Fecal Coliform	- 2.2 CFU/100ml (median of 7 consecutive tests) - 100 CFU/100ml (in any sample)
pH	- 6.0 - 9.0
Nitrate	- 40 mg/L (30 day average) - 200 mg/L (maximum)

Nitrite	- 0.02 mg/L (30 day average)
	- 0.06 mg/L (maximum)
Ammonia	- 1.3 mg/L (30 day average)
	- 18.0 mg/L (maximum)

1.1.4 The authorised works are influent pumping facilities, mechanical screens, one complete mix aerated lagoon, one polishing lagoon, multi-cell constructed treatment wetlands, supplementary phosphorous removal facilities, disinfection facilities, and related appurtenances approximately located as shown on attached Site Plan.

1.1.5 The authorised works must be complete and in operation by 31 December, 2006.

1.1.6 The location of the facilities from which the discharge originates is Lot A, Plan 23092,District Lot 24, Township 10, Nelson Land District and Lot C, Plan VIP 65968, Section 25, Township 10, Comox Land District.

1.1.7 The location of the point of discharge is Maple Lake Creek upstream of Royston Road.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The Village of Cumberland shall inspect the authorised works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the Village of Cumberland that prevents effective operation of the approved method of pollution control, the Village of Cumberland shall notify the Regional Waste Manager immediately and take appropriate remedial action. The Regional Waste Manager may reduce or suspend the operation of the Village of Cumberland to protect the environment until the approved method of pollution control has been restored.

2.2 Bypasses

The Village of Cumberland shall ensure that no waste is discharged without being processed through the authorised works unless prior written approval is received from the Regional Waste Manager.

2.3 Process Modification

The Village of Cumberland shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and or quantity of the discharge.

2.4 Plans - New Works

Plans and specifications of the new works shall be certified by a qualified professional licensed to practice in the Province of British Columbia, and submitted to the Regional Waste Manager for review prior to the start of construction. A qualified professional licensed to practice in the Province of British Columbia must certify that the works have been constructed in accordance with the submitted plans.

2.5 Sludge Reuse and Disposal

Sludge generated by the treatment process shall be managed in a manner approved by the Regional Waste Manager and in accordance with the sludge management strategies developed in the Regional District of Comox-Strathcona.

2.6 Standby Power

The Village of Cumberland shall provide auxiliary power facilities to insure that during power outages, the discharge from the authorised works continue to meet the effluent criteria specified in this operational certificate.

2.7 Odour Control

Should objectionable odours, attributable to the operation of the sewage treatment plant, occur beyond the property boundary as determined by the Regional Waste Manager, measures or additional works will be required to reduce odour to acceptable levels.

2.8 Effluent Upgrading

Based on receiving environment monitoring data and/or other information obtained in connection with this discharge, the Village of Cumberland may be required to provide additional treatment facilities.

2.9 Disinfection

Although disinfection of the effluent is not required at this time, suitable provisions should be made to include disinfection facilities in the future. If disinfection is by chlorination, dechlorination facilities will also be required.

2.10 Facility Classification and Operator Certification

The Village of Cumberland shall have the works authorised by this operational certificate classified (and the classification shall be maintained) by the Environmental Operators Certification Program Society (Society). The works shall be operated and maintained by persons certified within and according to the program provided by the Society. Certification must be completed to the satisfaction of the Regional Waste Manager. In addition, the Regional Waste

Manager shall be notified of the classification level of the facility and certification level of the operators, and changes of operators and/or operator certification levels within 30 days of any change.

Alternatively, the works authorised by this operational certificate shall be maintained by persons who the Village of Cumberland can demonstrate to the satisfaction of the Regional Waste Manager, are qualified in the safe and proper operation of the facility for the protection of the environment.

2.11 Infiltration and Inflow Reduction

The Village of Cumberland shall take measures, in accordance with the strategies developed in the Liquid Waste Management Plan, to reduce the inflow and infiltration into the sewage collection system. A report shall be submitted once every year to the Regional Waste Manager that provides details of the measures taken in the preceding year to reduce inflow and infiltration. The first report shall be submitted on or before December 31, 2006.

2.12 Operational Plan

The Village of Cumberland shall develop an Operational Plan, to be prepared by a qualified professional, which provides details for the proper operation and maintenance of sewage conveyance, treatment, disposal, including the monitoring details. The plan shall be certified by the qualified professional that it is adequate for the works being installed and the water reuse being proposed. The plan shall be submitted to the Regional Waste Manager for review prior to June 30, 2006.

3.0 MONITORING AND REPORTING REQUIREMENTS

3.1 Discharge monitoring

3.1.1 Sampling and Analysis

The Village of Cumberland shall install a suitable facility and obtain samples of the effluent for analysis as follows:

Parameter	Frequency	Sample Type
5-day Biochemical Oxygen Demand	weekly	grab
Total Suspended Solids	weekly	grab
Nitrate	monthly	grab
Nitrate	monthly	grab
Ammonia Nitrogen	monthly	grab
Ortho Phosphate Phosphorous (P)	monthly	grab
Total Phosphorous	monthly	grab

Dissolved Oxygen	monthly	grab
Fecal Coliform	monthly	grab
pH	monthly	grab

3.1.2 Flow Measurement

Provide and maintain a suitable flow measuring and recording device for the effluent volume discharged to Maple Lake Creek.

3.2 Receiving Environment Monitoring

A receiving environment monitoring program shall be carried out by the Village of Cumberland. The program shall be established in consultation with the Regional Waste Manager. Based on the results of this monitoring program, the Village of Cumberland's monitoring requirements may be extended or altered by the Regional Waste Manager.

3.2.1 Sampling Stations

The permittee shall establish and maintain six monitoring stations as follows:

Station #A: (140124) Maple Lake Creek 100 m above Trent River
Station #B: (127581) Trent River 200 m above Maple Lake Creek
Station #C: (127582) Trent River 100 m below Maple Lake Creek
Station #D: Trent River 200 m below Maple Lake Creek
Station #E: Trent River 1000 m above E&N Rail Bridge
Station #F: Trent River at E&N Rail Bridge

The exact sampling locations are subject to the approval of the Regional Waste Manager.

3.2.2 Sampling and Analyses

a) Substrate Sampling

The permittee shall collect a sample of the substrate at three sampling sites at each station #B through #F once during the third week of May, June, July and September each year, commencing in the year 2006. Each sample shall be collected by a qualified professional biologist. Each sample shall be analysed for Chlorophyll-a.

This sampling programme shall be reviewed after five years and may be reduced by the Regional Waste Manager if results are within the BC Approved Water Quality Guidelines.

b) River Water Sampling

The permittee shall collect a sample of the river water at each station A through F, at the same time the substrate samples are collected, and once during the months of October, November, January and March each year commencing in the year 2006.

Obtain analyses of the samples for the following:

Total Phosphorous (P);
Ortho Phosphorous (P);
Total Nitrogen (N);
pH;
Temperature.

This sampling programme shall be reviewed after five years and may be reduced by the Regional Waste Manager if results are within the BC Approved Water Quality Guidelines.

3.3 Monitoring Procedures

3.3.1 Sampling and Analytical Procedures

Sampling shall be carried out in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, or by suitable alternative procedures as authorised by the Regional Waste Manager.

Analyses are to be carried out in accordance with procedures described in the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, or by suitable alternative procedures as authorised by the Regional Waste Manager.

Copies of the above manuals may be purchased from the Queen's Printer Publications Centre, P.O. Box 9452, Stn. Pro. Govt. Victoria, British Columbia, V8W 9V7 (1-800-663-6105) or (250) 387-6409), and are also available for inspection at all Environmental Protection Offices.

3.4 Reporting

Maintain data analyses and flow measurements for inspection and every year submit data, suitably tabulated, to the Regional Waste Manager for the previous year. The first report is to be submitted by December 31, 2006. Based on the results of the monitoring program, the Village of Cumberland monitoring requirements may be extended or altered by the Regional Waste Manager.

An annual report shall be prepared by an independent qualified professional which includes a summary and interpretation of the discharge and receiving environment monitoring results for the previous year. The report shall provide an assessment of the impact of this discharge on the receiving environment and recommended changes (if any) to the monitoring program. The first report shall be submitted by December 31, 2006.

22. Recommendations

22.1 Conclusions from Stage 2

The following general conclusions were reached in the preparation of the Stage 2 Plan. Further detail is contained in the body of this report.

- The discharge of wastewater effluent to Maple Lake Creek should continue.
- The effluent discharge should meet BC Approved Water Quality Guidelines for aquatic life with orthophosphate significantly limited during the summer. The discharge should meet the objectives for Reclaimed Water Standards for stream flow augmentation.
- The existing combined sewers should be separated over the next few years and all new construction must be separated.
- Some sections of replacement sanitary infrastructure are required to avoid the potential for Combined Sewer Overflows.
- In order to reduce infiltration and eliminate exfiltration, a programme of replacing the oldest sanitary sewers in the core area of the village should be implemented over the next few years
- The treatment process should be improved to include a Constructed Treatment Wetland, together with the existing lagoon system, in order to meet the water quality objectives and to significantly reduce the discharge of orthophosphate during the summer months.
- Additional storage should not be constructed for summer low flow augmentation of the Trent River, unless separate funding is available.

22.2 Recommendations for Stage 3

The following recommendations are developed from the Stage 2 Plan and are detailed for implementation as part of the Stage 3 Plan:

1. Establish 2002 / 2003 flow monitoring in Maple Lake Creek and analyse for potential dilution of effluent.
2. Undertake a groundwater table monitoring programme in the bog / fen area over winter 2002 / 2003.
3. Implement Limna (duckweed) harvesting for summer 2003 and monitor effectiveness in phosphorous reduction in existing discharge.

4. Conduct a sediment sampling and monitoring programme (for heavy metals and other contaminants) downstream of discharge pre and post construction period.
5. Identify requirements for assessments and approvals required under Canadian Environment Assessment Act.
6. Complete studies and assessments required by CEA.
7. Complete a revised Environmental Impact Study in accordance with the MSR requirements for impact from construction of treatment wetlands.
8. Submit to the local Health Authority the detailed proposal for Reclaimed Water Discharge. Obtain approval before completion of final treatment process design.
9. Develop a detailed plan to meet the discharge goals, in particular to meet the specific requirements for the discharge of reclaimed water in accordance with MSR requirements.
10. Complete investigation and study to develop a detailed 10-year plan for stormwater separation to reduce inflows.
11. Complete investigation and study to develop a detailed 15-year plan for sanitary sewer repairs and improvements.
12. Complete detailed designs for sanitary sewer replacements as recommended in Stage 2 Plan.
13. Complete study and detailed design for sanitary sewer service extensions as identified in Stage 1 and recommended in Stage 2 Plan.
14. Complete detailed studies and designs for improvements to the treatment process including:
    - hydrologic design to maintain regime in bog / fen area upstream of wetland.
    - detailed design for performance improvements to existing lagoon system.
    - design of free water surface wetland as part of process train to meet effluent quality recommended in Stage 2.
    - operating and management plan for constructed wetlands.
    - detailed investigation and design for chemical addition, or alternative process, to precipitate phosphorous; include identification of best sites(s) for pilot testing.
    - detailed designs for precipitate collection, and removal to regional composting facility.
    - summer management plan for the depth of water in the wetlands to supplement flows to the Trent River, provided there is no negative impact on the wetland or the effluent quality.

15. Complete detailed design for upgrades to existing pumpstation and inlet works.
16. Complete design for emergency stand-by power facilities.
17. Establish effluent discharge and downstream monitoring and reporting requirements.
18. Include the wastewater design flows and criteria developed in Chapter 7 in the "Subdivision Control Bylaw".
19. Develop a Source Control programme to reduce phosphorous entering the sanitary collection system.
20. Develop a public access and information plan for the appropriate areas of the wetlands and downstream on Maple Lake Creek; the plan should include access restrictions where appropriate.

22.3 Other Recommendations

The following recommendations are made in the context of the Liquid Waste Management Plan, but are actions required of others:

21. Recommend to Land and Water BC that no water licenses be issued in the catchment of Maple Lake Creek between Cumberland Road and the Trent River to avoid potential health risks.
22. Recommend to Land and Water BC that no water licenses be approved in the Trent River watershed to avoid any negative impacts on low summer flows or potential dilution.

16. Canadian Wildlife Service, Ron Buechert, BSc., Ground-truthing, Delineation and Conservation Evaluation of Part of Sensitive Ecosystem Polygon #65003, Cumberland, July 2001.

17. Mimulus Biological Consultants, Environmental Assessment for the Proposed Cumberland Treatment Wetlands and Sewage Discharge, November 2001.

18. WetlandsPacific, A Report on the Conceptual Design and Costing of a Constructed Wetland for Cumberland, BC, January 2002.

19. Kerr Wood Leidal Associates Ltd., Cumberland Wastewater Treatment Plant Upgrading, March 2002.

20. WetlandsPacific, Selected Water Quality Projections in the Discharge of Cumberland's Proposed Constructed Wetland, December 2002.

APPENDIX A

Public Consultation

Village of Cumberland LWMP

Steering Committee:

Chair:	Mayor Moncrief
Members:	Councillor Lukay
	Councillor Baird
	Councillor Bates
	Councillor Keenan
Ex-Officio:	Helene Roberge, MWLAP

Public Advisory Group:

Chair:	Frank Lukay, resident
Members:	Ron Hansen, resident
	Mya Ambrose, resident
	Russ Bowers, resident
Ex-Officio	Mac Fraser, municipal staff
	Helene Roberge, MWLAP

Technical Advisory Group:

Chair:	Mac Fraser, municipal staff
Members:	Helene Roberge, MWLAP
	Phil Wong, Environment Canada
	March Klaver, Fisheries and Oceans Canada
	Peggy Ward, Canadian Wildlife Service
	Dwayne Stroh, Vancouver Island Health Region
	Peter Bailey, MCAWS
	Graeme Faris, Regional District of Comox-Strathcona
Ex-Officio	Frank Lukay, resident

AGENDA

Village of Cumberland Public Meeting

Liquid Waste Management Planning

Thursday, September 19th, 2002

7 pm in the Cumberland Cultural Center

- Welcome and Introduction
  - Councilor Lukay, Chair of the Liquid Waste Public Advisory Group

- Overview of Liquid Waste Management Planning Process to Date;
  - Mac Fraser, Manager of Operations;

- Presentation of draft Liquid Waste Management Plan - Stage 2 Report;
  - Douglas Anderson, Anderson Civil Engineering;

- Open Discussion;
  - attendees

- Closing;
  - Mayor Moncrief.

Village of Cumberland

Liquid Waste Management Plan - Stage 2

Draft Plan

Public Information Meeting

19 September 2002

Douglas W. Anderson, Anderson Civil Engineering

ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

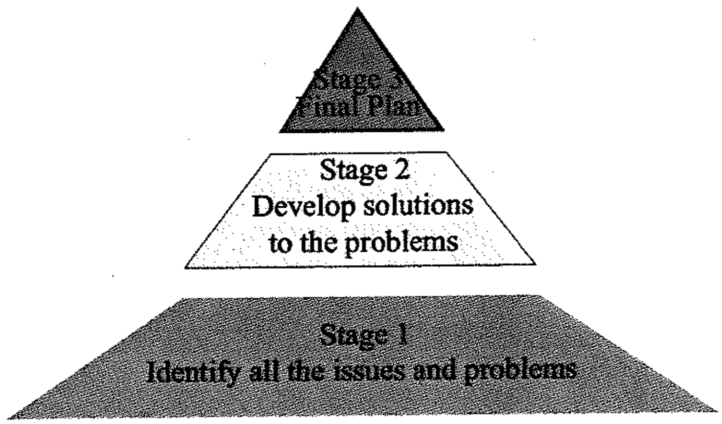
Liquid Waste Management Plan - Outline

1. LWMP process (Ministry of Water Land & Air Protection)
2. Municipal Sewage Regulation (MSR)
3. Issues reviewed in Stage 1
4. Options for Discharge & Treatment
5. Actions for Stage 2

ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Liquid Waste Management Planning



ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Municipal Sewage Regulation

Waste Management Act, Municipal Sewage Regulation (July,1999)

- Applies to all municipal sewage discharges
- Existing permits and LWMP are only exceptions
- Standards set for each type of discharge to the environment
- Requirements for environmental studies
- Technical standards to be met for design and operation
- Standards for reclaimed water for re-use
- LWMP will be evaluated against this regulation

ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Liquid Waste Management Plan History

2000 March	Public Meeting for LWMP Stage 1
2000 May	Public Presentation for LWMP
2000 June	LWMP for Ministry review
2001 February	Public presentation for Stage 1 Plan
2001 June	Stage 1 plan approved by MWLAP
2001 June – Dec	**Environmental Assessments**
2002 Jan –April	**Engineering Studies for Stage 2**
2002 March	**Application for CBCIP funding**
2002 May – Sept	**Review process**
2002 September	**Public presentation for Stage 2 Plan**

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Issues Reviewed in LWMP Stage 1

1. Population
2. Septic tanks, ground disposal
3. Wastewater quantities
4. Commercial & Industrial
5. Solid waste
6. Regional context
7. Source control
8. Inflow and infiltration
9. Effluent reuse
10. Septage
11. Stormwater
12. Receiving environment
13. Site locations
14. Options for treatment
15. Actions for LWMP Stage 2

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Issues Studied in Stage 2

1. **Impact on receiving environment downstream**
2. Wastewater flows for design
3. Alternatives for sanitary/storm sewer separation
4. Alternative discharge options
5. Alternative treatment processes
6. "Biosolids" handling
7. **Impact of construction on environment**
8. Low flow stream augmentation
9. Costs to implement

ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Issues Studied in Stage 2

1. Impact on receiving environment downstream
2. **Wastewater flows for design**
3. **Alternatives for sanitary/storm sewer separation**
4. **Alternative discharge options**
5. Alternative treatment processes
6. "Biosolids" handling
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8. **Low flow stream augmentation**
9. Costs to implement

ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Issues Studied in Stage 2

1. Impact on receiving environment downstream
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3. Alternatives for sanitary/storm sewer separation
4. Alternative discharge options
5. **Alternative treatment processes**
6. **"Biosolids" handling**
7. Impact of construction on environment
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9. Costs to implement

Anderson Civil Engineering

VILLAGE OF CUMBERLAND LIQUID WASTE MANAGEMENT PLAN STAGE 2

Issues Studied in Stage 2

1. Impact on receiving environment downstream
2. Wastewater flows for design
3. Alternatives for sanitary/storm sewer separation
4. Alternative discharge options
5. Alternative treatment processes
6. "Biosolids" handling
7. Impact of construction on environment
8. Low flow stream augmentation
9. **Costs to implement**

Anderson Civil Engineering

VILLAGE OF CUMBERLAND LIQUID WASTE MANAGEMENT PLAN STAGE 2

Projects Identified for Funding

- Complete LWMP Stage 3 plan
- Extend sanitary sewer mains to service existing on-site disposal areas
- Replace mains and duplicate to avoid future overflows
- Construct interceptor to divert flows at (Ulverston)
- Upgrade collection system mains to reduce infiltration
- Construct Treatment Wetland

VILLAGE OF CUMBERLAND LIQUID WASTE MANAGEMENT PLAN STAGE 2

Projected Costs

• Complete approvals & LWMP Stage 3	$ 150,000
• Connect existing septic tank areas	$ 520,000
• Sewer upgrades to avoid overflows	$ 365,000
• Diversion sewer on Ulverston	$ 300,000
• Upgrade mains to reduce infiltration	$ 1,134,000
• Construct Treatment Wetland	$ 6,145,000
Total	$ 8,614,000

VILLAGE OF CUMBERLAND LIQUID WASTE MANAGEMENT PLAN STAGE 2

Issues remaining to complete Stage 2

- Confirm performance expectations for Treatment Wetland
- Confirm absence of fish in Maple Lake Creek
- Confirm boundaries of land area available (SEI)
- Incorporate reviews by TAC
- Prepare Draft plan
- Complete reviews by TAC
- Submit Plan to MWLAP for review and approval

ANDERSON Civil Engineering

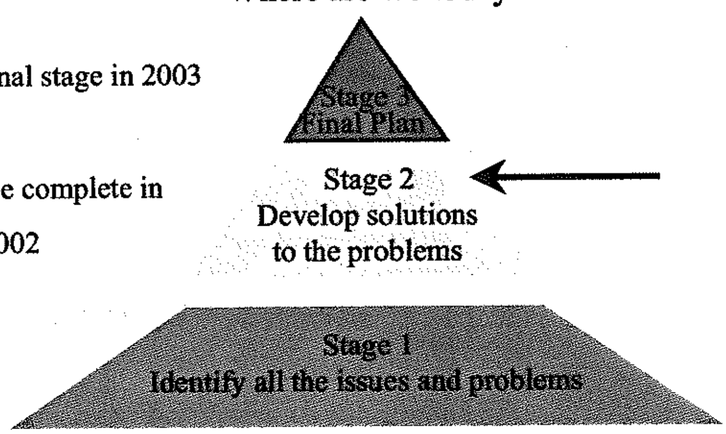
VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Liquid Waste Management Planning
Where are we today?

The final stage in 2003

Will be complete in

Fall 2002



ANDERSON Civil Engineering

VILLAGE OF CUMBERLAND, LIQUID WASTE MANAGEMENT PLAN, STAGE 2

Corporation of the
Village of Cumberland

2673 Dunsmuir Avenue
P.O. Box 340
Cumberland, B.C.
V0R 1S0
Telephone: 250-336-2291
Fax: 250-336-2321

April 8th, 2002

Comox Indian Band,
3320 Comox Avenue,
Comox, B.C.
V9N 3P8

Attention: Chief Ernest Hardy

Re: Village of Cumberland Liquid Waste Management Plan - Stage 2 - Technical Reports for Review

After months of hard work by Anderson Civil Engineering and various sub-consultants, Cumberland's LWMP Stage 2 is ready to take the next major step. Thank you for your patience.

As a member of the Village of Cumberland Liquid Waste Management Technical Advisory Group, please review and comment upon the six technical reports on the enclosed CD. The reports have been kept separate for ease of review as not all members will be interested in all reports. The review of these reports represents the technical portion of the Stage 2 report and hopefully will be followed with public consultation in May and formal submission to MWLAP in June.

Thank you for your continuing assistance with Cumberland's liquid waste management.

Mac Fraser
Manager of Operations
Village of Cumberland

encl:2

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes
excellent report.
What about the spagnum moss, pine bog - effect?

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes.
Have you tried an experimental very small scale wetland to see how it would work?

No P3 wanted!!

Do you support the Stage 2 report as presented ? If not, why not ?

yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

no

Are there any other comments you would like to make ?

- What impact will development at the interchange have on this plan?
- Hancock plans to log near Maple Lake - impact? extra runoff in that area?

Are you a resident of Cumberland ? yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

yes

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

yes

Do you support the Stage 2 report as presented ? If not, why not ?

yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

not sure

Are there any other comments you would like to make ?

Are you a resident of Cumberland ? Yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes, as far as I know - I have not attended any of the other meeting so I am new to the process.

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes (especially considering the number of meetings that have been held).

Do you support the Stage 2 report as presented ? If not, why not ?

Yes, I am very impressed with the treatment/ wetland plan.

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

Not that I know of.

Are there any other comments you would like to make ?

I would like to see the Constructed Treatment wetland plan go ahead as soon as possible - especially the part that deals with improving the sewer main along the ravine (Peace Park to Village Park) as my property on Windermere has had a number of flooding problems which involved a mix of storm & sewer water.

Are you a resident of Cumberland ? Yes - 2779 Windermere

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Addressed values as well
as requirements –
well done

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

in fact – excessive amount –
(I need more sleep –)

Do you support the Stage 2 report as presented ? If not, why not ?

yes - I support -
please continue good work

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

No

Are there any other comments you would like to make ?

Need to stress benefit - (i.e -
breeding habitat + tourism)
instead of cost to individual
(Need perspective price of / cost of)

Are you a resident of Cumberland ? yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

No

Are there any other comments you would like to make ?

I have attended a number of the Liquid Waste Planning Meetings ~~any~~ and I am very dissappointed in the lack of attendance for such an important issue.

Are you a resident of Cumberland ? Yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

No

Are there any other comments you would like to make ?

No

Are you a resident of Cumberland ? Yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

Are there any other comments you would like to make ?

No

Are you a resident of Cumberland ? Yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

yes, a rundown on the 90,000 / year to run a treatment wetland

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

yes - been lots of opportunity to take part - Would like to see more people come out but am sure you would too.

Do you support the Stage 2 report as presented ? If not, why not ?

yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

Are there any other comments you would like to make ?

thank you to all the time given by the councillors & people involved in this process.

Are you a resident of Cumberland ? yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

yes

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

yes

Do you support the Stage 2 report as presented ? If not, why not ?

yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

probably

Are there any other comments you would like to make ?

no

Are you a resident of Cumberland ? yes

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

YES

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

YES

Do you support the Stage 2 report as presented ? If not, why not ?

YES

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

NO

Are there any other comments you would like to make ?

NO

Are you a resident of Cumberland ? YES

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes the right issues were addressed. In addition, environmental enhancement, community benefits and educational opportunities for the various options should be included.

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

See above

Are there any other comments you would like to make ?

While the additional cost to Taxpayers will be substantial I personally will pay the price for having a system that will be the envy of many communities and a model that will be copied around the country.

Are you a resident of Cumberland ? [signature]

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

The Stage 2 report does not address the problem of septic pollution of the ~~[illegible]~~ Comox Lake Land Owners Association. Because of the financial obligation of Cumberland, they have nothing to contribute to the situation.

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Until Comox Lake is integrated it must be integrated

Do you support the Stage 2 report as presented ? If not, why not ?

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

Are there any other comments you would like to make ?

COLLIN BLAIR WATERHOUSE
P.O BOX 662
CUMBERLAND BC

Are you a resident of Cumberland ? No

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

Yes but maybe more info on actual choices chosen.

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes, good info. Especially the annual budget/taxpayer overhead.

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

Are there any other comments you would like to make ?

I looked in the local newspapers & didn't see an announcement for this meeting.

Are you a resident of Cumberland ? No (Royston)

Thank you for taking the time to attend tonight and providing your comments.

Village of Cumberland

Liquid Waste Management Planning

Stage 2 Public Meeting

September 19th, 2002

PUBLIC COMMENTS

Are you satisfied that the draft Liquid Waste Management Plan Stage 2 report presented tonight addressed the right issues ? If not, what else should the report include?

I think it covered just about everything.

Do you feel that the process to date has allowed you enough valued input and involvement ? If not, how can we improve it ?

Yes, good involvement. I've had no difficulty finding out

Do you support the Stage 2 report as presented ? If not, why not ?

Yes

Is there anything else that should be included in the Stage 2 report that was not mentioned tonight ?

I don't think so.

Are there any other comments you would like to make ?

I'd really like to see this happen soon. I have serious concerns about P3's. I think it could ruin this project.

Are you a resident of Cumberland ? Soon to be after boundary expansion

Thank you for taking the time to attend tonight and providing your comments.

APPENDIX B

Liquid Waste Management Stage 1 Summary

Executive Summary

Recommendations

Ministry of Water, Land and Air Protection letter dated June 13, 2001

Executive Summary

The Village of Cumberland has a current population of 2750 and an anticipated growth to 5000 within the limits of the Official Community Plan (OCP).

Cumberland is located in the catchment of Maple Lake Creek, which flows into the Trent River, then into Baynes Sound in the Gulf of Georgia (Figure 1) The coast area contains a high fisheries and shellfish resource. The Village of Cumberland is concerned to minimize or eliminate the urban impact on the Trent River and Baynes Sound.

The Liquid Waste Planning Area is defined as all the lands within the municipal boundary and other upland areas contributing to the flow in Maple Lake Creek as it leaves the municipal boundary (Figure 2). Land within the village boundary constitutes approximately 60% of this watershed. The remaining upland lands are within the Forest Land Reserve (FLR) and are being actively logged. Cumberland is committed to the holistic management of all flows within the watershed, with the objective of continuing to reduce the footprint of the village on the surrounding and receiving environment.

The sanitary sewage system has been subject to a discharge permit since 1967, with revisions up to the latest permit issued in 1997. The receiving water for the discharge is Maple Lake Creek. Previous assumptions on the assimilative capacity of Maple Lake Creek are no longer valid, and there is downstream impact on the Trent River from nutrient loads.

Nutrient loads include nitrogen and phosphorous, of which phosphorous has been identified as the limiting nutrient on fish habitat in the Trent River. The current permit imposes a 1.0 mg/l limit on total phosphorous. Nitrogen limits have not been separately identified. It is anticipated that a process that significantly removes phosphorous will also reduce nitrogen.

The Cumberland sewage collection system includes a large area of combined sewers where not only roof drainage but also street catch basins are connected. Both Inflow and Infiltration are high. All permits have required that steps be taken to eliminate stormwater from the flow to the treatment process.

The current permit requires that the village prepare plans for the following:

- source control
- stormwater management
- sludge wasting, screenings disposal, biosolids management
- Inflow and Infiltration control
- Storm / sanitary separation

This Liquid Waste Management Plan (LWMP) process addresses all of these through a three-stage process:

- Stage 1
    - identifies existing situation and objectives
    - assembles all previous studies and reports
    - identifies a set of options for treatment and management of flows
    - Identifies facilities requiring operational certificates
    - includes an extensive public input process
    - provides a guide and recommendations for subsequent stages
- Stage 2
    - examines in detail options for the treatment and management of flows
    - prepares comparative capital and operational costs

- compares alternatives and recommends preferred option
- Identifies requirements to be included in operational certificates
- develops guide to supporting management practices and municipal regulations
- includes an extensive public participation and review process
- provides a draft Liquid Waste Management Plan

- Stage 3
    - completes details and cost estimates for selected process
    - Complete discharge standards and operation requirements
    - Identify financing schedule
    - Develop implementation schedule
    - completes management guidelines and develops final municipal regulations
    - includes extensive public review and approval process
    - prepare draft Operational Certificate for Regional Environmental Protection Manager

This report is the result of the Stage 1 process.

The rate of effluent discharge varies significantly in response to storm flows in the combined sewers. Rapid response to storm events can be identified in the flow meter records. These flows are highly dilute during winter discharges, but in summer the flows are very low and represent sanitary sewage without Inflow, Infiltration or combined flows. The lack of dilution results in high nutrient concentrations. Due to the seasonal nature of the flows in

Maple Lake Creek, there is negligible dilution in the receiving waters in summer and the effluent constitutes the majority of the creek flow.

Alternative methods of treatment with capacity for phosphorous reduction have been identified including:

- constructed wetlands, to include treatment for stormwater
- sequencing batch reactor (SBR)
- activated sludge system
- chemical flocculation process
- biological nutrient removal (BNR)
- membrane filtration (with chemical addition)

Other methods relying principally on aeration alone are not expected to reduce phosphorous and have the potential to release nitrogen as ammonia (extremely toxic to fish). Each of the identified options will be examined in Stage 2 for effectiveness in phosphorous removal, tolerance for flow variation, capital cost, Operation and Management costs and operator skill levels.

5. Recommended Course of Action for Stage 2

1. Complete Environmental Impact Assessment for discharge to Maple Lake Creek receiving water, considering range of treatment options in Table 1
2. Study combined sewer flow records to identify and model the correlation with storm runoff events. Determine design flows (with and without separation)
3. Review extent of works for separation of combined sewers and prepare Class C cost estimates
4. Review all treatment options in Table 1 and establish rejection of those not selected for further study
5. Review details of the options and confirm Class C costs for upgrading existing treatment process as recommended in previous reports. [(2), (3)]
6. Study details of options and prepare Class C costs for alternative treatment processes to meet the permit requirements, with particular emphasis on phosphorous reduction.
7. Confirm detailed design and Class C cost estimates for Constructed Wetland options, including phased construction.
8. Identify requirements for quality and quantity of potential summer low flow augmentation of Maple Lake Creek. Study details of options and prepare Class C cost estimates.
9. Select preferred treatment option for planning and funding.

(continued)

10. Implement recommendations of Stormwater Management Plan[17] including:

    - Complete stormwater management studies for Northern Urban and Combined Sewer areas,
    - Initiate public education and participation programmes,
    - Develop design guidelines for low impact stormwater management,
    - Continue dialogue with upland landowners to minimize impacts,
    - Develop appropriate Best Management Practices.

11. Complete all other regulated requirements for Liquid Waste Management Plan, Stage 2, following due process

BRITISH COLUMBIA

SENT BY FAX: 250 336-2321

June 13, 2001

File: 76780-30/VCUMB

Village of Cumberland
2673 Dunsmuir Avenue
P.O. Box 340
Cumberland BC V0R 1S0

ATTENTION: Mac Fraser, Manager of Operations

Dear Mac Fraser:

Re: Village of Cumberland Liquid Waste Management Plan (LWMP) – Stage 1

Thank you for your letter of February 26, 2001 and the attached report entitled "Village of Cumberland Liquid Waste Management Plan, Stage 1, Volume 1, Final Report, February 2001". We also have a copy of "Volume 2, Supplementary Documents", which was submitted previously and is dated June 2000.

Stage 1 of a LWMP should present a number of options in conceptual form to deal with the liquid waste from a community and should advance a set of options for further study. The Village of Cumberland Stage 1 report identifies several options, all of which are being advanced to Stage 2. Some of these options will be ruled out early on in Stage 2 and only the most feasible options investigated in more detail. If options are ruled out this must be justified technically, economically and socially.

The 1997 permit amendment outlines the important issues to address in the Cumberland LWMP. These are the combined sewage and stormwater flows to the lagoon, and the phosphorus and fecal coliform loadings to Maple Lake Creek and the Trent River. Any option chosen in Stage 2 must deal with these issues and provide justification if the permit conditions are not met. Also, while an approved LWMP provides an exemption from meeting all the requirements of the *Municipal Sewage Regulation* (MSR), the MSR will be used as a guidance document for setting the discharge conditions and any deviation from the requirements of the MSR will also have to be justified.

I hereby approve the Stage 1 report and authorise the Village of Cumberland to proceed with Stage 2 of the LWMP. A number of issues, as outlined below, merit additional consideration in Stage 2.

. . . 2

Ministry of Water, Land and Air Protection
Vancouver Island Region
Mailing Address:
2080A Labieux Road
Nanaimo BC V9T 6J9
Telephone: 250 751-3100
Facsimile: 250 751-3103

1. Discharge/Reclaimed Water Use

Continued discharge to Maple Lake Creek (MLC) is being considered. In order to meet the requirements of the MSR for discharge to water bodies (Schedule 3), there must be some dilution of the effluent. If the dilution ratio is less than that specified in the MSR, this would have to be justified by an Environmental Impact Study (EIS). If there is not adequate dilution provided in MLC, then the potential use of the effluent as stream flow augmentation could be considered and the Reclaimed Water Standards (Schedule 2) would have to be met.

In general, the report does not discuss the standards for the use of reclaimed water in the MSR and these should be reviewed in Stage 2.

Another potential use of reclaimed water is enhancement of the existing natural wetland. This wetland is identified in the Comox-Strathcona Sensitive Habitat Atlas and the ministry's Sensitive Ecosystems Inventory. The Village would have to demonstrate that the treated effluent would be a benefit to the natural wetland, which would not be considered part of the treatment works. Downstream impacts on Maple Lake Creek and the Trent River would still have to be considered.

Discharge to the ocean would be by connecting to the Regional District of Comox-Strathcona Cape Lazo plant. This should be further evaluated as the capacity may be available and the plant is still under the control of the Regional District.

2. Environmental Impact Study (EIS)

Page 54 of the report indicates that the existing technical reports from this ministry are accepted "as valid and appropriate assessments of the assimilative capacity of Maple Lake Creek and the technical foundation on which to base the effluent standards of municipal liquid waste management in the municipality." Additional information is likely going to be required under the LWMP, especially if Cumberland is proposing different discharge standards from those specified in the permit and a number of alternative discharge scenarios are being considered. The scope is the EIS should reflect the need to obtain additional information to assess the most feasible discharge alternatives.

On page 57 the report indicates that "Except for fecal coliform, downstream human use...is not considered the controlling influence..." Water use is always considered in setting discharge standards and nutrients may be an issue from the perspective of human use, as algae growth can become an aesthetic problem. The "British Columbia Water Quality Guidelines (Criteria): 1998 Edition" should be consulted and the goal of any treatment system should be to protect the environment and not cause Water Quality Guidelines to be exceeded.

.../3

The issue of the amount of phosphorus that can be discharged to the Trent River may be difficult to determine without several years of data. The EIS for the Stage 2 plan could provide an estimate which would be used to set the discharge standards from the sewage treatment plant. The phosphorus removal system should have some flexibility to adjust as additional information is obtained from the receiving environment monitoring program.

If reclaimed water use in the natural wetland is being considered, the EIS will have to adequately deal with issues such as flooding, erosion, potential alteration of habitat, etc. as a result of the extra water.

3. Constructed Wetland

Various information sources indicate that the ability of constructed wetlands to remove significant amounts of phosphorus is not proven.

The report by C.K.Ventures Ltd., et. al. (1998) proposes that the phosphorus levels specified on the permit can be achieved by dilution with retained stormwater, if needed in the summer months. This would not reduce the overall phosphorus loading to the Trent River and may not solve the problem; also, dilution is not accepted as a treatment method. Any phosphorus removal strategy would have to be justified through an EIS.

The natural wetland would have to be modified for a constructed wetland to be part of the treatment works. Because the natural wetland is identified as a sensitive ecosystem, alteration should be conducted with caution and in consultation with wetland ecosystem experts.

4. Combined Sewer System

Ministry policy, in general, is that combined sewer systems are to be separated over the long term. The LMWP proposes to treat the existing combined flows as an alternative to sewer separation. This can be considered in the case of Cumberland because the combined flows are all routed to the sewage treatment plant; therefore, there are no Combined Sewer Overflows (CSOs), as defined in the MSR. The combined sewers can be considered as Inflow and the conditions of Schedule 1, 17 of the MSR could apply. The ministry may still require long-term sewer separation, as per Schedule 1, 14(3), to be done at the time of repair. This can be further discussed and investigated in Stage 2.

5. Stormwater

The Terms of Reference for Stage 1 indicate that the recommendations of the Storm Water Management Plan (May 2000) should be implemented. We have concerns about some of these recommendations, in particular #9, and #12. Recommendation #9 seems to indicate that additional combined sewers may be constructed. This contradicts ministry policy and the MSR Schedule 1(14)(2). Recommendation #12 would only apply of a constructed wetland is chosen as part of the treatment works.

.../4

Recommendations #13 and #14 indicate that Cumberland is interested in taking a proactive approach to stormwater management by preparing bylaws and guidelines and by revising municipal design and development standards. The Ministry supports this approach which considers the impact of changes in land use on stormwater hydrology and water quality and seeks to minimise these impacts.

Regarding BMPs, a lot of good information sources exist. Please let us know if you would like some references.

6. Source Control

A source control program should include education of public and industry as well as bylaw development. Pre-treatment of industrial and commercial discharges to the sanitary system may be required. We could provide you with some source control information from other jurisdictions.

The letter dated September 30, 1997 regarding the discharge from the Cumberland Regional Hospital Laundry Society in the Appendix indicates that the laundry has the capacity to recycle although it is not at the present time. Also, the letter indicates that a risk assessment report has been done on the laundry effluent's impact on the Cumberland treatment system. If this report is available, the information should be discussed in Stage 2. The impact of the laundry flow should be considered in more detail, particularly in terms of loadings of nutrients and BOD. Recycling should be considered as a method of reducing loadings to the sewage treatment plant.

7. Consultation with First Nations

A response from the First Nations dated April 10, 2000 indicates that they would like to meet to discuss the LWMP. We recommend that you follow up on this and arrange a meeting to present the information and discuss any of their concerns.

8. Recommended Course of Action for Stage 2

In light of the issues discussed in this letter, we have the following comments on the Recommended Course of Action for Stage 2, dated February 2001.

1. Discharge to Maple Lake Creek is not the only option. The scope of the EIS may need to be modified or expanded, depending upon which discharge option or reclaimed water use is considered for further study.
2. These flow estimates will be important for determining costs and sizing of treatment options, particularly because what is being proposed is to maintain the combined sewer system and treat the entire flow.
3. This is important for determining the cost-effectiveness of treating the combined flow. This estimate could be based on a long-term plan for sewer separation.

4. Any treatment options not considered for further study must be ruled out with adequate justification on a technical, environmental and social basis.
5. Once the goals for the discharge are established, as determined by and EIS, the options which are technically feasible and which can meet those goals should be considered for more detailed analysis, including a more detailed cost estimate. This may include upgrading of the existing system to treat the combined flow.
6. Only the most feasible options should be considered for more detailed cost estimates.
7. A more detailed cost estimate for the constructed wetland should only be undertaken if it is considered a feasible option.
8. The MSR has requirements for the use of reclaimed water which should be reviewed. Other agencies such as Fisheries and Oceans Canada may also have requirements. Consideration of this option should be part of the EIS. A more detailed cost estimate should only be done if this option is considered feasible.
9. This option should be chosen after all options have been considered and the goals for protecting the receiving environment have been established through an EIS.
10. We have concerns about some of the recommendations of the stormwater report, as discussed in the Stormwater section of this letter.
11. Please consult the "Guidelines for Developing a LWMP" and the MSR and if you have any questions, contact our office.

In addition to the items discussed above, we would like you to consider the following action items:

12. Arrange a meeting with the First Nations, as they requested in their letter of April 10, 2000, to discuss the Cumberland LWMP.
13. Establish a time frame for connecting areas with on-site systems to the sewage treatment plant.
14. Review the impact of the loading on the sewage treatment plant from the laundry facility and consider recycling.

Public input is considered to be one of the most important aspects of the waste management planning process. The plan should be flexible enough to change and adapt to public input and new information obtained during the technical assessment. Please continue to involve the public in the process and provide them opportunities to comment, as done in Stage 1.

We look forward to working with you and your consultants in during Stage 2 of the process. Hélène Roberge, Pollution Prevention Officer, will continue to be the primary contact for the ministry.

I recognise the effort which has gone into the Stage 1 report. I congratulate the Village of Cumberland on its innovative watershed-based approach to dealing with liquid waste issues and its comprehensive approach to stormwater management, incorporating both the hydrology and water quality aspects.

Yours truly,

D.F. Brown
Regional Waste Manager
Vancouver Island Region

cc: Douglas Anderson, P.Eng., Anderson Civil Engineering, fax: 250 754-4375

APPENDIX C

Figures

Metres 30 15 0 30 60 90 120 150 Metres

N

LEGEND

MIMULUS BIOLOGICAL CONSULTANTS

AVAILABLE FOR WETLANDS

ANDERSON
Civil Engineering

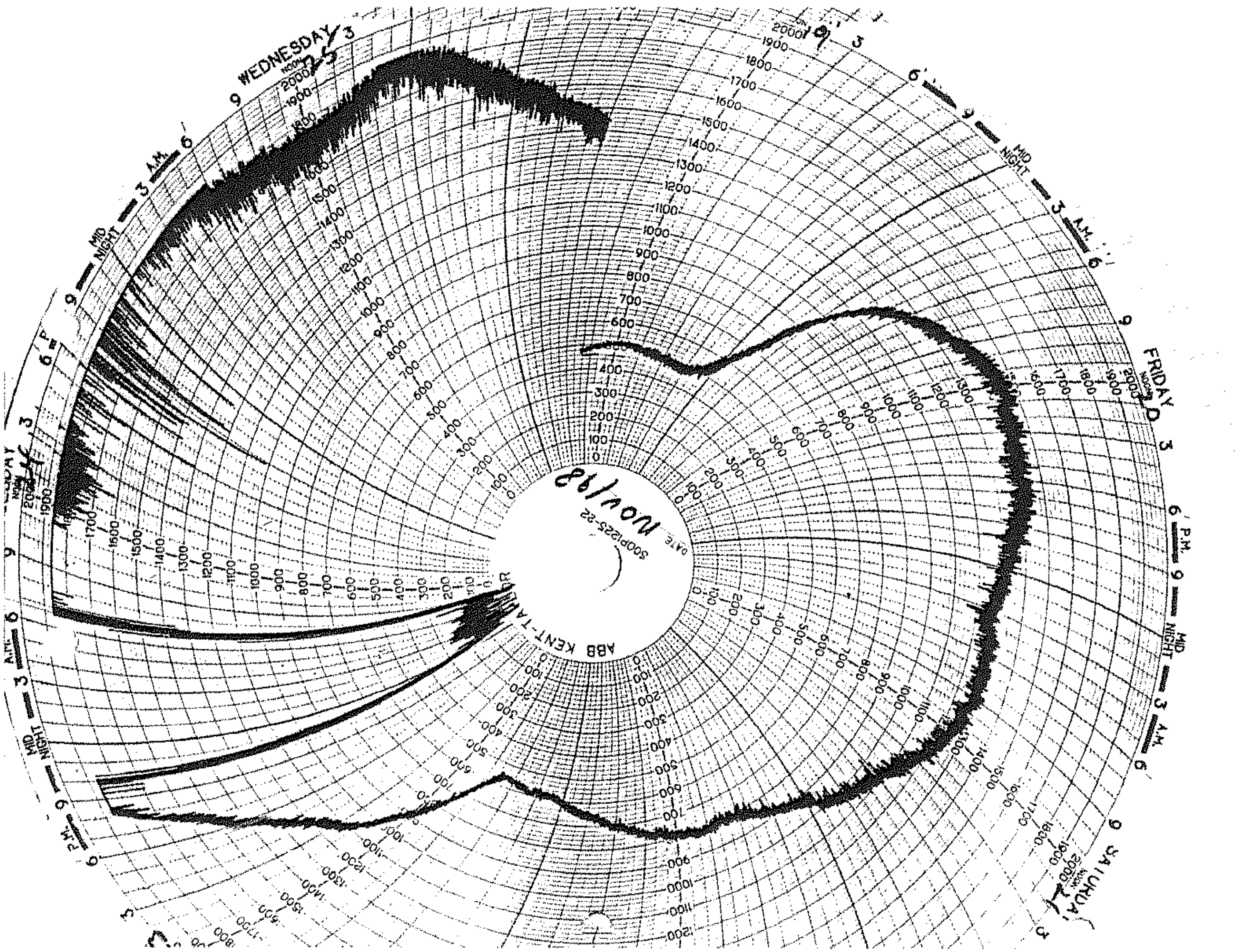
VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

AREA AVAILABLE
FOR WETLANDS

DATE: Nov, 2002

SCALE: 1:4,000

FIGURE 6.1

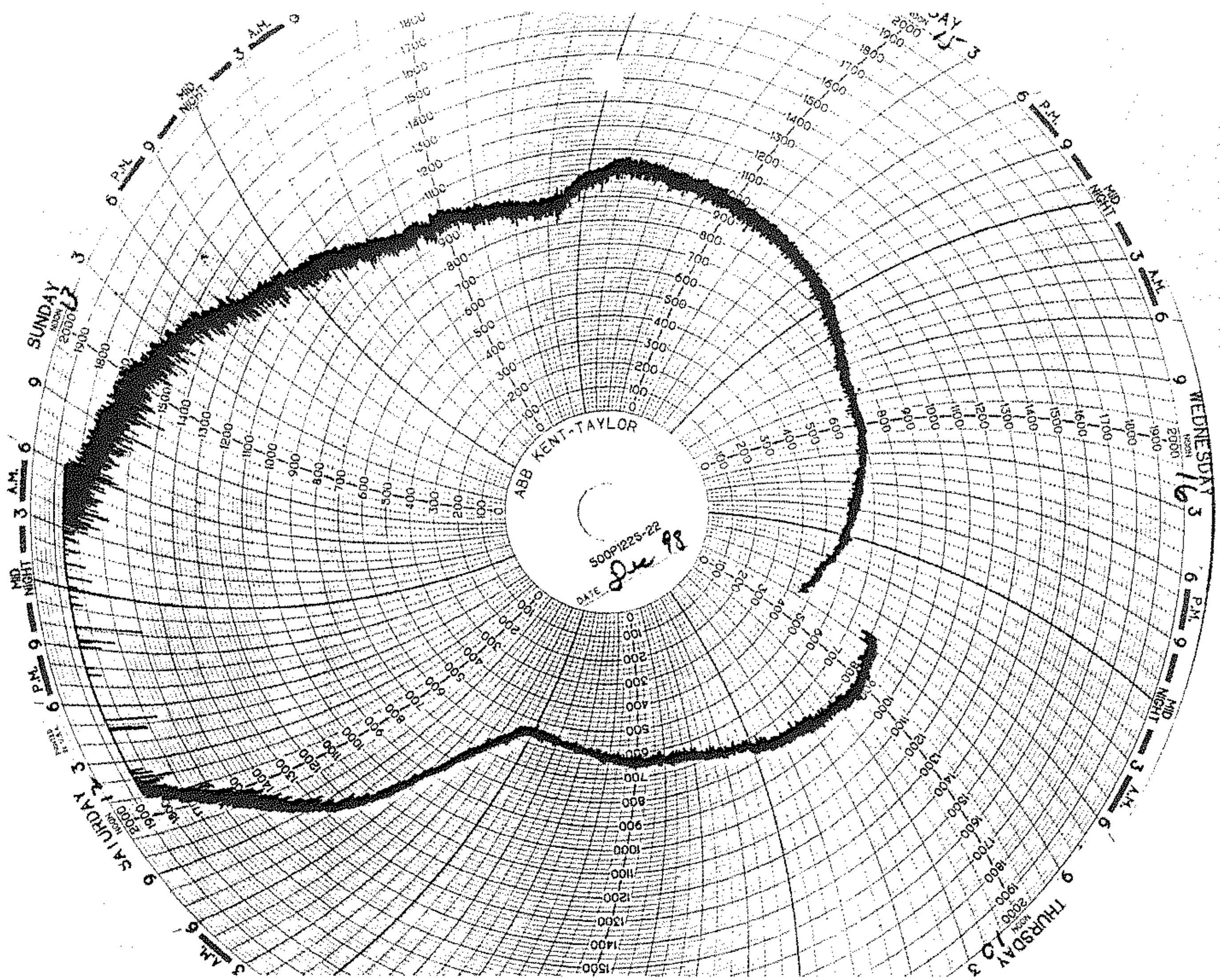


ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

FLOW RECORD
November 19 – 25, 1998

DATE: 99/12/21	FIG. 7.1
SCALE: 1:10,000	

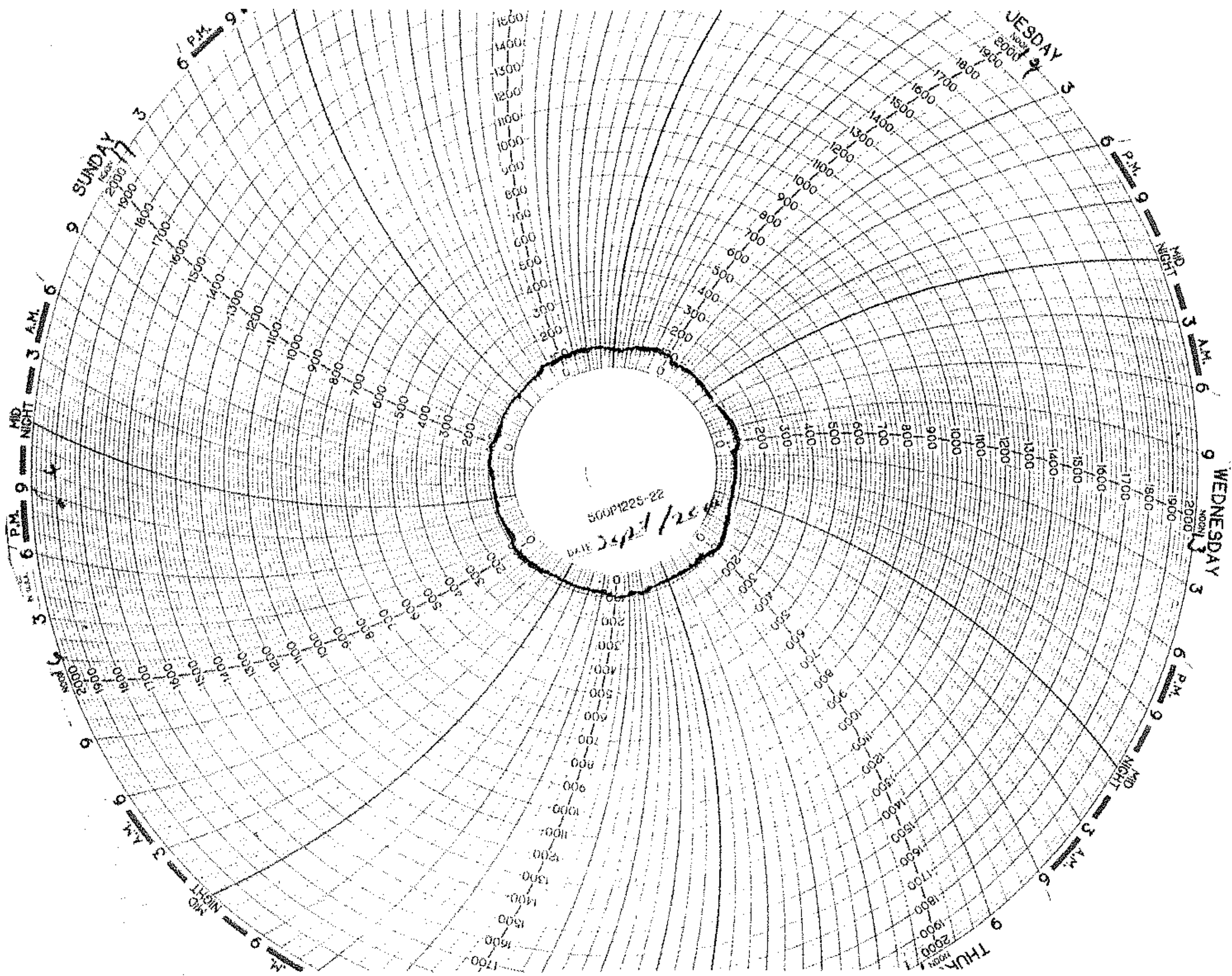


ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

FLOW RECORD
December 10 – 16, 1998

DATE: 99/12/21	**FIG. 7.2**
SCALE: 1:10,000	



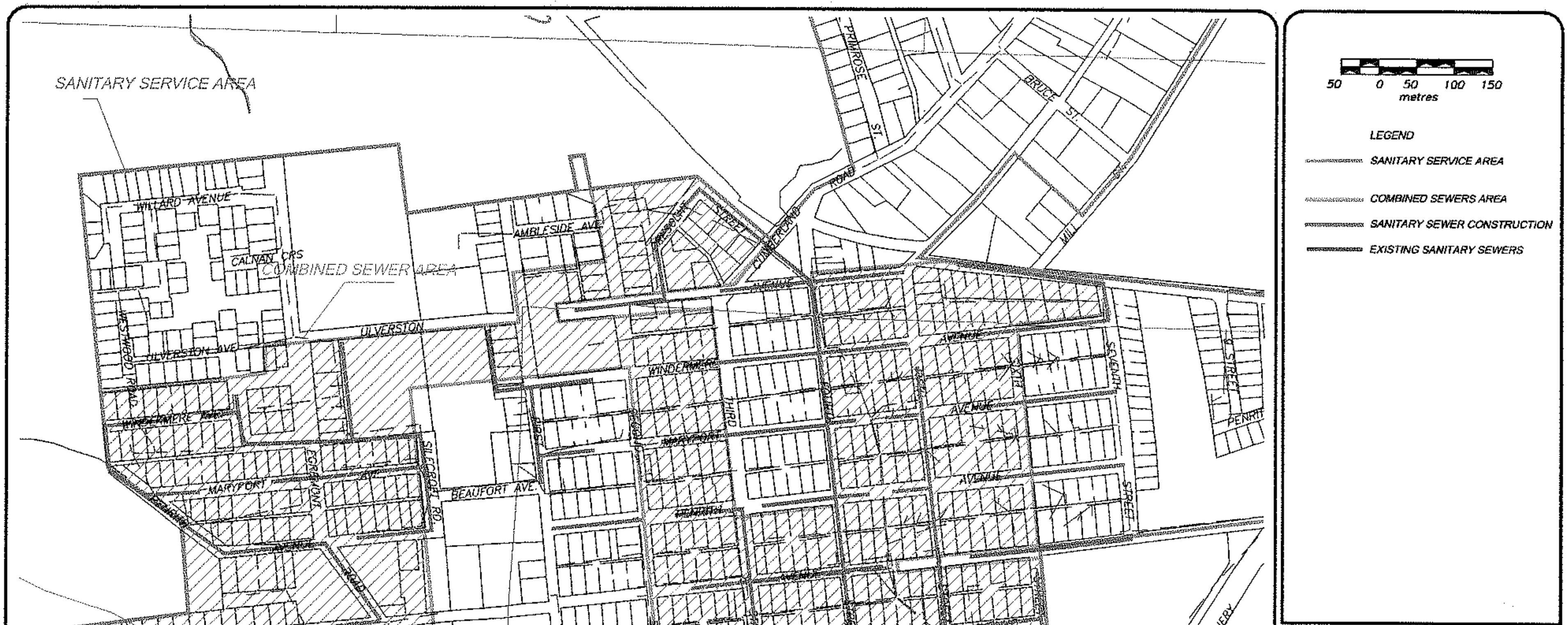
ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

FLOW RECORD
September 13 – 19, 2000

DATE:	99/12/21	FIG. 7.3
SCALE:	1:10,000	


SANITARY SERVICE AREA
COMBINED SEWER AREA
WILLARD AVENUE
CALNAN CRS
AMBLESIDE AVE.
ULVERSTON
ULVERSTON AVE
WINDERMERE AVE
MARYPORT
PENRITH
BEAUFORT AVE.
SILECROFT RD.
WINDERMERE
THIRD
FOURTH
FIFTH
SEVENTH
STREET
AVENUE
DERWENT
DERWENT AVENUE
SUTTON DR.
ALLEN
KESWICK
AVENUE
WELLINGTON
COLLIERY
COMOX LAKE ROAD
PLAN 27 RW
PRIMROSE ST.
BRUCE ST.
MILL ST.
OLD VILLAGE OF CUMBERLAND BOUNDARY (2002)
N
50 0 50 100 150
metres
LEGEND
SANITARY SERVICE AREA
COMBINED SEWERS AREA
STORM SEWER CONSTRUCTION
EXISTING SANITARY SEWERS
ANDERSON
Civil Engineering
VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2
STORM SEWER SEPARTION
ALTERNATIVE
DATE: March, 2002
SCALE: 1:5,000
FIGURE 8.1



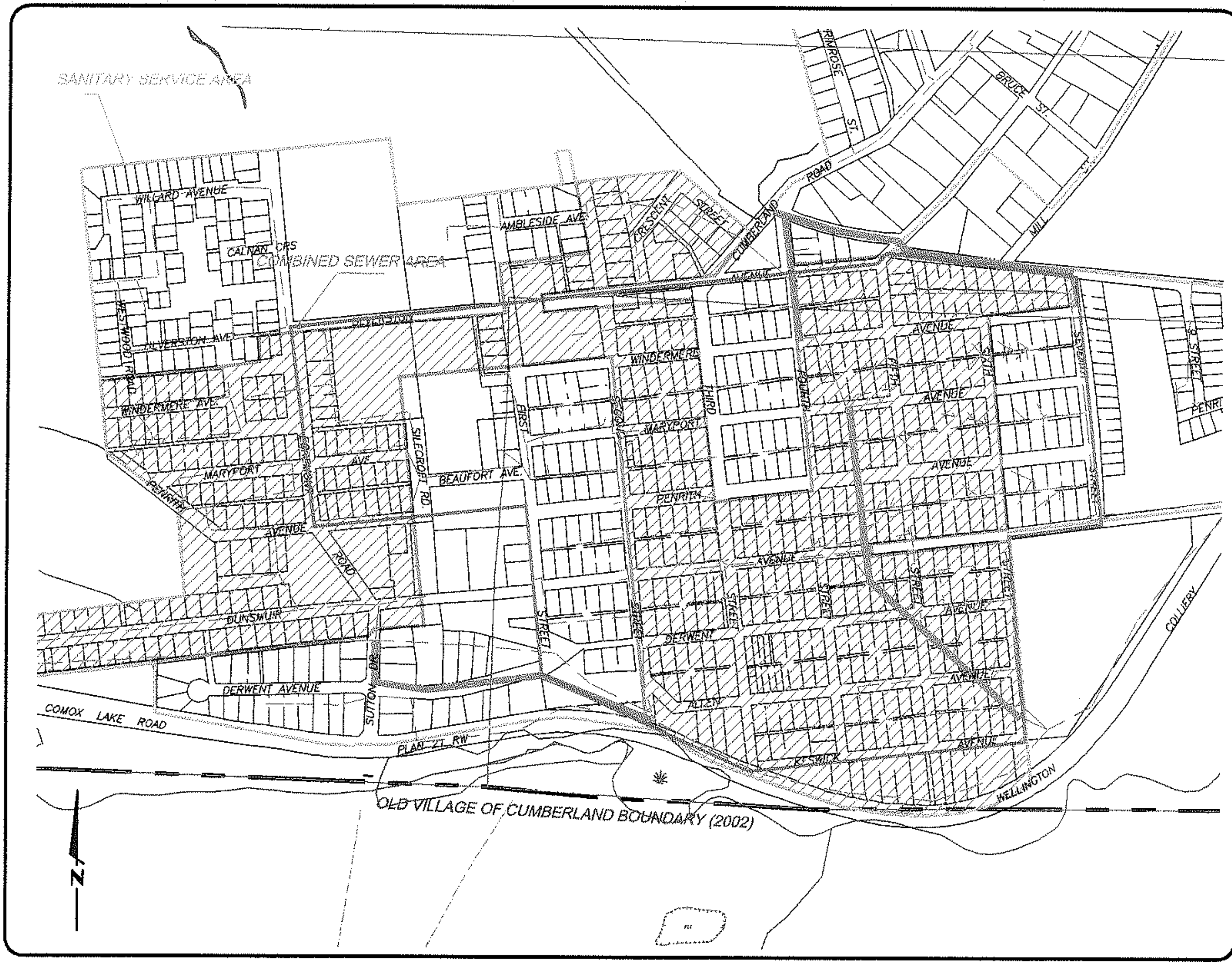
ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

SANITARY SEWER
SEPARTION ALTERNATIVE

DATE: March, 2002
SCALE: 1:5,000

FIGURE 8.2



50 0 50 100 150
metres

LEGEND

SANITARY SERVICE AREA
COMBINED SEWERS AREA
EXISTNG SANITARY SEWERS
UPGRADES FOR OVERFLOWS
REHABILITATION AREA FOR INFILTRATION

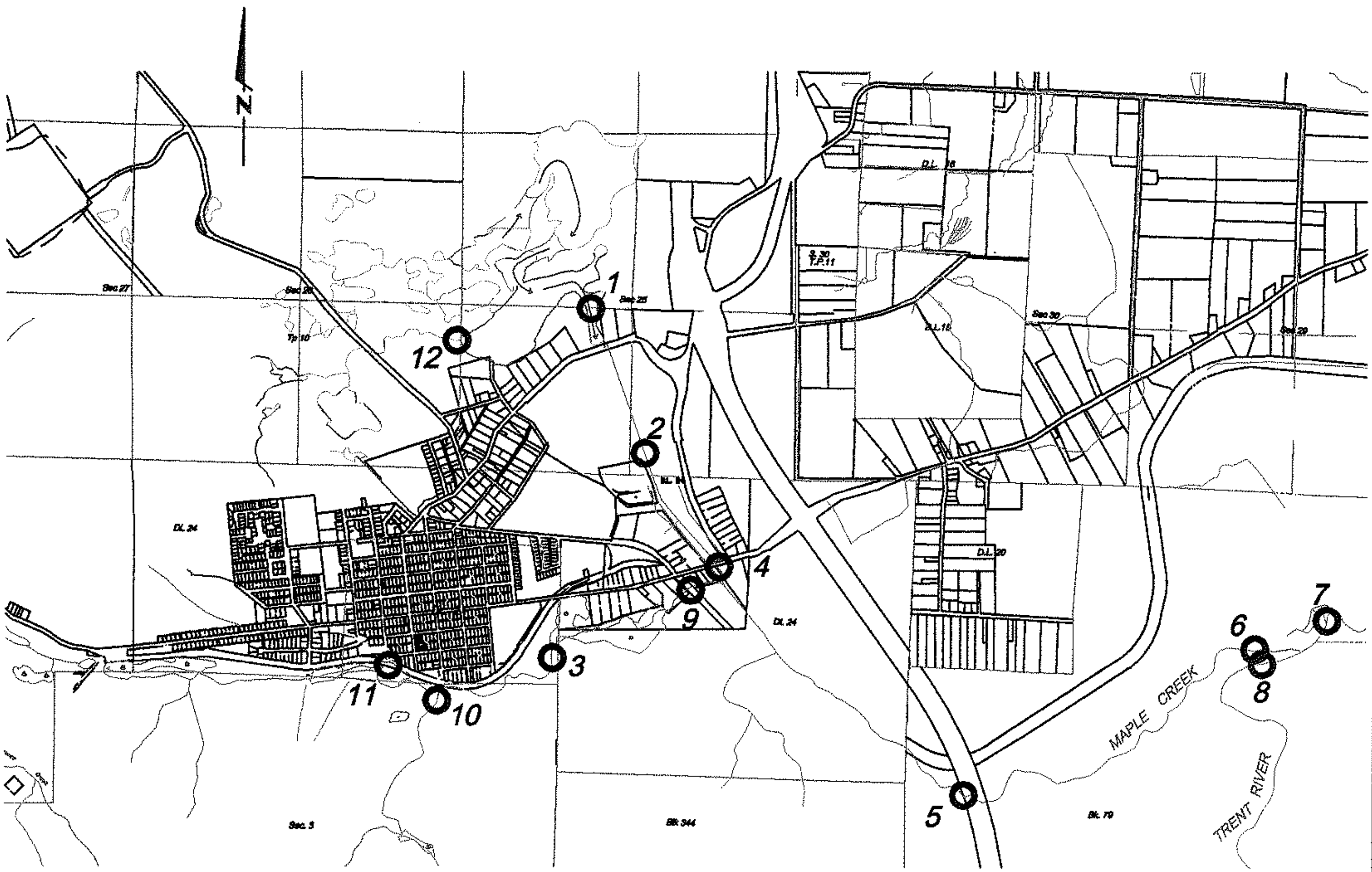
ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

UPGRADES FOR OVERFLOW
AND INFILTRATION

DATE: March, 2002
SCALE: 1:5,000

FIGURE 8.3



LEGEND / NOTES:

100 0 100 200 300
metres

ADDITIONAL TRENT RIVER SITES

(13) 400 m BELOW MLC

(14) 2,000 m BELOW MLC

(15) E & N RAILWAY

ANDERSON
Civil Engineering

VILLAGE OF CUMBERLAND
LIQUID WASTE
MANAGEMENT PLAN
STAGE 2

WATER QUALITY SAMPLING
LOCATIONS

DATE: April, 2002

SCALE: 1:20,000

FIGURE 20.1

APPENDIX D

LWMP Stage 2 Approval

Ministry of Water, Land and Air Protection - letter of approval dated April 11, 2003

BRITISH COLUMBIA

April 11, 2003

File: 76780-30/VCUMB

Village of Cumberland
2673 Dunsmuir Avenue
PO Box 340
Cumberland BC V0R 1S0

SENT BY FAX: 250 336-2321

ATTENTION: Mac Fraser, Manager of Operations

Dear Mr. Fraser:

Re: Village of Cumberland Liquid Waste Management Plan (LWMP) – Stage 2

Thank you for the letter dated January 23, 2003 sent on your behalf from Douglas Anderson of Anderson Civil Engineering and the attached reports entitled: "Village of Cumberland Liquid Waste Management Plan, Stage 2, Volume 1, Final Report" and "Village of Cumberland Liquid Waste Management Plan, Stage 2, Volume 2, Supplementary Documents."

Stage 2 of a LWMP should examine a number of options and associated costs in detail, include provisions for public input, and result in a draft waste management plan. I hereby approve the Stage 2 report and authorize the Village of Cumberland to proceed with Stage 3 of the LWMP. A number of issues, as outlined below, must be addressed in Stage 3.

1. Reclaimed Water Standards

Certain aspects of the requirements to meet reclaimed water standards (as per Schedule 2 of the Municipal Sewage Regulation (MSR) merit further consideration and discussion, as follows:

Chemical addition and filtration:
This part of the treatment train is meant to ensure that no viruses are present in the effluent. The MSR states that sixty day storage after secondary is acceptable in lieu of filtration under certain conditions.

. . . /2

Ministry of Water, Land and Air Protection

Vancouver Island Region

Mailing Address:
2080A Labieux Road
Nanaimo BC V9T 6J9

Telephone: 250 751-3100
Facsimile: 250 751-3103

The Village of Cumberland is proposing to sample for viruses as an alternative to including this part of the treatment train.

Emergency Storage:
The report indicates that the required 20 days of emergency storage are available in the summer months, but not in the high rainfall months. Please provide more detail as to how this storage is provided and for what time period.

Alternative Method of Disposal and Redundancy:
The report indicates that an alternative method of disposal (as per Section 10 (2) of the MSR) and duplication of the lagoons (as required in Appendix 1 to Schedule 7) for treatment will not be provided.

Effluent Quality:
Table 11.2 in the Stage 2 report includes the recommended effluent quality. Some of the effluent quality requirements in Schedule 2 are not met.

Other Issues to Consider:
Authorized Use: The MSR Section 10(7)(a) requires that the reclaimed water use be authorized in writing by the local health authorities having jurisdiction, or under a local service area bylaw.

Public Information: The MSR Section 10(8) requires that the reclaimed water provider provide information and communication materials in regards to reclaimed water use.

2. Draft Operational Certificate (OC)

The Stage 2 report includes a draft OC for the discharge from the Village of Cumberland sewage treatment plant. The following items should be considered in revising the draft OC during Stage 3.

Phosphorus and Ortho-phosphate Limit:
The OC specifies a discharge limit of 100 ug/L for orthophosphate during the summer period (May 1 to September 30). While this limit is based on the monitoring information that is available and seems like a reasonable target, there is no way of being certain that this limit will satisfy the goal of protecting Maple Lake Creek and the Trent River. Every river system is unique and will respond differently to the input of nutrients; therefore, the only way to determine if the amount of phosphorus going into the Trent River is acceptable, is to monitor the response in the receiving environment. Several years worth of data may be required to determine an ortho-phosphate limit. The OC will have to be worded appropriately, so that the receiving environment is protected in the interim.

. . . /3

Effluent Quality Limits:
There are discrepancies between some of the limits in the OC and the limits set in Table 11.2. The limits for nitrogen compounds should also be discussed.

Monitoring Requirements:
Section 3.1 of the OC outlines the requirements for discharge monitoring. The monitoring program, as presented, does not reflect the requirements of the MSR.

Section 3.2 of the OC outlines the requirements for receiving environment monitoring. The monitoring program, as presented, does not reflect the program outlined in the Stage 2 report. A site plan with the monitoring locations identified in the Stage 2 report would be helpful.

3. Design Issues

Winter Conditions:
To refine the design of the treatment works, winter discharge conditions should be further studied in Stage 3. Information on the flows in Maple Lake Creek and the Trent River are required to determine appropriate discharge standards for the winter period. If sufficient dilution is available, reclaimed water standards may not be required in the winter months.

Lagoon Performance:
The effluent quality from the lagoons is quite good all year long. Because of the relatively low HRTs (hydraulic retention times) during the winter months, it is possible that the good effluent quality occurs as a result of dilution rather than treatment. To determine if the lagoons are providing adequate pre-treatment prior to discharging to the wetlands, the lagoon performance should be further studied.

Flows:
The Stage 2 report includes design flows determined from different methods and applied to various aspects of the design. Please establish a relationship between the various design flows determined. The flows should be refined in Stage 3 to reflect the timing of sewer separation and other upgrades to the collection system, to ensure that the lagoons and wetland are sized accordingly for adequate removal.

Wetland:
The wetland design is still conceptual and should be more detailed in Stage 3.

The wetland design must ensure that the natural area to be preserved remains unaffected by changes resulting from construction of the treatment wetland. The Stage 2 report indicates that the natural fen/bog area should not be disturbed hydraulically. Also, there should not be any change in the nutrient composition to this area, according to the report by Ron Buechert (July 2001). The effect of draw down on the plants will need to be assessed, as discussed in the Stage 2 report.

. . . /4

4. Phosphorus Removal

We acknowledge that the Village of Cumberland is proposing an innovative way of achieving phosphorus removal by using a constructed wetland and that we will not know for certain how much phosphorus will actually be removed until the wetland has been operating for a period of time; however, an appropriate time frame for meeting the objectives of the LWMP will have to be set.

The Wetlands Pacific report (December 2002) indicates that Gearhart has found (based on data obtained from the constructed wetland in Arcata, California) that "At loadings of less than 1.5 kg/ha-day, with retention times of at least 15 days, an upper limit of 1.5 mg/L of orthophosphates can be annually removed". Table 7 in the Wetlands Pacific report indicates that removals as high as 2.25 mg/L are expected. Please explain this, as it seems to contradict the findings of Gearhart.

The Stage 2 report recommends that additional phosphorus removal be included, as the wetland is not expected to remove sufficient quantities of phosphorus to meet the effluent quality limits set to protect the Maple Lake Creek and the Trent River. The report recommends that source control and Lemna harvesting should be implemented now, and chemical phosphorus removal or another method be considered at a later date. In Stage 3, please specify timing for implementation of Lemna harvesting, source control and other treatment. Please review Section 20 of the MSR for guidance on what the source control bylaw should include.

5. Stormwater Management

In Stage 1, recommendation #10 includes activities to be implemented in regards to stormwater management. Please provide an update on the status of these activities or timelines for when they will be implemented as part of the LWMP.

With sewer separation being implemented, additional stormwater will need to be managed. The Village may be able to use the constructed treatment wetlands to pretreat and attenuate stormwater flows in the winter months. This will depend upon the effluent quality limits set for the winter months and the hydraulic capacity of the wetlands.

Please provide a plan in Stage 3 for the management of stormwater. You should consult the ministry document entitled: "Stormwater Planning: A Guidebook for British Columbia," at the following website:
http://wlapwww.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.html

6. Construction Costs and Schedule

Table 13.1 in the report outlines the recommended timing for implementing aspects of the plan, including extending some of the service area, upgrading the collection system,

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separating the combined sewer system and building a constructed treatment wetland. The table indicates that only part of the sewers will be separated by the time the wetland is fully built in 2006. Also, upgrades to the collection system for infiltration and exfiltration will not occur until after 2006, and will not be complete until 2020. Taking into consideration the hydraulic capacity of the treatment works, please provide technical justification for the timing of implementing these upgrades to the collection system. Please also provide a timeline for when all areas with on-site sewage systems will be connected, as requested in #13 of the Stage 1 approval letter dated June 13, 2001.

Table 13.1 includes estimated costs and timelines for implementing some aspects of the plan, but does not address all plan components. Issues like source control, stormwater management and biosolids management have not been included.

7. Waste Management Plan

Stage 3 should result in a LWMP being prepared and adopted by bylaw and in draft operational certificates. The LWMP should include an implementation schedule for all aspects of the plan, more detailed design and cost estimates and proposed financing arrangements.

Once Stage 3 is approved, a committee should be formed to monitor the progress of the LWMP. Stage 3 should include an outline of the structure and mandate of the committee.

8. Consultation

The Ministry of Water, Land and Air Protection considers public input to be one of the most important aspects of the waste management planning process. The plan should be flexible enough to be able to adapt to public input and new information obtained during the technical review. Please continue to provide opportunities for public review and input.

First Nations must be given ample opportunity to provide input to the plan. Please document any contact you make with them in regards to the LWMP and any input or response they provide.

9. Infrastructure Funding

We fully support the Village of Cumberland's request for infrastructure funding. Two major goals of the LWMP are to decrease the phosphorus loading to the Trent River and to produce reclaimed water for stream flow augmentation. To accomplish these objectives, a treatment process with several stages is required and the constructed wetland is an integral component of this process. The wetland has the potential to remove a significant amount of phosphorus it also provides a high quality effluent which can be used to supplement the low flows in the Trent River and enhance fish habitat. The recommended upgrades to the collection system, including sewer separation, are also required to ensure that the treatment system is not hydraulically overloaded.

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Congratulations on completing Stage 2. I commend the Village of Cumberland for its willingness to consider innovative approaches to solving a complex problem. We look forward to working with you in Stage 3.

Yours truly,

B.W. Medlar
Assistant Regional Waste Manager
Environmental Protection Division

cc: Douglas Anderson, Anderson Civil Engineering, fax: 250 754-~~1877~~ 4375
Eric Bonham, Ministry of Community, Aboriginal and Women's Services
fax: 250 ~~387-[illegible]~~ 356-7873

APPENDIX E

Classes of Cost Estimates

Classes of Cost Estimates for Capital Projects

A. Class A Estimate:

This is a detailed estimate based on quantity take-off from final drawings and specifications. It is used to evaluate tenders or as a basis of cost control during day-labour construction

B. Class B Estimate:

This estimate is prepared after site investigations and studies have been completed and the major systems defined. It is based on project brief and preliminary design. It is used for obtaining approvals, budgetary control and design cost control.

C. Class C Estimate:

This estimate, which is prepared with limited site information, is based on probable conditions affecting the project. It represents the summation of all identifiable project component costs. It is used for program planning; to establish a more specific definition of client needs and to obtain approval in principle.

D. Class D Estimate:

This is a preliminary estimate that, due to little or no site information indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs as identified in the construction cost manual for a similar project. It may be used to obtain approval in principle and for discussion purposes.

APPENDIX F

Disclaimer

DISCLAIMERS

- This report was prepared by Anderson Civil Engineering (the Consultant) for use by the Village of Cumberland. The material in it reflects the best judgment of the Consultant in light of the information available to the Consultant at the time of preparation. Any use that any third party makes of the report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. The Consultant accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.