Comox Valley
REGIONAL DISTRICT

COMOX VALLEY REGIONAL DISTRICT
SANITARY SEWERAGE MASTER PLAN

May, 2011

OPUS DAYTONKNIGHT

OPUS

McElhanney

COMOX VALLEY REGIONAL DISTRICT
SANITARY SEWERAGE MASTER PLAN

May, 2011

McElhanney

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This study is intended to assist the Comox Valley Regional District [CVRD] with long term planning of major sewerage system infrastructure. The Comox Valley has been experiencing rapid growth in past years and an analysis/assessment of existing core area sewer systems was deemed necessary. Initially, the scope of work was isolated to planning within the Comox and Courtenay 'core' area, over which the existing Comox Valley Sewerage Commission has jurisdiction. In the summer of 2008 the study mandate was expanded to cover most of the remainder of lands within the CVRD's jurisdiction. This expanded mandate included an assessment of options to best provide service to existing rural populations, and evaluation of system impact/requirements due a number of large potential land development projects within these same rural areas.

Prior work undertaken in 1979, by Associated Engineering, provided the overall core area system rationale and original CVRD sewerage system design outline. The CVRD is now roughly half way through the planning horizon established in the 1979 work. We note that treatment plant and pump stations were, by design, intended/sized to 25 a year design life only. This said, the CVWPCC has, over the past few years, undergone significant upgrading, in keeping with population growth and the 25 year initial construction treatment plant design capacities.

Population estimates for the core municipal areas have been completed, covering the 50 year study horizon. Similarly, estimates of population growth within development nodes to the north, and south of the core area have been produced. Based on these estimates, it has been determined that sewerage treatment will be required for 174,000 people, spanning the next 50 years.

Per client directive, the Sewer Master Plan was to incorporate the findings and recommendations of the 2005 Forcemain Realignment Study, completed by CH2MHill. The 2005 study was undertaken in response to the discovery of excessive erosion of the CVRD's foreshore forcemain's backfill material, adjacent to the Willemar Bluffs. Additional consideration was to be given to developing an alternate forcemain alignment, if technically feasible and cost effective.

Six route alternates were developed, and evaluated based on the cost, social/environmental, and technical merit. A twinning of the existing foreshore alignment, from the Courtenay River pump station to the proposed Docliddle station (core area route 6), ranked highest among alternatives considered.

Six overall system configuration options were developed to service lands outside of the core area. These options were generally grouped into *centralized* and *decentralized* treatment. Options 1, and 1A, both centralized treatment options, were developed based on the premise that all sewerage, regardless of origin, would be treated at the Comox Valley Water Pollution Control Center. Options 2, and 2A, were developed as decentralized treatment options. Option 2 proposed construction of three new sewage treatment facilities. Option 2a proposed construction of 6 new facilities, each located adjacent to a development node.

Evaluation of the first four overall system configuration options led to the development of two additional options, each designed to capitalize on specific flaws, inherent in Options 1 through 2A. Hybrid Options 3 and 3A were selected for further analyses.

Under Hybrid Option 3, sewage treatment for all developed areas within the CVRD study area, with the exception of Saratoga Beach, and Ships Point, would be provided through expansions to the CVWPCC. Sewage flows emanating in the Village of Cumberland, Royston, Union Bay, and remaining (northern) portions of Area A would be conveyed to a large pumping station located roughly at the intersection of Royston Road and Hwy 19A. This pump station would discharge via a submarine crossing of the Comox

Harbour to the proposed Docliddle station. An additional treatment plant would be constructed to service the hamlet of Saratoga Beach. Under Option 3, Ships Point is beyond the feasible service area of the CVWPCC.

Hybrid Option 3a is similar in most respects to Option 3. However, Option 3a proposes to construct a new treatment plant, in place of the Royston pump station and submarine crossing. Service to the Ships Point area is viable under Option 3a.

Based on cost, (both initial construction and 50 year net present value), social/environmental, and technical merit, Option 3a was selected as the preferred option. However, Option 3 remains a valid alternative to Option 3a, and should not be discounted until such a time as a marine outfall to Bayne Sound, or beyond, is proven feasible.

Further effort is required in order to advance sewerage system expansions throughout the CVRD, most notably:

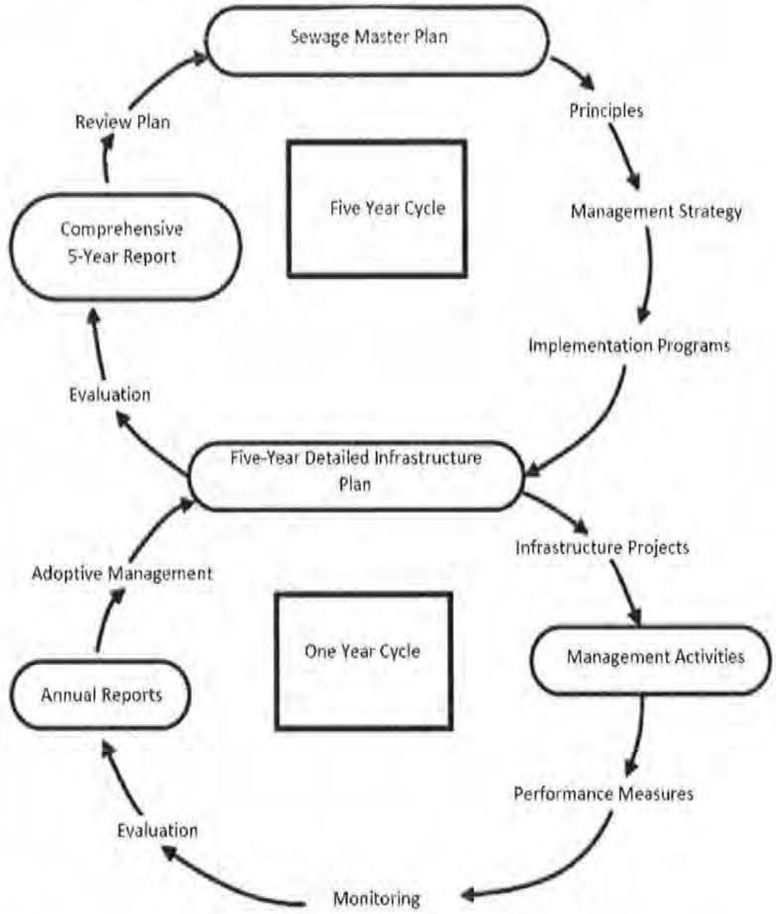
- Development of a governance structure for areas outside of the existing Sewerage Commission Mandate.
- Completion of Cumberland's Liquid Waste Management Plan.
- Detailed hydrogeological assessments of densely populated rural areas, and areas of known failing (onsite) septic systems to determine the required timing of regional sewage collection and treatment. Similar studies have been completed by Payne Engineering in support of past Liquid Waste Management Planning in the Union Bay/Royston Improvement District Area.
- Assessment of the condition, and remaining service life of the Willemar Bluffs section of forcemain, by a coastal engineering specialist. Past studies have indicated that remedial efforts completed to date may be reaching the end of their useful service life. The need for further remediation could affect the timing of the proposed Docliddle Station and associated works.
- Evaluation of opportunities for recovery and beneficial use of resources from wastewater treatment (e.g. reclaimed water, heat, biosolids, etc.)

2.0 INTRODUCTION

The Comox Valley Regional District sanitary sewage collection and treatment system was constructed and commissioned in 1984. The system was designed to accommodate flows from (then) presently developed areas, as well as future populations resulting from residential expansion and possible settlement into outlying areas. The system was designed on the basis of a 50 year operating life, with some components requiring upgrading or replacement as loads increased with time. These outlying expansion areas have, in the roughly 25 years since the Associated Engineering report was published, essentially become the new "core area".

The Sewer Master Plan update is one of four major regional planning initiatives being undertaken by the Comox Valley Regional District, including:

- The Comox Valley Sustainability Strategy;
- The Regional Growth Strategy;
- The Regional Water Strategy;
- And the Sanitary Sewage Master Plan.



The above strategies are to be integrated over time, in order to establish a comprehensive high level land use planning framework. This integration will require ongoing refinement of each initiative, as successive updates are undertaken, and/or land use projections are amended over time. It is imperative each regional strategy be consistent, both in terms of population projections, and its relative spatial distribution. The adjacent flow chart prepared by the CVRD's project manager illustrates the SMP context, within the regional sewer planning process.

The SMP was initiated prior to the development of the Regional Growth Strategy. Thus, the population projections contained herein represent a specific development/buildout scenario that may not exactly parallel the Regional Growth Strategy.

The development of a governance structure and policy was not part of the SMP scope. However, it is imperative this framework be established as soon as feasible. The apportioning of capital construction, operation, and maintenance costs cannot be decided in the absence of a governance policy. Similarly, achieving political buy in from those jurisdictions having alternative sewage treatment options may be difficult, if a clear understanding of voting structure, costing, etc is not available.

The agreed 50 year study horizon assumes an expanded service area will be established. In order to evaluate a variety of development and population growth scenarios, both core, and expanded [regional] areas have been established. Drawing C-1 overleaf, indicates the extents of the originally conceived "core area", along with the 2011 SMP study boundary.

2.1 Review of Past Studies

A large number of past reports were obtained from various sources throughout the preparation of the SMP. These studies have been catalogued, and are listed at the end of Section 2. The most recent reports covering each geographic area or system component are summarized as Appendix A.

The majority of these reference documents have been based on a significantly shorter design horizon, [i.e. up to 25 years vs. 50 years]. As such, adjustments have been assumed, particularly with respect to recommended population projections. Where information regarding confirmed or anticipated development is available, it has been incorporated.

Drawings S-6A and S-6B, (Appendix A) outline the essentials of past study results/recommendations. These drawings indicate the general study locations and recommended outcomes, for the expanded Comox Valley areas, and core areas respectively.

2.2 Technical Memos

This report presents, in part, a summary and synthesis of work undertaken in preparation of three required "Tech Memos", per the assignment terms of reference. Tech memos were prepared and submitted to the CVRD as follows:

Tech Memo #1 (TM1) – October 2008

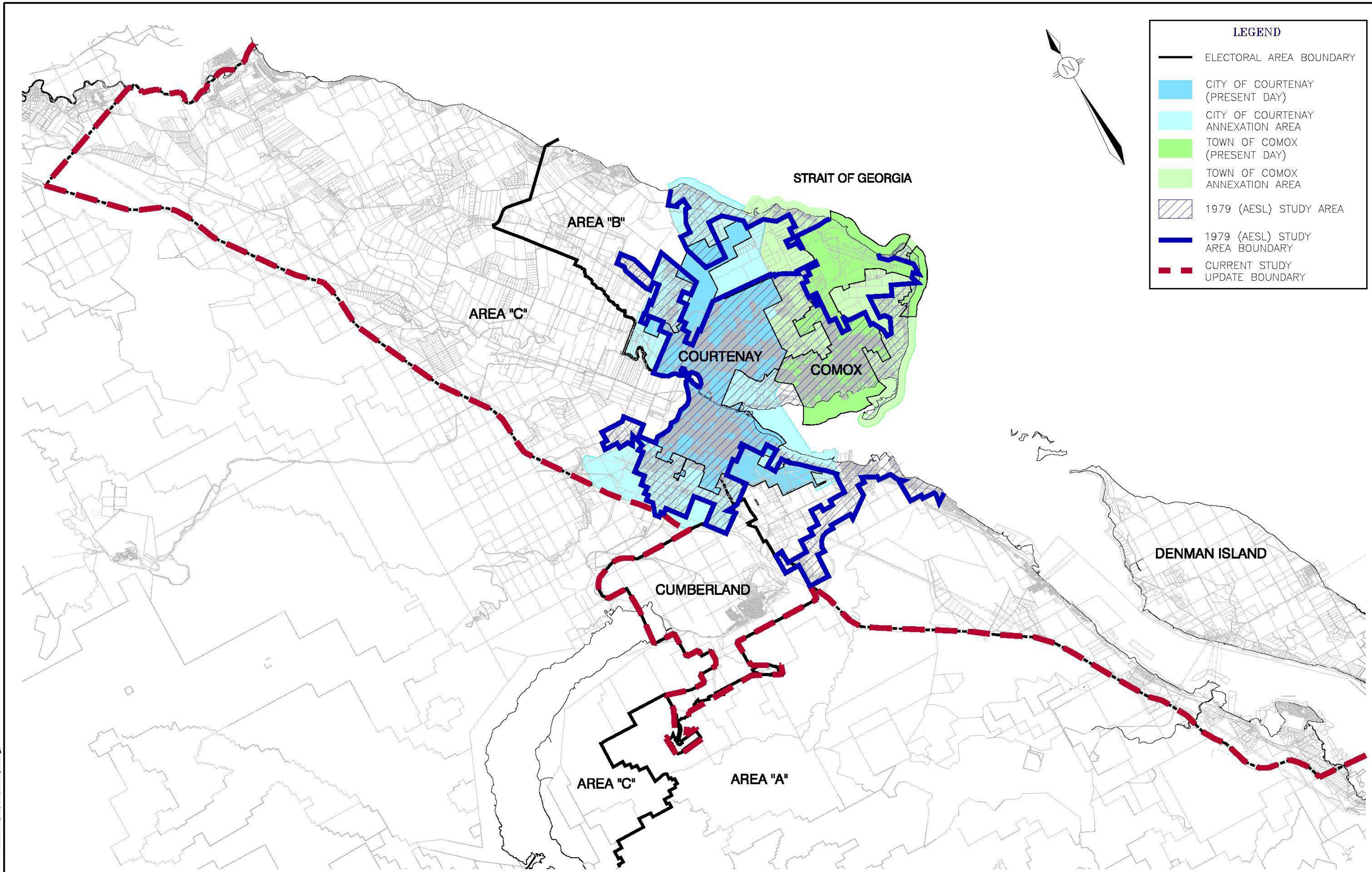
General Topics Include:

- Review of past study documents, flow records.
- Current system capacity analysis.
- Probable land use and settlement patterns.
- Population projections.
- Determination of per capita flow rates, design values.
- Inflow and infiltration analysis.
- Replacement timing for existing system components.

Tech Memo #2 (TM2) – December 2008

General Topics Include:

- Review of past CVRD LWMPs.
- Evaluate gravity diversion potential.



No.	Date	Revision	Dr.	Chk'd

McElhanney

McElhanney Consulting Services Ltd.

496 SIXTH STREET
COURTENAY, B.C. V9N 6V4

PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A	Checked: IW/BH	Date:21/FEB/2011
Drawn: CDE	Surveyed:N/A	

SCALE N.T.S.

Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

PREVIOUS STUDY AREA BOUNDARY VS. CURRENT STUDY UPDATE BOUNDARY

CVRD MASTER SEWERAGE STUDY

COMOX VALLEY, BC

Client Drawing No

MCSL Project No. 2211-46970-0

Drawing No. **C-1**

Sheet 1 of 4

Revision 0

Destroy all prints bearing previous number

Plotted: May 13, 2011 , 10:34:02 Filename: K:\ENG\46970\46970 Report2.dwg|C-1

- Willemar Bluffs pressure sewer decommissioning time line.
- Core area routing options.
- Overall system configuration options.
- Assess potential for outlying satellite treatment facilities.
- Comparison of satellite treatment plant construction/operation vs. pumping long distances.
- Municipal Sewage Regulation Discussion.

Tech Memo #3 (TM3) – March 2009

General Topics Include:

- Evaluation of core area route and overall system options.
- Integrated Resource Recovery (Management).
- Overall system funding.
- Cost estimates, net present value calculations, cash flow.
- Required CVRD Input (Regional Growth Strategy integration, cost recovery models, cost allocations, jurisdictional framework, etc).
- Development cost charge bylaw review.

Tech Memo #3 Revised (TM3R) – May 2009

General Topics Include:

- Tech Memo 3 content, separated into technical data & analysis, and governance/operational issues. The latter items were incorporated into the stand alone governance discussion paper, Appendix O.

Background detail and supplementary information contained in these tech memos is referred to throughout this report. It is assumed the reader has access to the three tech memos.

Table 1 – Summary of Background Reports			
Report Reference Number	**Date of Study**	**Author(s)**	**Title**
1	11/1979	Associated Eng.	Pre-Design report – Regional Sewerage Program RDCS
2	12/1979	Associated Eng.	Royston / Union Bay preliminary sewerage system review (PDF file = 'scan #4)
3	07/1991	Koers	Royston Sanitary Sewer Update (PDF file = 'scan #7')
4	1995	MCSL	City of Courtenay overall sewer system model and planning
5	11/1995	Stanley	Electoral Area "A" LWMP stage 1 (PDF file = 'scan #13)
5a	04/96	Stanley	Electoral Area "A" LWMP stage 1 (PDF file = 'scan #13)
6	04/2006	Stanley	Electoral Area "A" LWMP Final Report (PDF file = 'scan #12)
7	1997	MCSL	RDCS - Outlying areas servicing planning study, Anderton and Huband areas.
8	09/1998	unknown	UBID LWMP stage 1. (PDF file = 'scans #2, 5, 10.')
9	12/1999	Koers	UBID LWM committee sewage study (PDF file = 'scan #14')
10	12/2000	Motherwell	Union Bay secondary wastewater treatment options (PDF file = 'scan #11)
11	02/2001	unknown	UBID LWMP stage 2 (PDF file = 'scan #15')
	08/2001	Dayton and Knight	Comox Valley Sewage Commission – system condition overview
12	05/2002	Anderson	Royston LWMP stage 1 (PDF file = 'scan #9')
13	12/2002	MCSL	1995 study update for the City of Courtenay, overall system.
14	12/2004	Komex	Royston UBID marine disposal options (PDF file = 'scan #3')
15	01/2005	Komex	Royston/UBID sewage treatment options (PDF file = 'scan #6')
16	09/2005	Koers / Anderson / Komex / Payne	Royston/Union Bay collection / treatment / disposal study (PDF file = 'scan #1')
17	10/2005	CH2MHill	Forcemain realignment study
18	10/2005	EarthTech	C.V.W.P.C.C. Long Range Planning Review
19	11/2005	MCSL	Sandwick / HQ Road LAP – Sewer system
20	02/2006	MCSL	Meadowbrook / Huband LAP – Sewer system
21	04/2006	MCSL	Town of Comox original system modeling and planning
22	07/2006	Koers	Greenwood Trunk Sewer Concept planning update. RDCS = client
23	11/2006	MCSL	I&I update Town of Comox, calibration and revised capital plan
24	03/2005	Koers	Oyster Bay Saratoga LWMP
25	02/2008	Holland/Barrs	RD Sustainability Plan Draft Document
26	01/2004	EBA for MCSL	U.B.I.D. Hydro-geological study (PDF file = 'scan #8')
27	03/2004	MCSL	U.B.I.D. water system - 20 year capital plan (PDF file = 'scan #16')
28	05/2007	Koers	NE Comox SWMP
29	10/2007	Payne	Cape Lazo Sewage Study

3.0 EXISTING SYSTEM

3.1 Core Area Population

Present day populations were provided by the City of Courtenay ("the City") and the Town of Comox ("The Town)". 2006 Census data, adjusted to account for interim development, form the basis of this information. Planning staff from the member municipalities have indicated their 2006 populations were 22,500, in Courtenay, and 12,500 in Comox. In order to develop historic per capita flow rates, it has been assumed that population growth over the preceding four years has been relatively constant, at 4%.

3.2 Core Area, Per Capita Flow Rates

In order to establish present day per capita flow rates, raw flow data was analyzed, as obtained from the Comox Valley Water Pollution Control Center, and the CVRD's major pump stations. To simplify the analysis, several assumptions were made, including:

- Existing per capita residential flow rates have been expressed inclusive of Industrial, Commercial and Institutional (ICI) flows, noting that within most jurisdictions of moderate population, the relative proportion of ICI flows generated tend to remain constant over time, independent of increase in population.
- Residential Full Time Equivalent (FTE) population has not been used in the derivation of per capita sewerage flows. Briefly, the FTE concept allows for the apportioning of daily per capita flows generated outside of the home to the appropriate node within the collection system. It is legitimate to assume herein that modeled population either live and work within the same municipality, and/or those who travel outside the municipality for work are offset by an incoming work force. We believe this simplifying assumption to be appropriate, introducing only a very small margin of error.
- Existing population data, provided by the respective member municipalities, has been utilized. This data is based on the latest census data, adjusted to account for interim population growth.

Determination of the constituent sewerage components (inflow and infiltration, vs. dry weather sanitary), has been approached two ways. Method 1 is intended to isolate the domestic sewerage component of the total wastewater flow. The second method approaches the problem from the opposite perspective, isolating I&I from total flow data. Detailed descriptions of these methodologies can be found in TM1.

The following tables summarize the flow rates derived.

Table 2 - Summary of Flow Values - Method 1					
	Average Annual Per Capita Flow	Per Capita Sewerage Rates	Per Capita I&I Flows*	Mean Domestic Sewerage Rate	Mean I&I Rate
	(l/cap/day)	(l/cap/day)	(l/cap/day)	(l/cap/day)	(l/cap/day)
Courtenay					
2004/2005	384	190-250	134-195	220	165
2005/2006	384	222-273	111-162	248	137
2006/2007	383	198-256	127-184	227	156
2007/2008	347	189-240	106-158	215	132
Comox					
2004/2005	428	190-250	178-238	220	208
2005/2006	410	222-273	137-158	248	248
2006/2007	428	198-256	172-230	227	227
2007/2008	378	189-240	138-189	215	215
CFB Comox					
2004/2005	597	278-222	319-375	250	347
2005/2006	562	285-229	277-333	257	305
2006/2007	680	307-259	373-421	283	397
2007/2008	608	360-309	248-299	334	273

*Inferred I&I values are simply the difference in average annual flow and calculated sewerage flows.

Table 3 - Summary of Flow Values - Method 2					
	Average Annual Per Capita Flow	Per Capita Sewerage Rates	Per Capita I&I Flows*	Mean Domestic Sewerage Rate	Mean I&I Rate
	(l/cap/day)	(l/cap/day)		(l/cap/day)	(l/cap/day)
Courtenay					
2004/2005	384	161-213	172-224	198	187
2005/2006	384	191-231	154-194	174	211
2006/2007	383	151-199	184-232	208	175
2007/2008	347	154-198	149-192	171	176
Comox					
2004/2005	428				
2005/2006	410				
2006/2007	428				
2007/2008	378	Insufficient Data			
CFB Comox					
2004/2005	740				
2005/2006	696				
2006/2007	843				
2007/2008	753	Method Not Valid			

Flow rates produced via the above methods are not exact (they cannot be, given the limitations inherent in the available flow data). They do however provide a range of values for use in system analysis.

The flow data derived for Courtenay appears to be consistent with expected values for both domestic loads and I&I flows. Domestic sewerage rates over the four year period analyzed are between 171 and 248 l/cap/day, (averaging 208 l/cap/day). This range has been cited in previous local studies as a realistic estimate of sewerage flows.

Flow measurement equipment at the Jane Street pump station is located on the outlet side of the station. This arrangement only allows for the measurement of pump rates (not influent flows, as is the case in the Courtenay and CFB pump stations). Without influent flow rates, minimum and peak instantaneous flow rates cannot be determined, thus calculation per the two methods identified above is not possible. However, it is reasonable to assume that per capita dry weather sewerage flows are similar to those in Courtenay, and therefore the incremental increase in average annual (per capita) flow rates experienced in Comox over time are due to higher I&I rates. Past municipal system studies and flow monitoring completed by MCSL corroborate this assumption.

3.3 Existing System Condition and Capacity

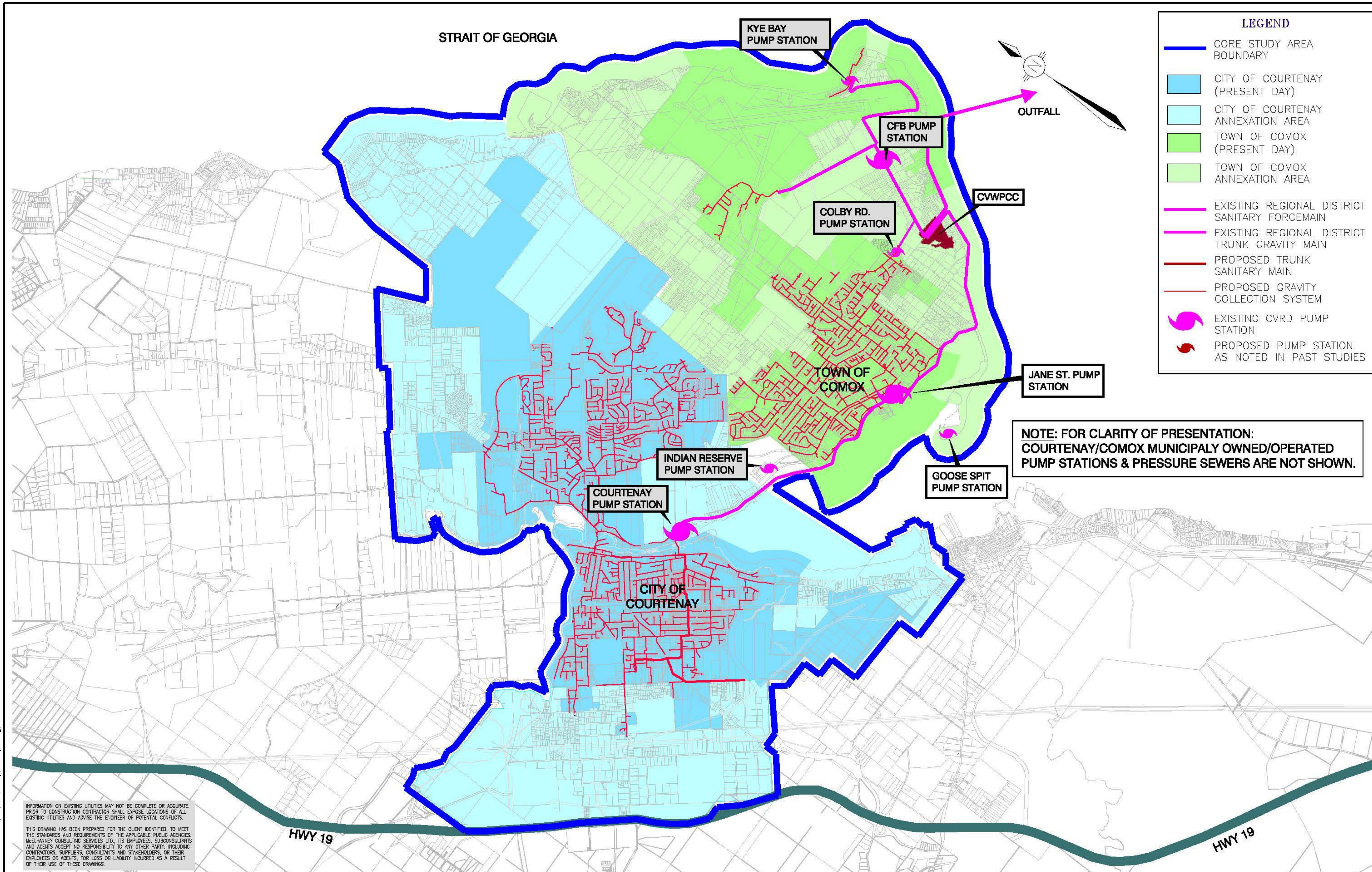
In order to assess the existing capacity of the various CVRD system components, a hydraulic model has been prepared utilizing the United States Environmental Protection Agency's Storm Water Management Model (SWMM) software. Very briefly, the SWMM software is a dynamic hydraulic modeling application, capable of single event, or extended period simulation. The platform was selected in large part due to its widespread usage, and the software's capability with respect to modeling multiple pump systems.

Geometric input has been derived primarily from as built drawings provided by the CVRD. Pump curves and control logic for each of the three modeled pump stations has also been supplied by the CVRD. A number of simplifying assumptions remain in the preliminary system model. For example, peak pump output is currently modeled at the Courtenay station. In addition, the attenuating effect of influent line storage has not yet been modeled.

Primary components of the CVRD's existing conveyance system having been modeled include:

- The Comox Valley Water Pollution Control Center (point of discharge).
- Courtenay River Pump Station.
- Comox (Jane Street) Pump Station.
- CFB Comox Pump Station.
- Foreshore Forcemain (from Courtenay pump station to CVWPCC).
- CFB Forcemain.
- CFB Gravity Sewer.

Drawing S-7 overleaf, indicates the relative locations of the CVRD collection and treatment system within the core area.



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

THIS DRAWING HAS BEEN PREPARED FOR THE CLIENT IDENTIFIED, TO MEET THE STANDARDS AND REQUIREMENTS OF THE APPLICABLE PUBLIC AGENCIES. McELHANNEY CONSULTING SERVICES LTD., ITS EMPLOYEES, SUBCONSULTANTS AND AGENTS ACCEPT NO RESPONSIBILITY TO ANY OTHER PARTY, INCLUDING CONTRACTORS, SUPPLIERS, CONSULTANTS AND STAKEHOLDERS, OR THEIR EMPLOYEES OR AGENTS, FOR LOSS OR LIABILITY INCURRED AS A RESULT OF THEIR USE OF THESE DRAWINGS.

Filename: K:\ENG\46970\final amp\46970-Report1.dwg\S-7

Plotted: May 13, 2011 , 14:41:08

No.	Date	Revision	Dr.	Chk'd

McElhanney

McElhanney Consulting Services Ltd.

496 SIXTH STREET
COURTENAY, B.C. V9N 6V4

PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A | Checked: IW/BH | Date: 01/OCT/2008

Drawn: TM | Surveyed: N/A

SCALE 1 : 30,000 (APPROX.)

Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

EXISTING SANITARY SYSTEM CORE AREA

CVRD MASTER SEWERAGE STUDY

COMOX VALLEY, BC

Client Drawing No

MCSL Project No. 2211-46970-0

Drawing No. S-7

Sheet 8 of 13 | Revision 2

Destroy all prints bearing previous number

Although the model is sufficiently accurate for the purpose of this high level planning assessment, further calibration is desirable.

Generally, recorded flows over the preceding four year period have increased with time. Flow variations, including decreases in some years over the previous, are also evident. Given the limited sample size, and recognizing that data has not been normalized to account for changes in precipitation year to year, we do not recommend drawing conclusions regarding future flow rates based solely on this information.

3.3.1 Conveyance Model Results – Pump Station Capacities

Table 4, overleaf, contains a summary of operational issues noted by CVRD staff at each major pump station. Note the derivation of constituent flow components, i.e. sewerage vs. I&I, can be found in Memo 1. Additional details follow.

CFB Comox Pump Station

The CFB pump station has been designed to accommodate a short to mid-term inflow of 110 l/s, based on the current arrangement of 3 – 35 HP pumps. Long term, the intended capacity of the pump station is 200l/s, based on 3 – 46 HP pumps.

Peak pump station influent has been measure in excess of 80 l/s. Given the size of the CFB catchment, and modest number of people contributing to the sewerage flows, I&I in the CFB catchment is concerning. However, CVRD staff has noted no operational issues with the CFB pump station.

Courtenay Pump Station

System curves have been developed for the Courtenay River pump station. Based on modeled results:

- The Courtenay pump station is capable of pumping 475 l/s against a total system head of 27.7m when Jane Street is not pumping.
- With Jane Street pumping at a maximum rate of 210l/s, the Courtenay station can pump 325 l/s against a total head of 29m.
- The Courtenay pump station is expected to handle peak wet weather flow under present day conditions without the Jane Street station pumping; however, limited wet well capacity at both stations preclude alternating station operation during periods of peak flow.

Jane Street Pump Station

System curves have also been developed for the Jane Street pump station, the results are as follows:

- A maximum pump rate of 135 l/s at 21.8m head can be achieved concurrent with Courtenay pumps running at 340 l/s.
- A maximum pump rate of 215 l/s at 21.5m is possible when the Courtenay station is not pumping.

Table 4 - CVRD Sewerage Conveyance System Summary		
System Component	**Description**	**Operational Issues Noted**
Courtenay River Pump Station	3 x 200 HP VFD Flygt Pumps	Pumps Plug With Regularity
	2 in Service at Any Given Time	Wet Well Storage Time < 15 min (during peak flow conditions)
	Wet Well / Dry Well Design	Corrosion of Steel Outlet Pipe
	Soft Start / Stop Operation = Yes	Potential Corrosion of Inlet Pipe
	Standby Power = Yes	No Overflow/Bypass
Jane Street (Comox) Pump Station	3 x 77 HP Flygt CP 3201 MT Pumps	H_2S Present Due to HMCS Force Main Connection
	2 in Service at Any Given Time	Corrosion of Pumps, Wet Well, etc noted
	Wet Well Design	Some Odour Present
	Soft Start / Stop Operation = No	
	Standby Power = Yes	
CFB Pump Station	3 x 35 HP Flygt CP 3300 MT Pumps	None
	2 in Service at Any Given Time	
	Wet Well Design	
	Soft Start / Stop Operation = No	
	Standby Power = Yes	
	350mm Dia Ductile Iron Forcemain	

Notes:

- Operational issues are per Jim Elliot, CVRD Manager of Wastewater Operations
- Component descriptions per as built records provided by the CVRD

Present day, peak wet weather flows tributary to the Jane Street station are expected to greatly exceed the maximum pump rate noted above. We believe this is defensible/plausible, noting that peak flows are likely not completely coincidental in Comox and Courtenay, given geographic locations, times of concentration of flows, etc. Additionally, wet well and line storage within the Jane Street system are likely capable of attenuating flows, particularly given the nature of peak wet weather flows within this catchment, i.e., inflow rates are high, but elevated flow rates do not persist for extended periods, thus overall volumes entering the pump station are effectively conveyed.

CVRD staff has indicated that during periods of high intensity, or prolonged precipitation, the Jane Street station pumps nearly continuously. It is recommended that flow measuring apparatus be installed on the inlet side of the pump station, in order to more accurately determine maximum required pump rates.

An inspection of the three CVRD lift stations was jointly undertaken by MCSL and CVRD staff on September 29, 2008. Minutes generated from the inspection have been attached as Appendix B, along with other meeting notes compiled to date.

3.3.2 Forcemains

Based on a maximum allowable velocity of 2.5m/s, CVRD pressure sewer capacities are summarized as follows:

- CFB Comox = 192 l/s
- Foreshore, Courtenay to Jane Street = 1100 l/s
- Foreshore, Jane Street to Goose Spit = 1350 l/s
- Foreshore, Goose Spit to CVWPCC = 1350 l/s

It is expected, particularly in the case of the Willemar Bluffs portion of the foreshore forcemain, serviceability issues will dictate replacement timing, rather than capacity. However, operating pressures required to achieve maximum capacity based on velocity may exceed suggested operating ranges. Determining the maximum safe operation pressure of the main should consider the varying (and changing) depths of cover, and history of breaches. Table 5, overleaf, contains a summary of forcemain capacities, geometry and operational issues.

3.3.3 Gravity Systems

The CFB gravity sewer consists of approximately 2200m of gravity main, varying in size from 375mm in the upper reaches to 600mm downstream. The majority of the line is 600mm at 0.12%. No other gravity sewers are yet owned or operated by the CVRD.

Table 6, double overleaf, provides a summary of line capacity. Note it is expected the CFB system will not have sufficient capacity to allow for full build out, without upgrading. Based on population and flow estimates developed in forthcoming sections, the anticipated year of replacement is 2029. However, should I&I rates within CFB Comox be reduced, deferral may be possible. We understand the Department of National Defense is contemplating a major infrastructure renewal project which could improve I&I rates.

Table 5 - CVRD Sewerage Conveyance System Summary					
System Component	Description	Operational Issues Noted	Peak Flow	Present Day Forcemain Velocity	Maximum Operation Capacity (Based on 2.5m/s Max Velocity)
			(l/s)	(m/s)	(l/s)
Forcemain, CFB Line	350mm Ductile Iron	None	83	0.86	192
Forcemain, Courtenay PS to Jane St.	750mm Hypres-con	None	375	0.85	1100
Forcemain, Jane St. to Goose Spit	860mm Hypres-con	None	491	0.85	1350
Forcemain, Goose Spit to CVWPCC	860mm Hypres-con	Erosion of Beach at Willemar Bluffs Resulting in Insuffi-cient Cover	600	1.03	1350

Notes:
-System component descriptions and operational issues provided by CVRD staff
- Present day forcemain velocities based on theoretical maximum pump rates, per MCSL SWMM model of CVRD system

Table 6 - CVRD Gravity Sewerage Conveyance System Summary									
System Component	**Manhole Number**	**Description**	**Operational Issues Noted**	**Peak Measured Flow**	**Pipe Diameter**	**Pipe Slope**	**100% Gravity Sewer Capacity**	**80% Gravity Sewer Capacity**	**Remaining Operational Capacity**
				(l/s)	(mm)	(%)	(l/s)	(l/s)	(l/s)
CFB Gravity Sewer (as modeled)									
Pipe 140	SMH 18 to SMH 17	375mm dia Concrete	None	83	375	1.97	246	197	163
Pipe 130	SMH 17 to SMH 16	375mm dia Concrete	None	83	375	1.55	218	175	135
Pipe 120	SMH 16 to SMH 15	375mm dia Concrete	None	83	375	1.26	197	157	114
Pipe 150	SMH 15 to SMH 14	450mm dia Concrete	None	83	450	0.73	244	195	161
Pipe 110	SMH 14 to SMH 13	450mm dia Concrete	None	83	450	0.44	189	151	106
Pipe 90	SHM 13 to SMH 4	600mm dia Concrete	None	83	670	0.12	285	228	202
Pipe 100	SMH 4 to CFB PS	600mm dia Concrete	None	83	600	0.12	213	170	130

Notes:
- System component column refers to MCSL SWMM model component
- Infrastructure descriptions, geometry etc from CVRD as built mapping
- Peak Measured Flow = the maximum inflow rate at the CFB Comox pump station, based on flow records provided by the CVRD
- Sewer capacities derived utilizing a Manning's "n" value of 0.013

3.3.4 Courtenay River Siphon

The Courtenay River siphon appears to function as designed, and the CVRD has not noted any operational issues. The siphon system consists of a cast in place concrete inlet structure at the end of 21st Street adjacent to the Courtenay River, two PVC conduits (600 & 350mm dia.), and an outlet structure immediately upstream of the Courtenay pump station. Allowance has been made for a third, 250mm dia. conduit. Based on the inlet arrangement, the combined capacity of the two lines is 670 l/s, with no surcharge in the inlet chamber. The combined capacity increases to 760 l/s when 0.4m of surcharge is achieved in the inlet chamber. Present day (peak) flows into the siphon are estimated to be 300 l/s., and ultimate, full build out flows are expected to reach 500l/s. Thus the siphon appears to have sufficient capacity to allow for build out of the catchment. The first domestic connection to the 21st Street sewer leading to the siphon is roughly 20m upstream of the inlet structure, and located at an elevation of 3.38m, geodetic. Based on upstream service locations, blockage of the 600mm dia. siphon, or excessive surcharge, could result in damage to private property.

It is recommended the CVRD undertakes routine flow monitoring in the 21st Street system, to ensure tributary flows are as expected. If west Courtenay sewerage rates increase beyond that predicted in this study, utilizing the third conduit within the siphon structure may be required.

3.3.5 Treatment Plant Capacity Analysis

Assessments of the CVWPCC and the Cumberland wastewater treatment facilities are attached as Appendices C and D. Provided below is a brief summary of salient points noted therein:

Brent Road Plant:

Opus DaytonKnight's preliminary assessment of the CVWPCC capacity is provided below. Major components of the assessment includes:

- Analysis of plant flow and load data from the past 5 years, and designation of per capita loading rates to be used for setting future expansion requirements.
- Analysis of plant performance data based on MSR requirements.
- Discussion of regulatory issues related to the permit and the Municipal Sewage Regulation (MSR). Further discussion is in the memo "Recent Evolution of Regulatory Framework" in Appendix F.
- A description of the treatment facility components.
- An assessment of the existing capacity of major components of the treatment plant, and comparison with the current loading on these components.

The following are the main conclusions:

- The plant often exceeds its permitted maximum discharge rate. This occurred on 28 days in 2007. The CVWPCC is considering registration under the Municipal Sewage Regulation (MSR), which will replace its current discharge permit.

- I&I typically causes an exceedance of a 2.0 multiplier between average dry weather flow and maximum day flow. At the CVWPCC peak, wet weather flows often exceed 3, and 4 times average flows. Further I&I reduction will likely be required to comply with MSR registration, if pursued.
- Table 7 gives the current utilization of the existing capacity of each major treatment system component, and also the total population that can be serviced by that component. The figures presented in this table all take into account the process reliability (redundancy) requirements (if any) of the MSR for a Category II facility. For example, the MSR requires the secondary clarifiers at a Category II facility to have sufficient capacity to treat at least 75% of the design maximum flow with the largest unit out of service. Further discussion of the basis of these numbers can be found in Appendix C.
- Upgrade is required to meet the MSR redundancy requirements, and takes into account the recently constructed 3rd basin. Implementing the redundancy requirements of the MSR, the aeration basins were at 90% of capacity under 2008 loading. Without the redundancy requirements, the basins are at 79% of capacity. This is based on the peak HRT criteria of 4 hours at maximum month flow.
- The configuration of the expansion (e.g. expansion of existing process units, construction of a new parallel plant or a combination of the two) should be determined at the pre-design stage.
- The existing treatment plant site could easily accommodate a doubling of plant capacity and, with the utilization of space saving technologies, perhaps more.

Table 7 – CVWPCC Capacity Summary

Process	Current Flow/Load as % of Installed Capacity	Installed Service Population
Mechanical Bar Screens	52%	71,000
Grit Removal Tanks	40%	91,000
Primary Sedimentation Tanks	79%	46,000
Aeration Basins	90%	40,000
Secondary Clarifiers	80%	45,000
Effluent Pump Station and Outfall	78%	47,000
Gravity Thickeners	100%	36,000
DAF Thickener**	100%	36,000
Centrifuge Dewatering	38%	96,000

**DAF capacity analysis has been updated based on new information presented by the CVRD (as at May 2011)

CVWPCC Outfall Capacity:

The outfall has a stated capacity of 60,000 m^3/d to 65,000 m^3/d (42 m^3/min to 45 m^3/min) with the effluent pump station operating (Earthtech construction drawings, Secondary Treatment Expansion Project, May 2007). A review of flow data at the CVWPCC from 2003 to 2007 carried out for this Master Plan showed that the highest sustained (3 hours or more) peak wet weather flow (PWWF)of about 52,000 m^3/d (36 m^3/min) occurred during 2006. The average of the highest sustained (3 hr) PWWF recorded during each year from 2003 to 2007 was about 47,000 m^3/d (33 m^3/min). The highest instantaneous PWWF of about 66,000 m^3/d (46 m^3/min) also occurred during 2006; however, the sustained (3 hr)

PWWF is probably the more relevant measure for outfall capacity, since some buffering of instantaneous peaks will occur in the effluent pumping basin.

Based on a sustained (at least 3 hour duration) PWWF of about 47,000m^3/d for the current contributing population of 36,500 people, it is extrapolated that the outfall will have capacity for 47,000 people with the effluent pump station operating. If outfall capacity is based on maximum day flow rather than sustained PWWF (current maximum day flow is about 35,000 m^3/d), the outfall with the effluent pump station operating could service approximately 65,000 people.

Information recently provided by CVWPCC operations staff showed that an extreme wet weather flow event occurred at the plant on December 24, 2010, when flow exceeded the capacity of the plant flow meter (50 m^3/min), and it was observed that the water level in the effluent pumping basin rose to within 75 mm of overflow, despite the fact that both pumps were running at full capacity. It appears that the plant flows were at or beyond the outfall capacity on that day; the CVRD should undertake further review of wet weather flows, collection system I&I reduction, and outfall discharge capacity to ensure that adequate capacity for future growth is available.

Cumberland's Treatment System:

Opus DaytonKnight's preliminary summary provides the following:

- Presentation of influent flows.
- Presentation of loads [BOD, TSS, various nutrients, etc] now experienced.
- A description of the treatment facility components.
- Overall system performance as relates to permitted values. It is noted that overall influent volume exceeds the permitted value by a factor of almost three. In addition, it has been reported that fecal coliform were well above allowable levels during winter months. Conversely, total phosphorous was above allowable levels in all but the winter months.
- Significant upgrades are necessary to bring the plant into compliance.

3.4 Recent Evolution of Regulatory Framework

Wastewater discharges in British Columbia in excess of 22.75 m^3/d are regulated under the Municipal Sewage Regulation (MSR) of the Environmental Management Act. The MSR (administered by the B.C. Ministry of Environment) sets out criteria for discharges to surface waters, ground disposal, and use of reclaimed water. The MSR also sets out standards for process reliability (process redundancy/standby capacity). The MSR standards were used in this Master Plan to develop concept designs and costs for wastewater treatment, and to assess the capacity of existing CVWPCC facilities (assuming discharge to Category II receiving waters as defined in the MSR).

The reclaimed water components of the MSR are currently being updated by the Ministry of Environment (tentatively scheduled to be implemented December 2011). Many of the proposed MSR revisions are matters of clarification for reclaimed water use; significant changes include increased flexibility regarding the storage and alternate disposal requirements for reclaimed water.

For discharges to open marine waters, the MSR requires a minimum of secondary treatment (maximum effluent concentration of BOD_5 and TSS 45 mg/L. Additional restrictions may apply if shown to be necessary by an Environmental Impact Study (EIS) of the discharge, which is required for registration under the MSR.

The Canadian Council of Ministers of the Environment (CCME) has developed a strategy for establishing national effluent quality standards, resulting in the proposed *Wastewater Systems Effluent Regulations* under the Fisheries Act. The proposed National Effluent Regulations will apply in a phased approach to discharges of 10 m^3/d or more, and require effluent average concentrations of 25 mg/L for BOD_5 and TSS, maximum residual chlorine 0.02 mg/L, and un-ionized ammonia less than 1.25 mg N/L (the total ammonia corresponding to 1.25 mg N/L un-ionized ammonia according to supporting information supplied with the draft National Effluent Regulations would range from about 50 mg N/L at pH 8 to about 450 mg N/L at pH 7). For discharges greater than 17,500 m^3/d, the effluent average concentrations of BOD_5 and TSS will be calculated on a monthly basis.

The CVWPCC discharge is currently regulated by the B.C. Ministry of Environment under Permit PE-5856, which specifies a maximum discharge of 18,500 m^3/d with maximum effluent concentrations of 45 mg/L for BOD_5 and 60 mg/L for TSS. The current maximum day discharge from the CVWPCC exceeds the permitted limit by a wide margin (e.g., the 2007 maximum day discharge exceeded 30,000 m^3/d); therefore, the discharge will have to be registered under the MSR, at which point the existing Permit will be cancelled.

The CVRD intends to register the discharge from the CVWPCC under the MSR. A pre-registration meeting with the Ministry has been held, and a two-stage EIS for a projected maximum day discharge of up to 49.6 Ml/d[1] from the CVWPCC outfall has been completed by WorleyParsons (July, 2010). The EIS showed that, based on modeled dilutions and receiving water characteristics, the minimum treatment standards set out in the MSR for open marine discharges will be sufficient to meet relevant water quality standards. The addition of effluent disinfection was recommended to protect shellfish beds (chlorine, ultra violet, or ozone).

For the CVWPCC, It is expected that facilities designed to meet the MSR criteria for effluent discharges to open marine waters for BOD_5 and TSS would also meet the monthly averages required by the new National Effluent Regulations. Removal of ammonia should not be required under either regulation. If disinfection using chlorine is added to the plant, de-chlorination to meet the new National Effluent Regulations will be required.

3.5 Existing Collection System Inflow and Infiltration

3.5.1 I&I Due to System Age

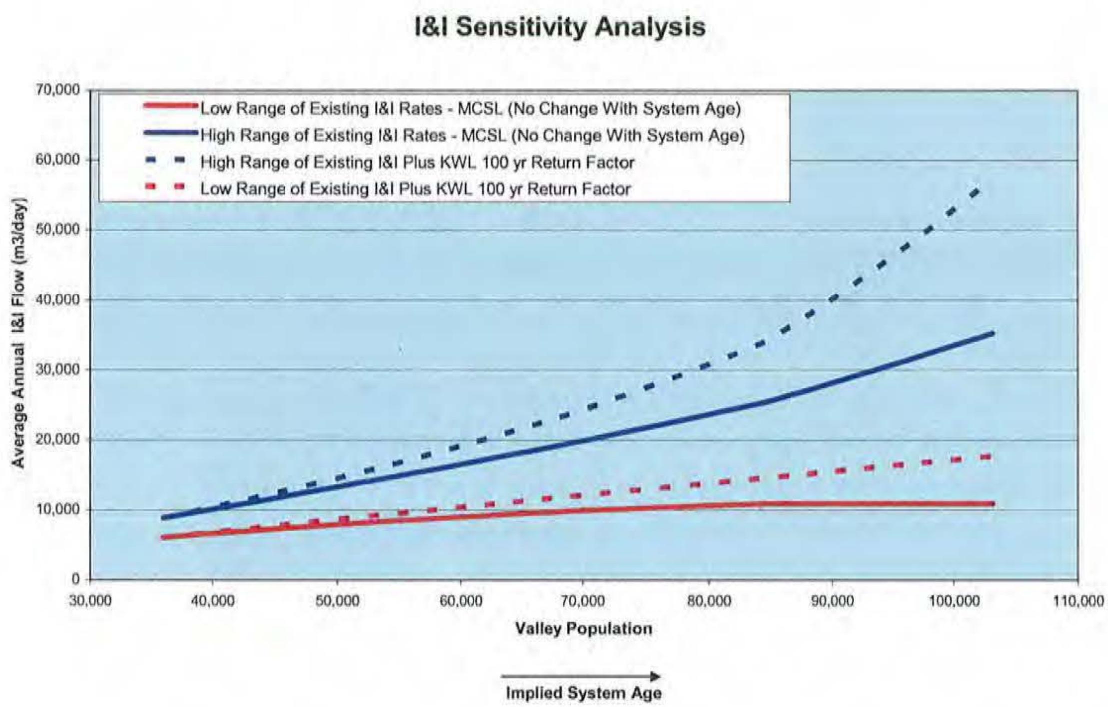
In 2005, Kerr Wood Leidal Associates Ltd. (KWL) authored a study for the Capital Regional District entitled *"I&I Rates and Sewer Infrastructure Age: Is There a Strong Correlation?"* The study sought to establish a correlation between sewer system age and I&I rates, utilizing the Rainfall Dependent Inflow and Infiltration Envelope (RDI&I-E) method. The RDI&I-E method is a graphic statistical method that allows for the forward projection of I&I rates using known rainfall events and corresponding sewer flows observed during these events.

The study found that the age of pipe is indeed the prime indicator of I&I, not material composition or construction methodology as was once thought. The range of I&I rates over time, as produced by the KWL formula, are dramatic in comparison to the design values utilized by most municipalities. As can be seen in the tabulated values, I&I rates projected at a system age of only five years already exceed cur-

[1] The 2007 ADWF rate measured at the CVWPCC was 13.1 Ml/d

rent long term design values within the member municipalities.

Discussions with Courtenay engineering and public works staff suggest an average system age of 30 years. Comox staff have indicated their system roughly of similar age. Based on the KWL formula, we would expect the **peak** I&I rates in each of the member municipalities to be in the order of 0.38 l/s/ha. Based on flow data in hand, it appears that Courtenay's average annual I&I rate is in the range of 0.02 to 0.03 l/s/ha, and upwards of 0.16 l/s/ha in **peak** wet weather conditions. Comox flow rates are higher yet, 0.05 to 0.07 l/s/ha average annual, and upwards of 0.41 l/s/ha during peak wet weather conditions.



The above graphic provides a comparison of the upper and lower range of current I&I rates as noted in the SMP, compared to the rates that could potentially be realized, with the application of the KWL system age factor. The exponential relationship between system age and I&I rate is noteworthy.

Table 8, below, provides a comparison of existing and anticipated I&I rates based on geographic location. The anticipated rates noted reflect the assumption that the CVRD and member municipalities are committed to reducing I&I in the short term, and maintaining modest rates into the future. For comparative purpose we have included flow rates calculated using the KWL formula.

Table 8 - Probable Inflow and Infiltration Rates by Geographic Area						
Municipality	Catchment Description	Approximate System Age	Estimated I&I Rate Based on Flow Records	I&I Rate per KWL Study		Governing (Long Term) Design Value
		(yr)	(l/s/ha)	(l/ha/day)	(l//s/ha)	(l/s/ha)
Courtenay	East Courtenay	15	0.16	n/a	n/a	0.17
	West Courtenay	30	0.16	32,755	0.38	0.17
Comox	Tributary to Jane St PS	30	0.41	32,755	0.38	0.41
	Tributary to CFB PS	30	1	32,755	0.38	1
Cumberland	New Development	n/a	n/a	n/a	n/a	0.17
	Existing Combined Areas	75	8	141,398	1.64	8
CVRD	New Development	n/a	n/a	n/a	n/a	0.17

Notes:

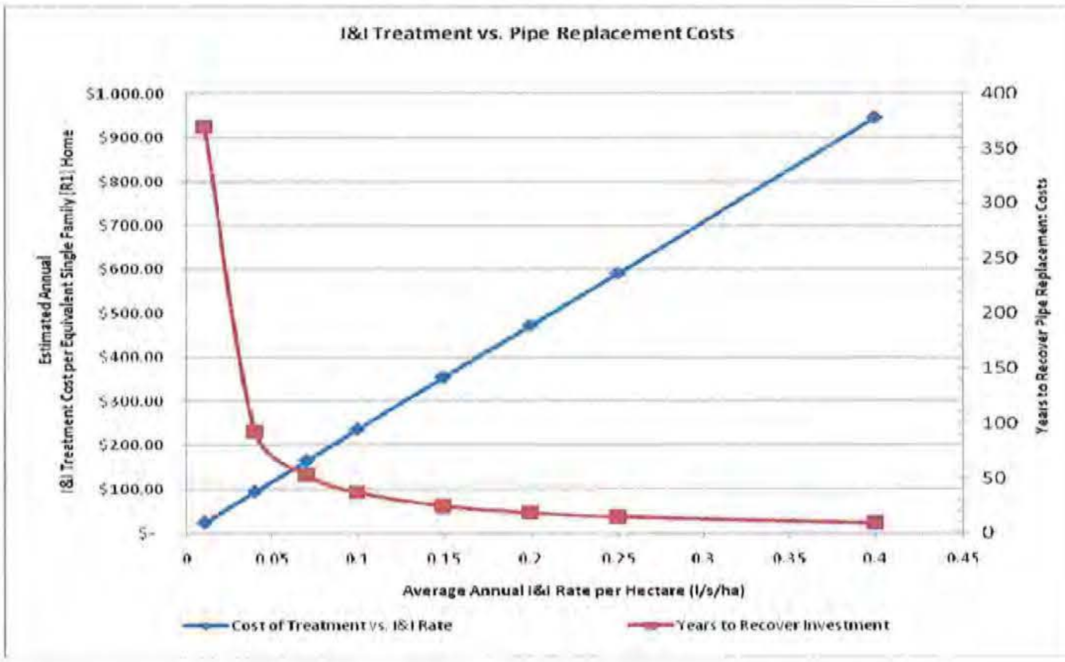
- Governing long term design value = the criteria that will be utilized in flow projections over time.
- Courtenay I&I rate of 0.16 l/s/ha based on flow data provided by CVRD
- Comox (Jane Street) I&I rate of 0.41 l/s/ha = composite rate for Comox based on flow monitoring and modeling
- Comox (CFB) I&I rate of 1.0 l/s/ha assumes that total tributary area is 72 ha, gross area = 580 ha, less 508 ha for base, CVAC
- Cumberland I&I rate of 8.0 l/s/ha per Village of Cumberland LWMP, and is inclusive of combined sewerage areas.
- Estimated system ages provided by respective municipalities
- "CRD Study" refers to the 2005 CRD report entitled "I&I Rates and Sewer Infrastructure Age: Is there a Strong Correlation?" wherein I&I rates long term were estimated using the formula: $I\&I_{100} = 12{,}355e^{(0.0325 \times \text{sewer age})}$

The highest I&I reduction returns per dollar invested typically come in the early years of I&I reduction programs. Cross connected catchbasins, roof drains and the like are readily identifiable through smoke or dye testing and contribute significantly to peak wet weather flows. The costs associated with remediation of these cross connections, particularly catchbasins, is relatively small.

Beyond the immediate relief provided through redirection of cross connections, reduction in I&I, particularly the infiltration component, becomes costly. Over time, as gravity sewers age, gaskets begin to fail, roots penetrate, and new connections of suspect workmanship are made, all causing ground water infiltration to increase. Short of lining, or replacing these sewers, there is little that can be done to cost effectively reduce base infiltration in existing sewers. The following graphic illustrates the potential cost recovery timeline for replacing local collector sewers in single family (R1) areas. Note this graphic is based on a very specific scenario, including:

- Single family, R1 sized lots
- Existing 200mm dia sewers, no AC pipe removals
- New pipe installation costs of $350 per metre
- Sewage treatment costs of $0.67/m3 (provided by CVRD)

- No allowance for the time/value of money
- No consideration of cost savings achieved through the deferral of otherwise needed (capacity driven) treatment plant expansion/component replacements.



The analysis, although very simplistic, illustrates the protracted break even dates for infiltration influenced pipe replacements. Prior to initiating pipe replacement projects, it is recommended that full consideration be given to not only economic criteria, but also social, environmental, and regulatory requirements.

3.5.2 I&I reduction Targets

Many jurisdictions have found that significant amounts of storm water inflow are being introduced to the sanitary system through basement sump pumps that have been cross connected. These specific cross connections are often unidentifiable through smoke testing, and thus very difficult to isolate, unless rigorous inspection and reporting programmes are implemented.

Better construction practices, including video inspection, pressure testing, manhole exfiltration testing etc., will have an effect on long term I&I rates in areas of new construction. However, prudent engineering practice would suggest realistic I&I reduction and design targets be established. Underestimating long term I&I rates could accelerate the need for sewer replacements due to capacity shortfalls. The need to understand infrastructure service life, in the context of the Public Sector Accounting Board (PSAB) requirements, is now increasingly becoming a priority of municipalities and sewage treatment purveyors. I.e., the need for communities to now allocate sufficient funds for the replacement of existing infrastructure, could be significantly impacted by the need to prematurely replace sewage collection system, for instance. Table 9, below illustrates recommended target I&I rates for each member municipality.

Table 9 - Target I&I Reduction Rates & Associated Flow Reductions in Existing Collection Areas							
Point of Connection to CVRD System	Subcatchment Description	Approximate Subcatchment Area	Current Peak I&I Rate	Target I&I Rate		Potential Reduction in Peak Flows	
				Short to Mid Term	Long Term	Short to Mid Term	Long Term
		(ha)	(l/s/ha)	(l/s/ha)	(l/s/ha)	(l/s)	(l/s)
Courtenay River Pump Station	West Courtenay	800	0.22	0.17	0.17	40	40
	East Courtenay	1150	0.12	0.12	0.17	0	n/a
Jane Street Pump Station	1	182	0.37	0.3	0.3	12	12
	2	105	0.70	0.5	0.4	21	32
	3	38	0.37	0.3	0.3	2	2
	4	90	0.37	0.3	0.3	6	6
	5	233	0.37	0.3	0.3	15	15
					Total	**56**	**67**
CFB Comox Gravity Sewer	Existing Collection Area	72	1	0.5	0.4	36	43

Notes:

- Courtenay I&I rates (east and west) are inferred from overall existing peak I&I rate of 0.16 l/s/ha. The relative age of east Courtenay infrastructure is significantly less than west Courtenay, I&I rates have been estimated based on this differential.
- Comox I&I rates in catchments tributary to Jane Street pump station are is indicated in the 2007 Town of Comox I&I Study.
- CFB Comox I&I rates have been estimated based on flow data provided by CVRD staff, and the assumption of an effective tributary area of 72 ha.
- Long term target I&I rates assume that efforts to reduce I&I over time will continue, but will likely only offset the increase in system I&I due to increasing age.

I&I rates, although commonly measured on a unit area basis, should also be considered in the context of flow per capita, with respect to development density. As density increases within a given catchment, the proportion of total peak wet weather, and average annual flows attributable to I&I, on a per capita basis, decreases. The various methods of calculating per capita sanitary sewer loading utilized by local municipalities provide significantly differing flows, as illustrated in the following Table 10.

Table 10 - Sanitary Design Criteria Comparisons: Various Densities, Total Population of 100							
	Design Criteria Summary	Area	I&I	PDWF	Total Flow	Peak Wet Weather Flow	
		(ha)	l/s	l/s	l/s	l/cap/day	l/ha/day
City of Courtenay/ Town of Comox							
10 people per ha	360 l/cap/day	10.00	0.60	1.77	2.37	2046	20,461
20 people per ha	I&I = 0.06 l/s/ha	5.00	0.30	1.77	2.07	1787	35,738
40 people per ha	PF = Harmon	2.50	0.15	1.77	1.92	1657	66,291
MMCD							
10 people per ha	300 l/cap/day	10.00	1.70	1.13	2.83	2444	24,438
20 people per ha	I&I = 0.17 l/s/ha	5.00	0.85	1.13	1.98	1709	34,188
40 people per ha	PF = Graphic (3.2)	2.50	0.43	1.13	1.55	1342	53,688
City of Campbell River							
10 people per ha	300 l/cap/day	10.00	0.60	1.47	2.07	1791	17,915
20 people per ha	I&I = 0.06 l/s/ha	5.00	0.30	1.47	1.77	1532	30,645
40 people per ha	PF = Harmon	2.50	0.15	1.47	1.62	1403	56,107
CRD							
10 people per ha	250 l/cap/day	10.00	1.30	1.23	2.53	2184	21,841
20 people per ha	I&I = 0.13 l/s/ha	5.00	0.65	1.23	1.88	1622	32,450
40 people per ha	PF = Harmon	2.50	0.33	1.23	1.55	1342	53,668

3.5.3 Design Criteria and Demand Management

Provided overleaf are summary design sewerage and I&I rates recommended for adoption by the CVRD. The importance of adopting realistic, if not conservative, sewerage design values cannot be understated. Failure to acknowledge and account for increasing inflow and infiltration, as collection systems age, can lead to unexpected capacity shortfalls and the need to prematurely replace major system components.

Table 11 - Summary of Recommended Design Criteria for CVRD Sewerage Master Plan Update								
Point of Connection to CVRD system	Sub Area Description	Inflow and Infiltration Rate	Per Capita Sewerage Flow (Inclusive of ICI Flows)	Gravity Sewers		Forcemains		Peaking Factor
		(l/s/ha)	(l/cap/day)	Capacity	Min. Velocity	Min. Velocity	Max. Velocity	
Courtenay Pump Station	Existing Developed Areas	0.17	240	100 - 200mm = 50% 250mm = 60% 300+mm = 70%	0.6 m/s	0.75m/s	2.5m/s	MMCD
	Core Areas (Not Yet Serviced)	0.17	240					
	New Development Beyond Core	0.17	240					
	Cumberland	0.5	240					
Comox (Jane Street) Pump Station	Existing Developed Areas	0.4	240					
	Core Areas (Not Yet Serviced)	0.17	240					
	New Development Beyond Core	0.17	240					
CFB Comox Pump Station	Existing Developed Areas	1.00	240					
	Core Areas (Not Yet Serviced)	0.17	240					
	New Development Beyond Core	0.17	240					

Notes:

- Sewage pumping stations should, at a minimum, be able to pump the expected 10-year peak sewage flows with the largest capacity pump out of operation.
- 20-year peak flows should be handled with only minor modifications. I/e/, for a two pump station, each pump should have sufficient capacity to handle peak flows. For a three pump station, with the largest pump out of operation, the two remaining pumps operating in parallel should be able to pump the peak sewage flows.

- Existing I&I rate for areas tributary to Jane Street pump station area assumed to remain constant, or decrease over time. A reduction in I&I appears feasible, based on the existing elevated wet weather flow rates. The Town of Comox is actively pursuing I&I reduction in this area.
- Existing I&I rate for areas tributary to Courtenay pump station area assumed to remain relatively constant, over time. At present peak I&I rates in this catchment are 0.16 l/s/ha
- Existing Cumberland I&I rate = approximately 8 l/s/ha due to combined system. It has been assumed that connection to the CVRD system will not be permitted until overall existing I&I rates are reduced to a maximum of 0.5 l/s/ha

Caution should be exercised in the reduction of design flow rates based on expected flow reductions resulting from the use of low flow household plumbing fixtures. While some savings can be realized through the use of dual flush toilets, for instance, this reduction is modest in comparison to offsetting inflow and infiltration, particularly as system age increases. Based on information provided by the Capital Regional District, target sewerage flow reduction expected as a result of demand management in the greater Victoria area amounts to less than 5% of the total annual flow. In the case of the CVRD, if similar flow reductions were realized, total annual savings (in 2010 dollars) could amount to $170,000. However, conveyance system component replacement deferrals would be largely unaffected by this modest reduction. This, due to the non-coincidental peak wet weather and domestic sewerage flow patterns typically experienced, and the very slight (approximately 2%) reduction in PWWF.

4.0 ULTIMATE SERVICE AREAS, POPULATIONS AND DENSITIES

4.1 Core Area Populations

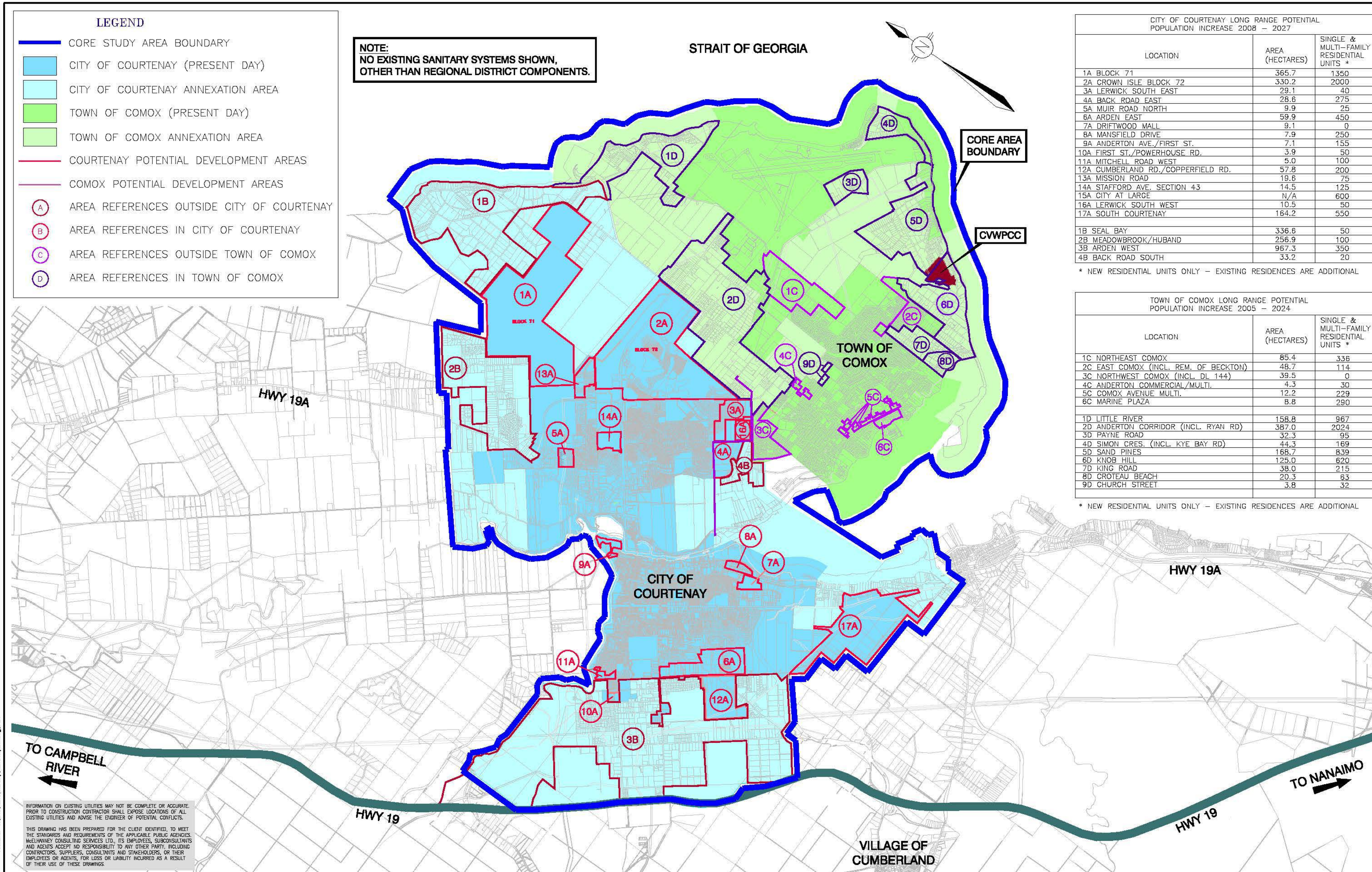
Projected land use and development timing within the municipal "Blue/Green" MOU area was provided by each respective municipality. The information presented predicts build out of "green field' sites within the "Blue/Green" area over approximately 16 years. Generally, densities of both Comox and Courtenay, per the projections provided, are not expected to increase significantly from those of today, until such time as redevelopment and densification of existing properties becomes financially viable.

Drawing S-8A, overleaf, indicates the expected areas of growth within the core, municipal "Blue/Green" area. It has been agreed the future core expansion areas to be considered within the SMP are to be coincidental with the future expansion areas defined in the MOU.

Future population projections within the core area have been modeled utilizing three differing growth rates over the 50 year horizon. The "most probable" projection, as defined by City staff, predicts relatively aggressive growth (4% 2008-2018, 3% 2019-2028, 2% 2029-2038, and 1% 2039-2058). If population growth as anticipated by City staff is realized, the population of Courtenay within 50 years could reach 70,000 people.

In Courtenay, "most probable" population projections for the SMP have been generated based on known areas of infill development, future boundary expansion, and general densification over time, as described in the document entitled "City of Courtenay – Long Range Potential Development Plan and Population". This document was supplied by City staff, and formed the basis of the "Blue/Green" Mapping, and associated Memorandum of Understanding between the two municipalities. Growth beyond the year 2024 has been estimated to be 2.0% per annum. This rate is slightly less than the Statistics Canada average over the preceding 15 year period, and yields a 2058 population of approximately 81,000.

Upper and lower bound population estimates have also been generated by assuming constant growth rates over the 50 year design horizon. The lower bound estimation of 49,000 people by year 2058 has been based on the Statistics Canada 45 year average growth rate of 1.48% per annum within the Comox Valley. Upper bound population estimates of 125,000 have been based on a 4.5% growth rate to year 2024, dropping off to the Statistic Canada 15 year average growth rate of 2.88% thereafter.



CITY OF COURTENAY LONG RANGE POTENTIAL POPULATION INCREASE 2008 – 2027		
LOCATION	AREA (HECTARES)	SINGLE & MULTI–FAMILY RESIDENTIAL UNITS *
1A BLOCK 71	365.7	1350
2A CROWN ISLE BLOCK 72	330.2	2000
3A LERWICK SOUTH EAST	29.1	40
4A BACK ROAD EAST	28.6	275
5A MUIR ROAD NORTH	9.9	25
6A ARDEN EAST	59.9	450
7A DRIFTWOOD MALL	9.1	0
8A MANSFIELD DRIVE	7.9	250
9A ANDERTON AVE./FIRST ST.	7.1	155
10A FIRST ST./POWERHOUSE RD.	3.9	50
11A MITCHELL ROAD WEST	5.0	100
12A CUMBERLAND RD./COPPERFIELD RD.	57.8	200
13A MISSION ROAD	19.6	75
14A STAFFORD AVE. SECTION 43	14.5	125
15A CITY AT LARGE	N/A	600
16A LERWICK SOUTH WEST	10.5	50
17A SOUTH COURTENAY	164.2	550
1B SEAL BAY	336.6	50
2B MEADOWBROOK/HUBAND	256.9	100
3B ARDEN WEST	967.3	350
4B BACK ROAD SOUTH	33.2	20

* NEW RESIDENTIAL UNITS ONLY – EXISTING RESIDENCES ARE ADDITIONAL

TOWN OF COMOX LONG RANGE POTENTIAL POPULATION INCREASE 2005 – 2024		
LOCATION	AREA (HECTARES)	SINGLE & MULTI–FAMILY RESIDENTIAL UNITS *
1C NORTHEAST COMOX	85.4	336
2C EAST COMOX (INCL. REM. OF BECKTON)	48.7	114
3C NORTHWEST COMOX (INCL. DL 144)	39.5	0
4C ANDERTON COMMERCIAL/MULTI.	4.3	30
5C COMOX AVENUE MULTI.	12.2	229
6C MARINE PLAZA	8.8	290
1D LITTLE RIVER	158.8	967
2D ANDERTON CORRIDOR (INCL. RYAN RD)	387.0	2024
3D PAYNE ROAD	32.3	95
4D SIMON CRES. (INCL. KYE BAY RD)	44.3	169
5D SAND PINES	168.7	839
6D KNOB HILL	125.0	620
7D KING ROAD	38.0	215
8D CROTEAU BEACH	20.3	63
9D CHURCH STREET	3.8	32

* NEW RESIDENTIAL UNITS ONLY – EXISTING RESIDENCES ARE ADDITIONAL

No.	Date	Revision	Dr.	Chk'd

McElhanney
McElhanney Consulting Services Ltd.
496 SIXTH STREET
COURTENAY, B.C. V9N 6V4
PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A | Checked: IW/BH | Date: 01/OCT/2008
Drawn: TM | Surveyed: N/A

SCALE 1 : 30,000 (APPROX.)

Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

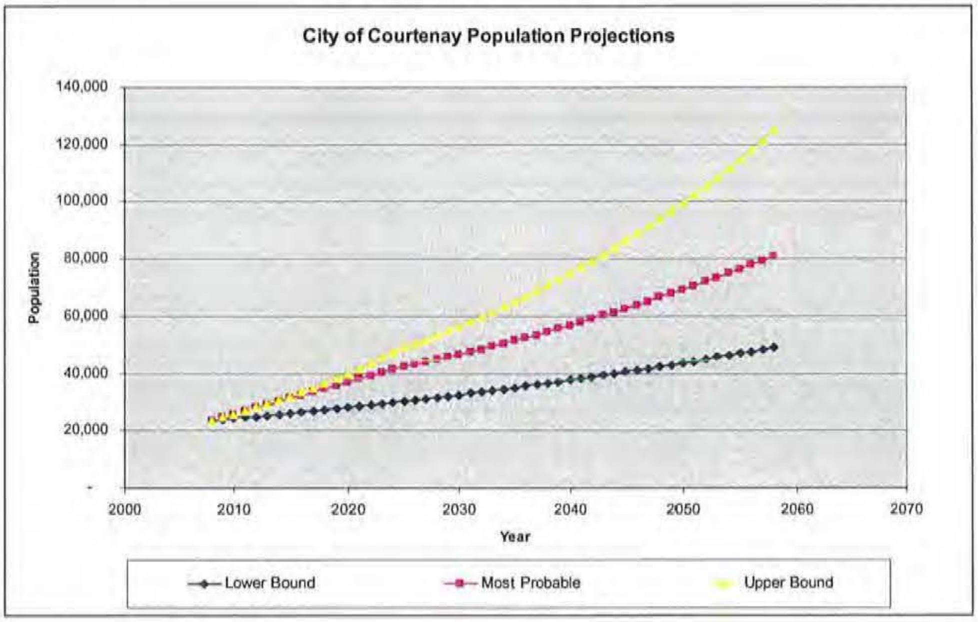
PROBABLE FUTURE DEVELOPMENT CORE AREA

CVRD MASTER SEWERAGE STUDY

COMOX VALLEY, BC

Client Drawing No.
MCSL Project No. 2211-46970-0
Drawing No. S-8A
Sheet 9 of 13 Revision 2
Destroy all prints bearing previous number

Filename: K:\ENG\46970\final emp\46970-Report.dwg\S-8A
Plotted: May 13, 2011, 14:41:28



Spatial population projections have not been supplied by the Town of Comox. We have made some assumptions therefore, as indicated on drawing S-8A. Town staff indicated a projected growth rate for the foreseeable future of roughly 3% per annum. We have assumed therefore that, in keeping with the Courtenay projections, population growth out to 2024 will be consistent with the "Blue/Green" MOU, and will then taper off in the longer term. Based on upper, lower and most probable growth rates thereafter, a total population range from 25,000 to 50,000 is indicated. Most probable estimates place the Comox population at 33,000.

Estimates of population growth directly attributed to Komox First Nations development have not been provided. However, this background growth is accounted for within the population estimates generated for each of applicable development nodes noted herein.

Beyond the 2024 projections made by City and Town staff, overall development densities and annual growth rates are very uncertain. For comparative purposes, we have researched the overall densities of various municipalities within the province. Interestingly, Courtenay and Comox have higher average density than the cities of Kelowna, Prince George and Kamloops. The calculation is based on gross municipal area and census populations, which explains the relatively low densities of communities such as Langley, Abbotsford, Saanich and Surrey, which all include significant agricultural reserves.

For comparative purposes, we have explored the possible range of populations, within the urbanized core of the Comox Valley that could materialize if an overall density between that of present day Nanaimo and Victoria is realized. Based on this assumption, the 50 year population of the "Blue/Green" area could range from 180,000 to 225,000 based on densities of 2,000 to 2,500 people per square km. In order to achieve the above noted populations within a 50 year timeframe, annual growth would need to average between 3.3% and 3.75%. This rate is quite aggressive, but not unimaginable, based on past periods of local Comox Valley growth. The table below indicates overall population densities per square kilometre, per Statistics Canada:

Table 12 - Population Density per km^2			
Vancouver	5039	Comox	800
Victoria	3966	Kelowna	504
White Rock	3633	Abbotsford	344
Surrey	1245	Langley	305
Saanich	1046	Kamloops	270
Nanaimo	881	Prince George	224
Courtenay	822	Campbell River	206

Tables 13a and 13b (located in Appendix Q), illustrate the projected growth in both Courtenay and Comox, utilized in the SMP.

4.2 Outlying Areas

MCSL met with CVRD planning staff on two occasions, July 21st and August 12th, 2008, to discuss various development and land use scenarios. Drawing S-8B, overleaf, indicates expected development nodes, based on previous settlement patterns, "local area" planning process(es), anticipated major developments forthcoming, and past Liquid Waste Management Plans (LWMPs), outside of the core study area.

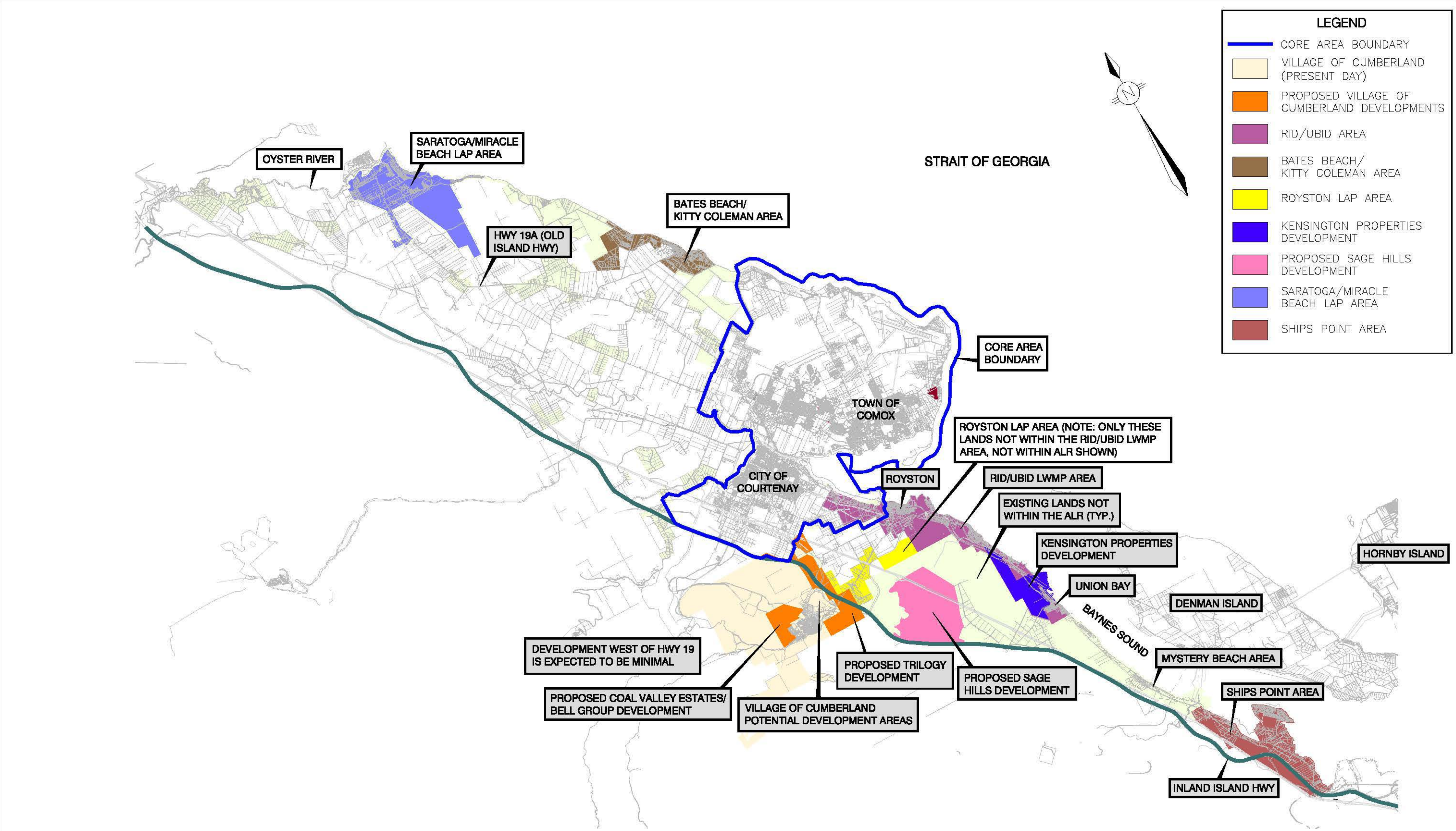
Provided below are brief descriptions of the Various Local Area Plans (LAPs) and LWMP boundaries, as utilized in this report. Given the age of some of these documents and the anticipated land use changes not reflected in the original documents, population projections have been updated. Unless noted otherwise, present day populations have been determined by lot count, and the assumption of 2.5 persons per lot. This method of calculation does not account for either vacant lots or secondary dwellings, but is sufficiently accurate for the purpose of this study.

Saratoga/ Miracle Beach Development Node

The Saratoga/Miracle Beach development boundary utilized in this study is consistent with the Saratoga/Miracle Beach (LAP) bylaw number 2100. Generally, the area is bounded by the Oyster River to the north, and the Strait of Georgia to the east. The area extends south to the end of existing residential development on Miracle Beach Drive, is inclusive of the Miracle Beach Provincial Park, and Block 29, Lot 2, Plan 3139, an approximately 360 ha parcel of land owned by Raven Forest Products. The Hwy 19A corridor, north of Enns Road, McCauly Road, and the western boundary of those lots fronted by Oaks Road, complete the western boundary of the LAP area.

The 2005 Saratoga/Miracle Beach LWMP identified three development "zones", based on existing development densities and lot sizes, assumed forthcoming development, and the existing status of onsite sewage treatment systems. The service area identified in the LWMP was restricted to Zones 1 and 2, based on the assumption that forthcoming development would be concentrated in these areas, and size of the existing residential lots would not be conducive to on-site treatment.

The 2005 LWMP cited a design population of 4,460 people, by year 2020. This estimation is based on the 2005 equivalent population of 3260 (during the summer months), and an annual growth rate of 2%.



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

THIS DRAWING HAS BEEN PREPARED FOR THE CLIENT IDENTIFIED, TO MEET THE STANDARDS AND REQUIREMENTS OF THE APPLICABLE PUBLIC AGENCIES. McELHANNEY CONSULTING SERVICES LTD., ITS EMPLOYEES, SUBCONSULTANTS AND AGENTS ACCEPT NO RESPONSIBILITY TO ANY OTHER PARTY, INCLUDING CONTRACTORS, SUPPLIERS, CONSULTANTS AND STAKEHOLDERS, OR THEIR EMPLOYEES OR AGENTS, FOR LOSS OR LIABILITY INCURRED AS A RESULT OF THEIR USE OF THESE DRAWINGS.

No.	Date	Revision	Dr.	Chk'd

McElhanney
McElhanney Consulting Services Ltd.
496 SIXTH STREET
COURTENAY, B.C. V9N 6V4
PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A	Checked: IW/BH	Date:01/OCT/2008
Drawn: TM	Surveyed:N/A	

SCALE 1 : 80,000 (APPROX.)

Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

PROBABLE FUTURE DEVELOPMENT OUTLYING AREAS

CVRD MASTER SEWERAGE STUDY
COMOX VALLEY, BC

Client Drawing No
MCSL Project No. 2211–46970–0
Drawing No. S-8B
Sheet 10 of 13
Revision 2
Destroy all prints bearing previous number

Kitty Coleman/Bates Beach Development Node

A Local Area Plan does not exist for the Kitty Coleman/Bates Beach area. However, given the proximity to the core area, and relatively high development density (and therefore potential long term problems associated with this individual ground disposal fields), the area has been included in this study.

The Kitty Coleman/Bates Beach residential area is generally bound by Loxley Road to the south, the agricultural land reserve to the west, to the north by the NE ¼ of section 23 and the SW ¼ of section 25, and to the east by the Strait of Georgia.

The majority of existing waterfront development south of the Area B boundary consists of half acre lots, with roughly 25m frontages. This arrangement does not lend itself to the creation of new lots through subdivision. However, given the increasing value of waterfront real estate, it is possible that future redevelopment with higher density residential could take place.

The remainder of this sub-area is comprised of larger parcels, generally varying in size from 2.5 to 90 acres. CVRD planning staff indicted that significant densification in the Kitty Coleman/Bates Beach area is not expected, based on the lack of municipal servicing and existing zoning.

Ships Point Development Node

The Ships Point development node is bounded to the west by the BC Hydro transmission line ROW, to the south by Curran Road, the east by Bayne Sound, and extends north roughly to the Tsable River. Existing development on the peninsula has density comparable to an urban R1 standard, with lots averaging approximately 2,000m^2, and minimum lot sizes in the 1,200m^2 range. Existing lots east of Hwy 19A generally range from one half to 5 acres. Lots on the west side of Hwy 19A, with the exception of the Cougar Smith and Holiday Road areas, are significantly larger.

The Ships Point area includes several shellfish processing plants, and numerous shell fish leases.

As was the case with the Kitty Coleman area, CVRD planning staff do not foresee significant densification in this area, based on the lack of municipal servicing, and existing zoning.

Village of Cumberland

Cumberland's population has been steady at approximately 2,000 people for several years. Recent residential development, particularly the first three phases of Coal Valley Estates and Ulverston Station, have pushed 2008 population estimates to approximately 2,650 people.

The Village of Cumberland is poised to undergo potentially very large transformations in both land use and population. Two major developments, with the combined potential to quadruple the population of the Village, have been proposed. We understand that Village staff are in the process of determining the scope of infrastructure upgrading required to service these developments. This includes the related Cumberland LWMP process, ongoing, further described in Section 5.2.2 below.

The proposed Coal Valley Estates project is located at Rem 1, DL 24, immediately to the north west of the developed portions of the municipality. The development includes approximately 1,000 residential units, as well as a small commercial component.

Trilogy Property's development encompasses approximately 307 ha of the so called interchange lands. Much of the gross area is undevelopable, due to servicing constraints, environmental concerns, etc. The current proposal would see roughly half of the 307 ha developed into a mixture of commercial and residential.

A third major land development proposal has been submitted to the Village for consideration. The proposed "Bell Group" development, as we understand it, includes approximately 1,700 seniors' oriented units, of varying levels of care. Also proposed is a 9 hole golf course and commercial center. We understand that the Bell Group is exploring the potential for a private, onsite treatment system. The Village of Cumberland has indicated that consideration would be given to this alternative, but has not committed, given the ongoing longer term sewage treatment planning.

Union Bay/ Royston Improvement District LWMP Area

The projected UBID/RID boundary is generally consistent with the service area identified in the Royston /Union Bay Sewage Collection, Treatment, and Discharge Study of September 2005. Generally, the study boundary encompasses the moderately densely developed waterfront from Seymour Road in the south to Fraser Road in the north.

In 2008, the City of Courtenay annexed the Buckstone Road area of Royston. A portion of this area was considered tributary to the 2005 study area. Based on initial City of Courtenay development projections, the south Courtenay annexation area will likely see 500 residential units at build out, not accounted for in the original LWMP.

For purposes of this study, the Kensington residential/commercial/golf development (Union Bay) is included within the Royston/UBID area.

Sage Hills Development

The proposed Sage Hills development has the potential to generate a significant number of residential units, along with planned university and sports facilities. The development, located in Block 93, Plan 80201 encompasses over 840 ha, south of the existing core area. To date, an official development application has not been filed, thus, the probability of this project moving forward cannot be ascertained. However, it is reasonable to assume that should Sage Hills move forward, services extended to the area will likely encourage further development in Area A adjacent to the site.

4.3 Population Discussion

Population projections have been developed for each of the outlying settlement expansion nodes identified above. Population projections give consideration to major land development projects where *active development proposals* have been deposited with the CVRD. Where possible, unit counts, and population projections have been obtained directly from the various applicants.

As with the Core area, lower bound, upper bound, and most probable population scenarios have been developed. Tables 13c through 13f, indentifying projected 50 year horizon populations in each geographic area described above, are attached in Appendix Q. Summaries are provided below.

Table 14 -Ultimate Service Area (50 Year) Population Projections				
Development Node	**Present Day**	**Lower Bound**	**Most Probable**	**Upper Bound**
UBID/ RID LWMP Area	3,236	8,074	22,860	36,563
Village of Cumberland	2,650	7,981	20,107	21,046
Remaining Area A	2,702	3,467	5,633	12,524
Saratoga Beach	3,460	7,213	14,309	19,324
Kitty Coleman	1,350	2,220	2,814	3,634

5.0 UPGRADING OPTIONS

Two route selection matrices have been developed to assist in the evaluation of system conveyance and treatment options. Each matrix is comprised of criteria and relative weightings selected with input from the client group.

The fist matrix was developed for evaluation of core area conveyance options. This matrix places emphasis on not only the traditional considerations of technical feasibility and cost, but also social/community and environmental impacts. The second matrix is to be used to evaluate overall system configuration options. This matrix is similar to the first in many respects, however, a fourth consideration is introduced. Integrated Resource Recovery, (IRR) in this context, refers to the potential for use of solid and liquid waste to create energy, reduce greenhouse gas emissions, conserve water, and recover nutrients.

Presentation of the matrix evaluation outcomes for <u>both</u> the core area routes and the overall CVRD system configuration options follows (in Section 5.3) the description of each option and the discussion of related issues.

5.1 Core Area

5.1.1 Core Area Route Options

Six alternate routes have been considered as replacements to the existing Courtenay pump station discharge forcemain alignment. Each route considered in this section has been selected to capitalize on a specific attribute, be it minimizing overall pump distance, elevation change, number of pump stations, construction phase disruption to existing residences, etc.

Topographic information utilized in this section was obtained from a variety of sources, including "Trim" mapping provided by the CVRD, City, and Town, existing survey data in hand from previous MCSL projects, and (in house) supplemental topographic survey. This data is considered sufficiently accurate for the purpose of this preliminary analysis.

"Ground truthing" of each proposed route has been carried out by MCSL staff. Appendix G contains field reconnaissance reports generated during the "truthing" process for each of the six route alternates. The reports note general site conditions, potential route detractor, and other factors which could affect constructability. Drawing S-11 (Appendix R), indicates the relative locations of each route discussed below.

The sixth potential route, which is discussed in detail follows the current foreshore alignment. We understand that CVRD staff are keen to explore the opportunity to replace the foreshore forcemain section extending around the Willemar Bluffs, south east of Comox. It is understood that the section of forcemain between the Courtenay River pump station and Willemar Bluffs is not suffering from tidal erosion. However, other factors exist which may warrant selection of an alternate alignment, if and when the forcemain reaches capacity. These factors could include environmental sensitively of coastal areas, and the potential for elevated sea levels due to climate change, amongst others.

5.1.2 Route 1 – South Greenwood Connector (Hudson Road Trunk)

Route 1 proposes to utilize the yet to be constructed southern leg of the Greenwood trunk sewer, also referred to as the Hudson Road trunk. This option would allow for the conveyance of Courtenay River pump station flows to the CVWPCC with relatively minimal impact to existing developed areas. However, this option requires pumping to a geodetic elevation of approximately 70m. Although feasible, Route option 2 would require very costly pumping infrastructure, which is likely not readily available except though specialty distributers. Further, Option 1 would ultimately require upsizing of some sections of the Greenwood Trunk, already installed. Upgrading of the CFB pump station, forcemain, and gravity sewer would also be required.

Utilization of this route does not negate the need for construction of the proposed Willemar Bluffs replacement and Docliddle pump station. This infrastructure would need to be constructed to service the Jane Street catchment, and potentially the southern outlying areas, depending on overall system configuration. Similarly, the Greenwood system would be required to service the remainder of the CVRD area.

5.1.3 Route 2 – Beaufort Avenue

Route 2 makes use of the Comox Ave/Beaufort Ave corridor through downtown Comox. This route has the advantage of maintaining a significantly lower maximum elevation than route 1, at approximately 40m geodetic.

Construction of route 2 provides the benefit (over route 1) of allowing the Greenwood system to be advanced as development directly tributary to it dictates. However, due to the degree of existing development along the Comox Ave/Beaufort Ave corridor, and the associated existing underground servicing, utility conflicts are probable. Disruption to existing residents and businesses would also be greater than route 1.

5.1.4 Route 3 – Block 71

The proposed Block 71 route is the lengthiest of all options considered. This route utilizes the lower elevations of Block 71 and the "Poge" property to bypass the height of land that bisects east Courtenay and Comox. The estimated maximum elevation along this route is 50m geodetic.

This option has the potential benefit of being advanced, in large part, by the development of Block 71. Construction of the Greenwood Trunk, along with significant upgrades to the CFB gravity sewer, pump station and forcemain would be required. Replacement of the Willemar Bluffs section of forcemain would still be required, long term.

5.1.5 Route 4 – Guthrie Road

The Guthrie Road alignment, as with route 1, would require pumping over a maximum elevation of nearly 70m. However, the total distance pumped in route 4 is approximately 2 km further than option 1.

We understand that BC Hydro has recently constructed a major duct bank along the Lerwick/Guthrie corridor. The duct back is significant in terms of physical size, thus decreasing the remaining availability of subsurface cross sectional area within which a large diameter forcemain could be located.

5.1.6 Route 5 – Robb Road

The Robb Road alignment differs from those presented above, in that much of the distance covered through the Town of Comox can be achieved via gravity. Similar to routes 1 and 4, this option requires pumping to a maximum elevation of nearly 70m. However, the total distance pumped is significantly shorter that other routes, at approximately 2,200m.

As with all other options noted, route 5 requires that the Willemar Bluffs realignment be completed, and the Greenwood system be constructed. Route 5 also requires the Docliddle pump station be sized to accommodate flows that would otherwise be in excess of those required of routes 1, 3 and 4.

5.1.7 Route 6 – Default Foreshore Alignment

The existing foreshore forcemain from the Courtenay River pump station to the Jane Street pump station appears to be functioning as intended. This section has not shown any signs of erosion, such as those seen in the Willemar Bluffs section. The need to replace this upstream section of forcemain will likely be driven either by eventual capacity shortfall, or a desire to incorporate redundancy in the system. This is contrasted to the Willemar Bluffs section whose replacement timing will likely be dictated by serviceability. Required timing of these upgrades will depend in large part on the preferred overall regional system configuration, as described in Section 6 below.

Per initial direction provided by the client team, a new forcemain alignment was to be identified, in order to remove the existing alignment from the Comox waterfront, particularly the Willemar Bluffs area. Subsequent analysis of available alternate route options led to a re-evaluation of the foreshore route, at least as far as the Willemar Bluffs. This alignment appears preferable for a number of reasons, not the least of which is the reduction in static head from 70m to approximately 45m. This elevation differential is significant, given the magnitude of waste water flows generated within Courtenay and Comox at present, and the roughly three fold increase in flow expected over the 50 year horizon.

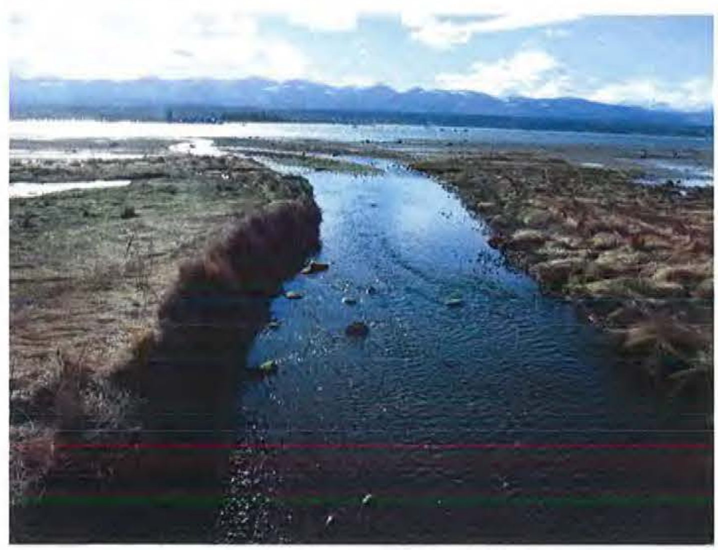
Field reconnaissance undertaken by MCSL staff indicates a number of minor construction impediments, none of which are expected preclude the feasibility of route 6. Examples follow.

Courtenay Slough flood gates. The proposed forcemain could potentially pass over top of the relief culverts. However, consideration should be given to the long term upgrade requirements of the gate. Based on recent studies undertaken on behalf of the City of Courtenay, the flood gates may be undersized, and located too low to allow for expected long-term sea level change due to global warming.

Dyke Road. Traffic flows along the Dyke Road are heavy, as this is one of two primary routes into the Town of Comox. Careful coordination and traffic management will be required.

Komox Indian Reservation. Construction of underground utilities in all areas of the Comox Valley should be subject to archaeological assessments prior to commencement. Excavation in areas of particular cultural significance, including the Comox harbour and foreshore, should be attended by members of the Komox band, and appropriate archaeological professionals. The complexity of obtaining a site alteration permitting through the Ministry of Tourism, Culture and the Arts appears to be increasing.

Indian Creek, Brooklyn Creek, Golf Creek crossings. A number of existing watercourses must be traversed if route 6 is to be pursued. Confirmed fish presence in several of these streams will require a Ministry of Environment "Section 9" approval, and/or Fisheries Authorization. Construction scheduling will need to reflect work being carried out during summer fisheries windows.



Comox Marina. The Comox Marina and adjacent institutional park areas are heavily used, particularly in the summer months. It is advised the CVRD pursue right of way agreements, where appropriate. Discussions with the Town should be initiated in the near future, to ensure the CVRD's interests are protected, in the event of any further development in the Comox Marina area.

General Environmental Sensitivities, Estuarine Areas. Essentially the entire route 6 alignment falls within areas of varying environmental sensitivity. A comprehensive environmental assessment and impact study should be undertaken in advance of preliminary design, should route 6 ultimately be selected the preferred option.

Route 6 has several distinct advantages over other route options considered, namely:

- Deferral of a portion of the new forcemain construction costs. The section of forcemain between the Courtenay station, and the new Docliddle station, could remain in service for up to 25 years.
- Avoidance of existing utility corridors, minimizing disruption to existing businesses and residents.
- The ability to incorporate redundancy into the conveyance system, by maintaining the existing foreshore forcemain as a serviceable alternate alignment, i.e. with same discharge location as the new/proposed Courtenay pump station pressure sewer.

5.1.8 Willemar Bluffs Forcemain Condition

Per Client direction, the recommendations of the 2005 CH2MHill Forcemain Re-Alignment Study, have been incorporated into the Sewer Master Plan. This direction is based on the limited options that appear to exist to enhance existing sections of the forcemain that are prone to erosion. Past efforts have included the installation of gabion baskets, at a cost of approximately $5,000 per lineal meter of main. If this cost were carried forward, armouring of the remaining +/- 2.5km of forcemain could cost upwards of $12.5 million. Alternatives to the use of Gabion baskets would generally be limited to similar physical armouring, however, the environmental and cost implications appear to be prohibitive.

The environmental impacts associated with a failure of the foreshore forcemain would be profound. No viable alternative, or redundancy, exists within the CVRD's forcemain system, at present. Wet well storage time in the Courtenay and Jane Street stations has been determined to be essentially nil, during peak wet weather events. Wet well storage time during average day flow conditions is also insufficient to allow for emergency repairs of the forcemain, if required.

The remaining service life of the foreshore forcemain is not known with certainty. The erosion issues noted above could ultimately dictate replacement timing, as opposed to capacity. In the case of the latter criteria, based on most probable development scenarios, replacement would be required by approximately 2024. Lower than expected rates of development could further defer upgrading. However, determining replacement timing based on serviceability criteria is less certain. Based on discussions with CVRD staff, the following is known:

- The HYPRESCON forcemain appears to be in fair condition. Joints having been exposed during the course of routine inspections, and remedial erosion protection works appear to be in fair to good condition.
- CVRD staff believe that half of the 50yr service life remains, but degradation is obviously accelerated by erosion/exposure.
- Remedial erosion protection works appear to be functioning as intended.
- Cathodic protection appears to be working well. CVRD staff has recently had the anode bank replaced. A survey will be completed in the New Year to verify efficacy.

It is recommended the CVRD engages a coastal engineering specialist, in order to determine with greater certainty, the rate of erosion over the forcemain, and anticipated replacement timing. This information should be utilized to confirm current operation and maintenance practices are adequate, and to establish a timeline to relocate the forcemain.

5.1.9 Docliddle Pump Station Location

In 2005, the CVRD commissioned CH2MHILL to prepare a study evaluating alternative forcemain routes, the intention being the eventual decommissioning of the Willemar Bluffs pressure sewer. The study considered several alternative alignments, eventually selecting the Croteau/Lazo route as the most optimal. The study also recommended a new pump station be constructed on Docliddle Road. The pump station would intercept flows from the foreshore forcemain, pumping over the height of land to the CVWPCC. **We concur with the recommendations of the 2005 study and therefore have incorporated these into the various overall system configuration options presented in later sections.**

In order to develop an understanding of the longer term, overall, pumping requirements of the CVRD system, within the context of the Docliddle pump station, a series of hydraulic models have been created utilizing PCSWMM software. Additionally, system curves have been developed for each scenario analyzed.

Three alternate pump station locations were selected for analysis. Each location was selected based on station elevation, as this is the primary factor in determining impact on the CVRD's existing downstream pump stations. It has been determined the three (Docliddle) pump station elevations worthy of consideration are 0m, 12m, and 17m geodetic. No consideration has been given to property acquisition requirements, at this conceptual stage.

Based on CVRD input, a wet well designed pump station is preferred over an inline, booster station. This wet well arrangement would potentially allow for the future diversion of gravity flows from eastern portions of the Comox collection system. We have therefore not analyzed the requirements or impacts an inline station could have on the Jane Street and Courtenay River Pump stations.

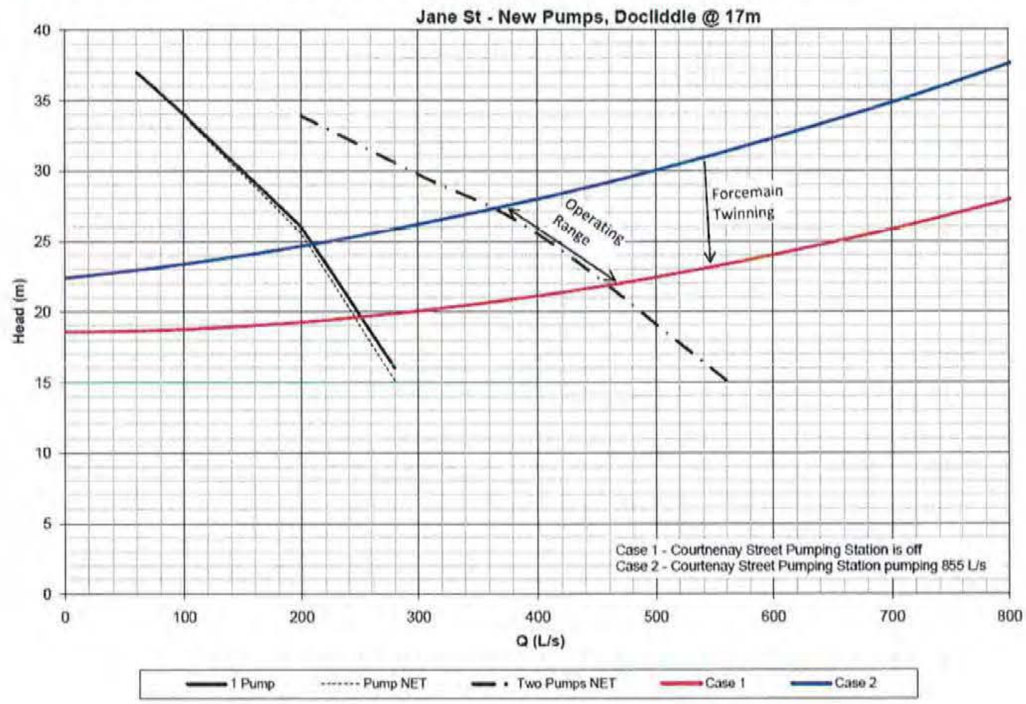
5.1.9.1 Docliddle Pump Station Location 1 – 0m Geodetic

The commissioning of the Docliddle station would require, on day one, all pumps in the Courtenay and Jane Street stations be replaced, as the lack of static head would push the pumps beyond their specified operating range. Construction of the new Docliddle station at sea level would also require additional environmental approvals, beyond that required of alternate locations. Construction of the Docliddle station at 0m geodetic is not favoured.

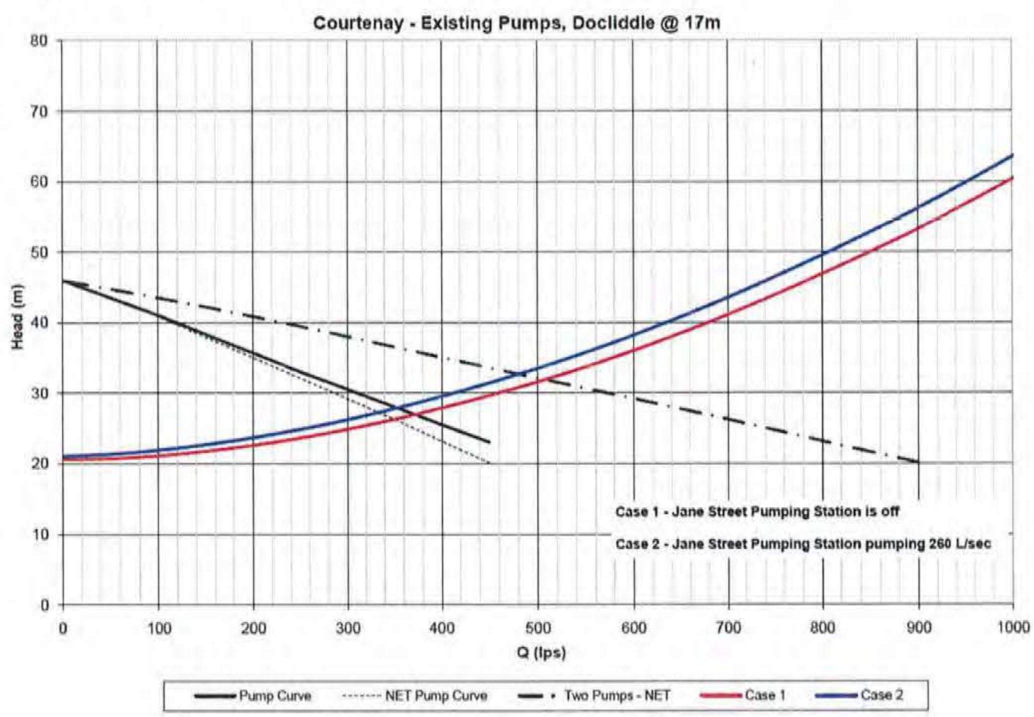
5.1.9.2 Docliddle Pump Station Location 2 – 17m Geodetic

Construction of the Docliddle station at 17m geodetic has been discussed in past studies undertaken on behalf of the CVRD. This elevation was selected largely to match the existing forcemain hydraulic grade line, i.e. the reduced static head and line losses between Croteau Road and the CVWPCC have dictated the proposed station location. By placing the station at 17m geodetic, the static pumping requirements of the new station are reduced by 17m, yielding lower operating (line) pressures.

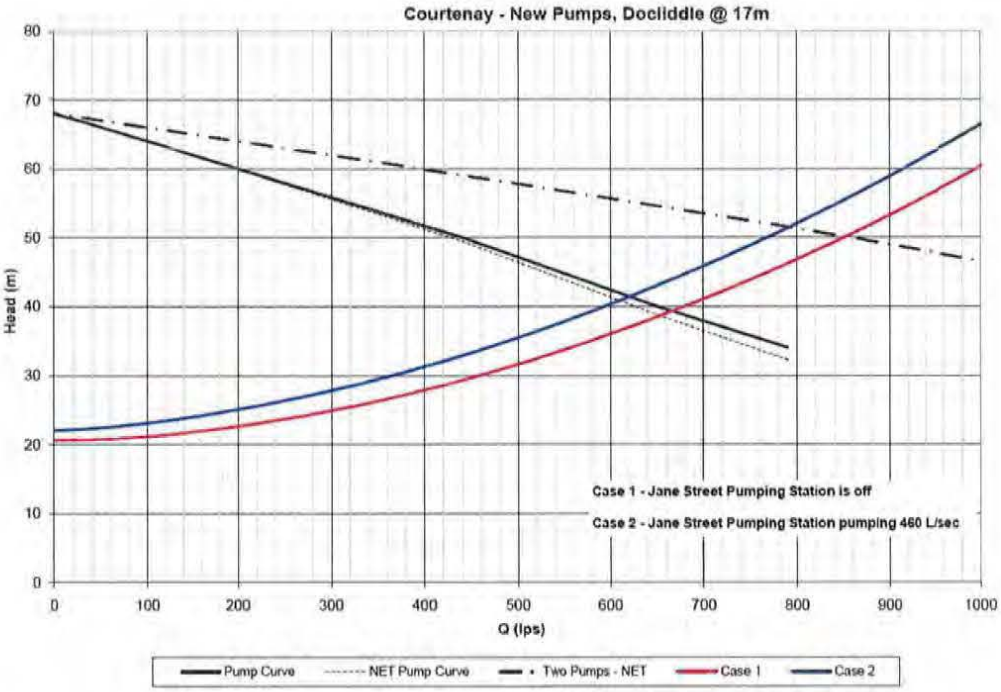
The following system curve indicates the operating range of the Jane Street station, under full build out conditions. Note new 110 hp pumps will ultimately be required to meet future flow conditions, if the Docliddle station is constructed.



System curves have also been developed for the Courtenay River Pump station, under both present day, and full build out scenarios.



The sizing of new pumps in the Courtenay station is largely unaffected by the location of the Docliddle station. The elevation differential (12 to 17m) is considered insignificant, in comparison to friction losses within the 6km of forcemain between Courtenay and Docliddle. Under either scenario (12m or 17m), two 525hp pumps (Flygt CP3351/905) could be used, with different sized impellers.



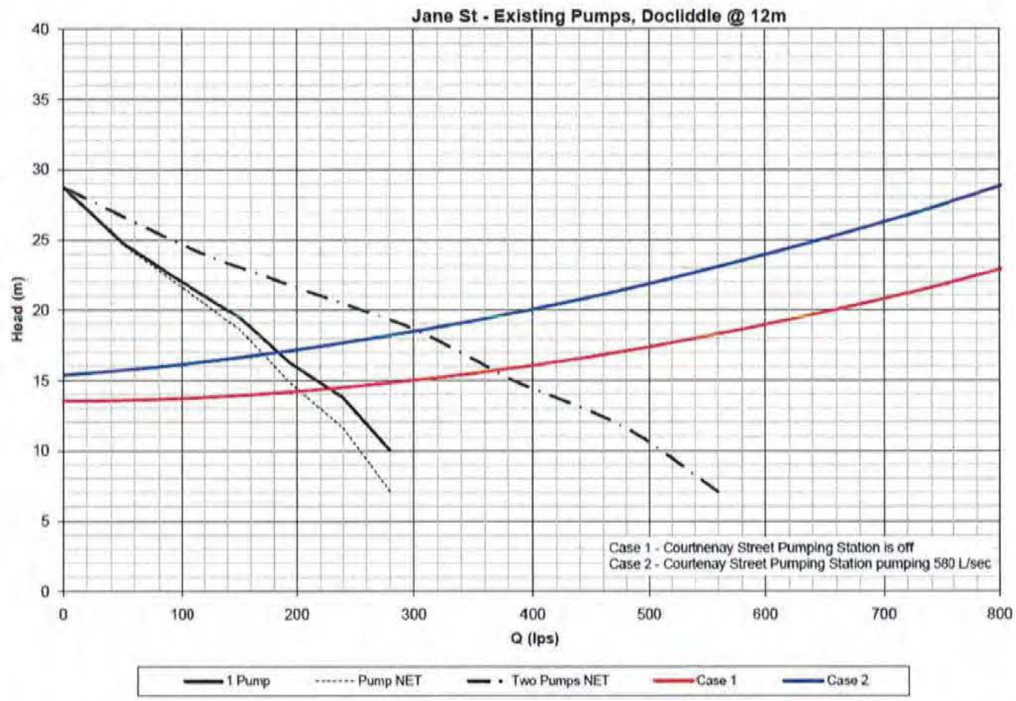
Under both scenarios these pumps would provide approximately 840 L/s of capacity, sufficient until approximately the year 2038, at which time they would again need to be upgraded to meet future demand. This timing would approximately coincide with the twinning of the forcemain between the Courtenay and Docliddle pump stations, unless serviceability issues forced earlier upgrades.

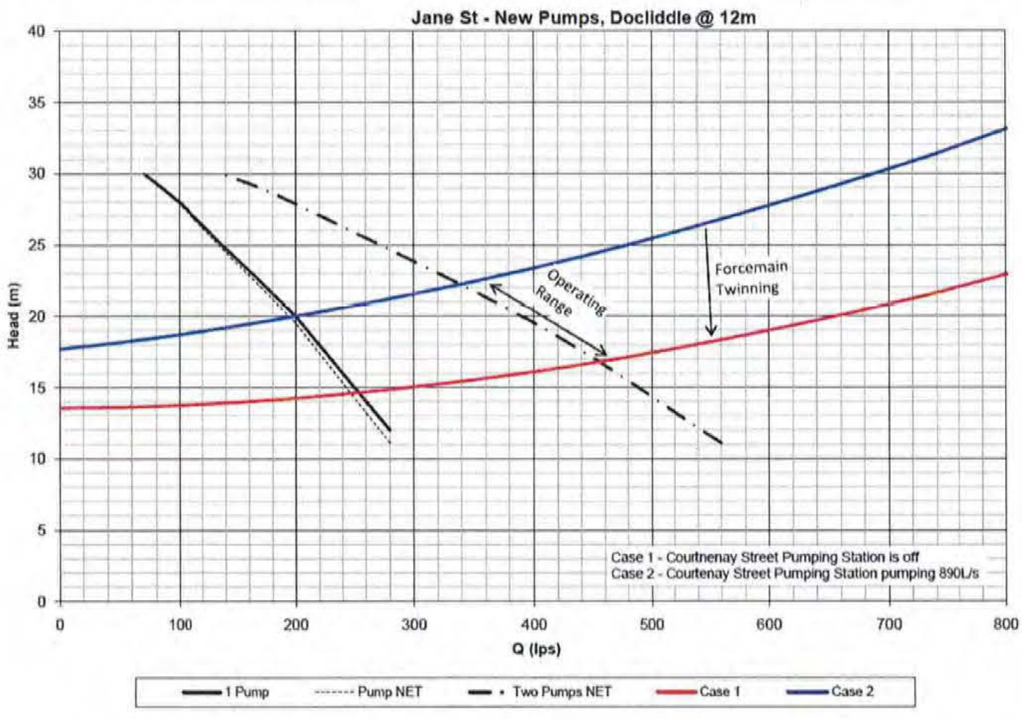
5.1.9.3 Docliddle Pump Station Location 3 – 12m Geodetic

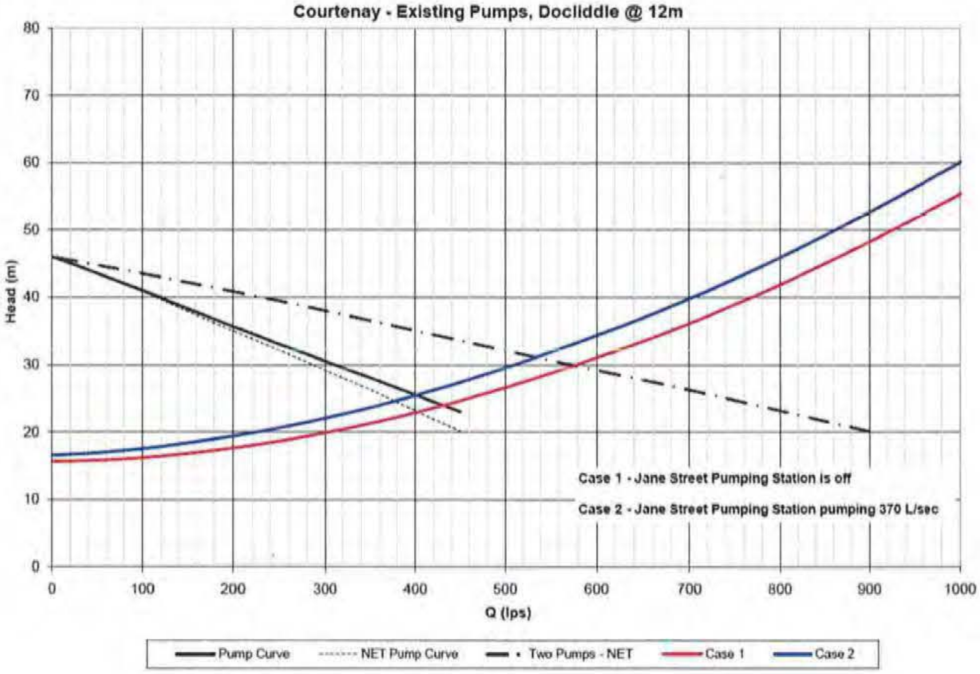
12m geodetic has been determined to be the lowest Docliddle pump station elevation that would not necessitate immediate pump replacement at the Courtenay and Jane Street stations. If the proposed Docliddle station were constructed at 12m, the Jane Street station capacity would increase from approximately 200l/s to 300 - 360l/s. Note this new maximum pump rate is still significantly lower than measured flows within the existing Comox collection system. However, it is believed these peak instantaneous flows are relatively short lived, and largely attenuated by wet well storage and upstream conveyance system (pipe) routing.

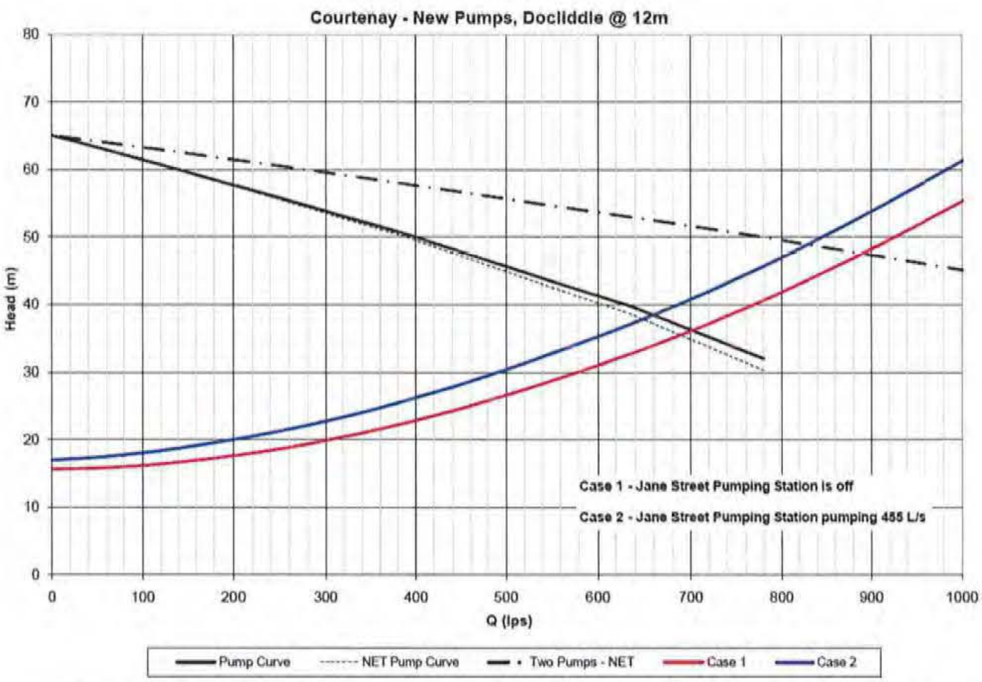
As discussed in the preceding section, upgrade requirement at the Courtenay River station are largely unaffected by a static head decrease of 5m.

The following system curve indicates the operating range of the Jane Street station, under full build out conditions. 90 hp pumps will ultimately be required to meet future flow conditions, if the Docliddle station is constructed at 12m geodetic.


Jane St - Existing Pumps, Docliddle @ 12m
Head (m)
Q (lps)
Case 1 - Courtnenay Street Pumping Station is off
Case 2 - Courtenay Street Pumping Station pumping 580 L/sec
1 Pump
Pump NET
Two Pumps NET
Case 1
Case 2


Jane St - New Pumps, Docliddle @ 12m
Head (m)
Q (lps)
Operating Range
Forcemain Twinning
Case 1 - Courtnenay Street Pumping Station is off
Case 2 - Courtenay Street Pumping Station pumping 890L/s
1 Pump
Pump NET
Two Pumps NET
Case 1
Case 2





It is recommended the new Docliddle pump station be constructed at 12m geodetic. This location would provide the following distinct benefits over other options considered:

- The Courtenay and Jane Street stations could continue to utilize their existing pump arrangements. The Courtenay station requires upgrading essentially immediately; however, construction of the Docliddle station at 12m could defer required pump upgrades until roughly 2020.

- Pump upgrades required at the Jane Street station would be deferred, and downgraded from 2 x 110hp to 2 x 90hp.
- Additional costs of constructing the station along the foreshore are avoided.

Table 15 - Docliddle Pump Station Driven Upgrades of Courtenay and Jane Street Stations				
	Docliddle @ 17m		Docliddle @ 12m	
	Courtenay Station	Comox Station	Courtenay Station	Comox Station
Current PWWF (2010) (L/s)	342	353	342	353
Current Capacity (L/s)	500	200	560	310
Existing Pump Life (Replacement date)	2016	Concurrent with Docliddle Construction	2020	Concurrent with Docliddle Construction
New Pump Power (HP) (required)	525 x 2	110 x 2	525x 2	90 x 2
New Capacity (L/s)	830	410	860	400
New Pump Life (Replacement date)	2037	2058	2039	2058

5.1.9.4 Docliddle Station Major Component Sizing and Probable Estimates of Cost

Peak wet weather flow rates derived in the 2005 forcemain re-alignment study are similar to those identified in the Sewer Master Plan. This correlation is largely coincidental, as tributary population projections, and design I&I rates in the two studies differ. Notwithstanding this variation in design parameters, the component sizing noted in the 2005 realignment study is generally consistent with this study. Based on input received from CVRD staff and the anticipated hydraulic requirements of the station, the following major components are required, assuming flows from the core area :

Pumps

- Initially, three – 525hp variable frequency drive pumps will be required. This arrangement would allow for 2 duty pumps, and a third standby (as required by the MSR).
- Ultimately, three 620 hp variable frequency drive pumps would be required, 2 duty and 1 standby.

Wet Well Storage

- Initially, wet wells should be designed to accommodate hydraulic requirements over a 25 yr design period.
- The wet wells should be expandable to suit the physical parameters of the ultimate/build out pumping requirements of the station. Sufficient redundancy should be incorporated to ensure continual operation, i.e. backup power, redundancy of control, etc.

Back Up Power

- CVRD staff has indicated a preference for dual backup generators, each appropriately sized to operate independently.

Miscellaneous

- The station should be designed to allow for the direct inflow of sewerage from east Comox, per the recommendations of the following section.
- The new station should be designed in a manner that does not preclude the existing Willemar foreshore forcemain from being used a backup conduit, in the event the Docliddle station experiences a failure, or is temporarily taken out of service. (Secondary system redundancy).
- Consideration should be given to incorporating a jockey pump, to decrease pumping energy costs and wear of large, expensive pumps during non peak flow conditions.
- Odour control and building/site aesthetics should be addressed in the station's design.

Expected Construction Costs

- Based on the above noted design criteria, and recent construction costing received for similar projects, the Class D cost estimate for the Docliddle pump station is $9 million, inclusive of 50% engineering and contingencies.

5.1.10 Gravity Diversion Opportunities

Several gravity diversion options have been considered, in an effort to reduce the total effluent volume conveyed to the CVWPCC via the various CVRD pump stations. The benefits of gravity conveyance are significant, including:

- Decreased initial capital costs for pump station construction
- Increased service life of existing infrastructure
- Decreased operating and maintenance costs
- Decreased conveyance time, thus reducing production of hydrogen sulphides, foul odours and corrosive conditions.
- More sustainable infrastructure, increasing the probability of obtaining higher level government grants for construction.

5.1.10.1 Jane Street Catchment

A large portion of the Jane Street catchment could potentially be intercepted by the proposed Docliddle pump station.

The 2006 Town of Comox Sewerage Study established a sewerage system numbering scheme based on the five major sub catchments tributary to the Jane Street pump station. Catchment 5, as defined therein, encompasses approximately 20% of the lands tributary to the Jane Street pump station. Generally speaking, the eastern boundary of catchment 5 is coincident with the height of land running from Knob Hill to the Foxxwood area. The western catchment boundary parallels the alignment of Brooklyn Creek. Drawing S-12, located in Appendix R, indicates the exact boundaries of catchment 5.

A total area of approximately 230 Ha is presently serviced via the catchment 5 trunk sewer. This area does not include lands outside of the present day Town boundary in the Butchers Road area, which could (in future) drain to Jane Street. The total tributary area in aggregate is approximately 270 Ha.

Based on the proposed pump station location (Docliddle and Croteau Roads), approximately 190 Ha of existing serviced area and 40 Ha of future tributary land, could be intercepted upstream of the Jane Street station. Based on the Town of Comox hydraulic model, the total resultant peak wet weather flow reduction at Jane Street, present day, would be in excess of 90l/s. Long term, flows tributary to Jane Street could be reduced by over 100 l/s.

The majority of the lands tributary to the Colby Road pump station, approximately 66 Ha, could also be intercepted by the forcemain relocation system. However, the Colby pump station would still be required to service the relatively new Colby Road subdivision. Drawing S-12 outlines the area of potential diversion and the diversion pipe route.

5.1.10.2 Courtenay Pump Station Catchment

The potential may exist to redirect flows emanating in west Courtenay away from the Courtenay River pump station. Such a diversion would only be useful if an alternate treatment facility was available south of the City, or a submarine connection was constructed to convey flows from outlying southern areas to the CVWPCC. These concepts will be discussed in later sections.

Three diversion options are readily apparent, each allowing incrementally larger flows to be redirected away from the Courtenay River pump station. The desired outcome of this process is to decrease flows to the Courtenay River pump station, such that major upgrades to the station and forcemain are deferred, or negated entirely.

Option 1 - 26th Street Gravity Diversion

According to the City's sewerage model, present day peak wet weather flows tributary to the Mansfield pump station, and the 26th Street trunk sewer, total 54 l/s. Option 1 would require construction of a small pump station, presumably located at the site of the existing Mansfield pump station, as well a forcemain connection to a southern treatment facility. The gross area presently serviced that could potentially be diverted away from the Courtenay River pump station under Option 1, is 200 Ha. An additional (approximately) 400 Ha of land to the south of the 26th Street catchment is not yet serviced. In future, sewage from these areas that would otherwise need to be pumped to the Courtenay River station via the Courtenay River siphon, could be diverted away as well.

Option 2 - 21st Street Gravity Diversion

The 2001 City of Courtenay Sewer System Study recommended construction of the "Arden Central Trunk Sewer" (ACTS), as a replacement for the existing 21st Street trunk sewer. The 21st Street trunk conveys the majority of West Courtenay's sewerage flows to the Courtenay River pump station, via the siphon river crossing. The trunk was intended to service the western most areas presently within the City boundary, as well as any lands beyond, which over time may require sanitary servicing. The City has commenced upgrading of the 21st Street trunk sewer at strategic locations, focusing primarily upon sections which are nearest to, or have exceeded capacity.

It is possible to intercept the 21st Street system, and divert to a southern treatment facility by way of a new pump station located at either the existing Mansfield pump station location, or on the Comox Logging Road right-of-way. The catchment area serviced by the 21st Street trunk is significant. At present, approximately 420 Ha are serviced, however, long term, the potential service area of the 21st Street trunk is in excess of 1,500 Ha.

Option 3 - West Courtenay Catchment in Aggregate

It is possible to redirect all west Courtenay sewerage flows by intercepting at the Courtenay River siphon. At present, the (West Courtenay) area tributary to the siphon is 720 Ha. Long term, based on the "Blue/Green" map (refer to interim progress Memo #1, drawing S-7 for details), the total tributary area could approach 2,300 Ha. (A small portion of east Courtenay also drains to the siphon. These flows are minor, and only occur during large flow events, during which the Puntledge pump station is not able to keep up. Flows are diverted away from the Puntledge system by way of flow splitting manhole, and are redirected to the Anderton pump station via a gravity river crossing at Lewis Park).

Redirection of west Courtenay flows in aggregate would require construction of a large pump station within the 20th Street ROW, adjacent to the river. Redirection of West Courtenay flows in aggregate would reduce the peak wet weather flows to the Courtenay River by upwards of 500 l/s, long term.

Drawing S-13 – West Courtenay Catchment Diversion Details (Appendix R), indicates the three diversion opportunities outlined. Overall catchment areas can be found on the previously introduced drawing S-12.

Option 4 – Greenwood/Hudson Road Trunk Diversion

There are at present, modest sewerage flows generated in east Courtenay being pumped by the Courtenay River station which, long term, are intended to flow via the Greenwood Trunk sewer to the CVWPCC. However, these flows are expected to increase significantly, particularly as development of remaining Crown Isle lands increases.

5.1.10.3 Discussion

The opportunity to redirect gravity flows presently tributary to the Jane Street pump station would be immediate, assuming the Docliddle station is commissioned. It is recommended the CVRD give consideration to this option, as it could increase the remaining service life of the Jane Street station significantly, perhaps deferring the need for capacity driven upgrades indefinitely.

Gravity diversion options within the Courtenay River pump station catchment are largely dependent upon a southern treatment facility being constructed. The cost of constructing a new, very large pump station, forcemain of yet to be determined length, and provision of increased treatment capacity at a new southerly treatment facility, must be critically compared to the decreased costs of pumping to the CVWPCC, over the design life of the new infrastructure. Significant upgrades to the CVWPCC could also potentially be deferred, depending on the magnitude of flows diverted.

5.1.11 Nocturnal Pumping Options

A degree of system optimization can be achieved through the use of on line storage facilities and Supervisory Control and Data Acquisition (SCADA) systems. Very briefly, the nocturnal, or non peak period pumping idea seeks to reduce capital and system operating costs by coordinating conveyance infrastructure, providing a more uniform flow to the treatment facility. The initial costs of tankage infrastructure required to reduce capital costs of new infrastructure (vs. reducing operational costs) are significantly different.

In order to reduce the size of conveyance infrastructure through the implementation of nocturnal pumping, sufficient storage must be available to attenuate peak flow conditions, over an extended period of time. Providing this volume of storage, given the environmental and hydrogeologic conditions in the Comox Valley (i.e. total precipitation and elevated ground water conditions) would have a significant cost, both in terms of capital and operation and maintenance.

Alternatively, provision of increased wet well storage at pumping stations, and the introduction of a SCADA system, could decrease conveyance energy requirements, at a more modest cost. To fully capitalize on the utility provided by a SCADA controlled system, all new pump stations designs should include sufficient wet well storage to allow for each facility to pump into a common forcemain while all other facilities detain flows. The volume of storage required at each facility would need to be carefully analyzed, and should account for long term peak wet weather flows tributary to each station, pump cycle times, maintenance considerations, and potential for odour generation, etc.

This option is much more practical that the preceding option. Prudent design of conveyance infrastructure still requires sizing these components, especially pumps and forcemains, to handle simultaneous peak wet weather flows.

5.2 Outlying Areas

5.2.1 <u>On Site Disposal Opportunity Assessment</u>

EBA Engineering was retained as a subconsultant to investigate issues which will have an impact on the longevity of smaller on-site disposal systems within the CVRD. This would include individual, single dwelling systems and community systems discharging up to 22.75 m^3/day under the Ministry of Health (VIHA) jurisdiction[2], and private developments discharging more than 22.75m^3/day under the Ministry of Environment Municipal Sewage regulation (MSR) legislation.

There has been concern expressed by CVRD staff that these systems will likely fail over time and system owners may then approach the CVRD, requesting ownership and/or maintenance of these systems be assumed by the CVRD.

There are many examples of developed residential areas within the CVRD and outside of existing municipal boundaries, wherein relatively dense development has been allowed to occur, with individual on-site septic treatment and ground disposal as the sanitation means. For example, the Meadowbrook area, north of Courtenay, appears now to contain a growing number of failing ground disposal systems. Realistic sanitation options available for residents in these areas are:

1) Community based collection system and connection to the CVRD's trunk conveyance/treatment facilities or, over time.
2) Replacement of existing conventional septic tank and gravity disposal fields with more elaborate and sophisticated systems that include small (package) wastewater treatment facilities prior to ground disposal, costing roughly in the order of $30,000 per household.

By way of illustration, the <u>existing</u> Ships Point area has approximately 288 residential lots within the densely developed Tozer/ Ships Point Road neighbourhood. Thus, the approximate long term value of on-site system replacements in this area would be in the order of $8.6 million, assuming that single-home package treatment plants were universally required in this area. This is not an insignificant sum, as compared to a community based system.

---

[2] The maximum daily discharge allowed under VIHA regulation is 22,750 l/day, which approximately equates to 15 single family residential units.

GROUND DISPOSAL POTENTIAL

Complimentary geotechnical overview studies provided by EBA Engineering have been used to assess the relative potential for ground disposal of sewage, within the study area. The level of detail provided at this time is sufficient for the assessment of broad tracts of land, but should not be used for detailed/micro site assessment. The complete report can be found in Appendix E.

Several areas of existing, moderately dense development, have been identified as having poor to very poor ground disposal potential, specifically:

- Ships Point
- Waterfront properties throughout the entire CVRD
- "Downtown" UBID
- Large portions of Cumberland
- Meadowbrook/Huband area
- Kitty Coleman
- Saratoga/Miracle Beach Area

Some of these areas have begun to experience septic system failures, particularly the Meadowbrook/Huband and Saratoga/Miracle Beach areas. Further, significant new developments have been proposed, either through formal application, or through expression of interest, in nearly all of these areas. Thus, beyond the need to provide service to new development, the issue of remediation of existing failing systems should be addressed.

The CVRD does not currently have a mandate to provide sanitation services to areas of failing, or potentially failing, septic systems. However, political pressure may result from the high cost of individual package plant systems required to provide enhanced treatment prior to ground disposal and/or replacement of failing ground disposal systems, and the environmental impacts associated with failure.

5.2.2 Cumberland Liquid Waste Management Plan Status

Development in Cumberland, Interim Wastewater Treatment

The Village of Cumberland Wastewater Treatment Plant is a lagoon system, consisting of an aerated primary cell and a facultative secondary cell. Treated wastewater is discharged to Maple Lake Creek. Cumberland is currently engaged in a Liquid Waste Management Plan (LWMP) process, started in 1998. At the time of preparation of this report, the most recent document from the LWMP process was "Supplemental Report – Version 2", First Draft, January 27th, 2011.

This report identified several possible treated sewage discharge options:

- Discharge to Maple Lake Creek year round: The MOE is in the process of setting a new phosphorus water quality objective for streams on east Vancouver Island. This is likely to be 5 µg/L during May to September. The report noted that this will be a major challenge to meet.

- Discharge to Maple Lake Creek seasonally, with alternative discharge required for the summer period: The alternative summer discharge would avoid the above phosphorus restrictions.

- Ground application north of the Historic Village: No specific site was identified.

- Ocean discharge to the north end of Baynes sound, the Georgia Straight or via the existing Cape Lazo outfall.

Treatment options presented in the above report include:

- Lagoon treatment with phosphorus removal to allow year round discharge to Maple Lake Creek. Alternative discharge as required by the MSR would be either by constructed wetland, discharge to ground (rapid infiltration) or ocean outfall.

- Lagoon treatment with year round discharge to ground (rapid infiltration).

- Lagoon treatment with summer discharge to ground (rapid infiltration) and winter discharge to Maple Lake Creek.

- Discharge to a new regional treatment plant.

As the Cumberland sewage collection system has combined sewers, the system experiences very large I&I flows. The Village has a program in place to separate sewers by 2023. The report noted that treatment and disposal facilities would either need to be designed for the very high I&I seen in the system, or buffering storage for wet weather flows would be required.

The Village is involved in the CVRD South Regional Sewage System Collection, Treatment and Discharge Study, currently underway (which is associated with the 4th treatment option listed above).

The LWMP process, now underway in the Village of Cumberland, should be developed in concert with the Regional Sewerage Master Plan.

5.2.3 Centralized vs. De-centralized Treatment

Two distinctly different overall system configurations were initially considered; centralized treatment and decentralized treatment. Both of these concepts, by virtue of their generality, give rise to numerous sub options. Four variations of overall system servicing, two based on centralized treatment, and two on de-centralized treatment, were therefore considered. The attached drawings O1 through O4 (Appendix R) contain schematic representations of each option, as described in the following sections.

Servicing corridors for the outlying CVRD development nodes have been investigated. The greatest concentration of proposed development is generally found immediately adjacent to the Strait of Georgia. This geographic distribution greatly restricts the number of utility corridor options. The four overall system configurations discussed in following sections also limit route possibilities for these furthest outlying areas. Complete analysis conveyance route options for the following system configurations, and various sub options, can be found in Interim Progress Memo #2.

Capital construction cost and net present value estimates for each option considered are presented below. Each estimate contains allowance for each major components required to provide service to all CVRD development nodes.

Treated wastewater that cannot be reclaimed for beneficial use is normally disposed of via outfall discharge or infiltration to ground via subsurface tile fields or rapid infiltration basins. The feasibility of ground infiltration depends on local geological conditions and drainage, and this method is typically restricted to smaller plants serving up to a few thousand people. Larger plants typically require outfall discharges if the effluent cannot be beneficially used.

In the wet west coast climate, reclamation of effluent for irrigation will require either seasonal storage with irrigation of all stored effluent during the dry season, or irrigation during the dry season with outfall discharge (or other means of disposal/reuse) during the wet season. Stream (or wetland) augmentation may be considered where acceptable to regulatory agencies, but the feasibility of this approach depends on the local situation and on the size of the discharge relative to stream flow. Other potential uses for reclaimed water may include industrial applications (process water, cooling water, etc.), toilet flushing in high-density residential or commercial/institutional buildings, fire protection, and landscape impoundments. All of these applications require site-specific feasibility investigations and stakeholder consultation. Note the MSR currently requires an alternative method of disposing of all reclaimed water, in addition to any seasonal storage. We understand this requirement can be waived by the MOE if they are satisfied that there will be no public health protection implications or impact on treatment reliability.

For the purpose of developing cost estimates and comparing options in this Master Plan, secondary treatment with outfall discharge to open marine waters was assumed. Other options (advanced treatment with effluent reclamation and reuse and/or infiltration to ground) should also be considered in light of site-specific constraints, once the location and size of treatment facilities has been finalized.

Table 16 - Capital Cost Comparison, Conveyance And Treatment ($\$x10^6$)

	Option 1	Option 1a	Option 2	Option 2a
Route 1	198.6	197.3	186.7	238.4
Route 2	207.9	209.6	200.3	245.4
Route 3	203.3	217.2	188.5	233.6
Route 4	200.9	210.4	184.1	229.4
Route 5	209.8	207.3	198.7	243.8

Table 17 - Conveyance & Treatment Npv, i = 5% ($x10^6^)				
Option/Route	Conveyance	Treatment	Total	Rank
O1/R1	134.9	217	352	2
O1/R2	150.4	217	367	5
O1/R3	143.4	217	360	4
O1/R4	139.1	217	356	3
O1/R5	151.9	217	369	7
O1A/R1	133.6	217	351	1
O1A/R2	151.7	217	369	6
O1A/R3	161.2	217	378	10
O1A/R4	152.5	217	370	9
O1A/R5	152.3	217	369	8
O2/R1	83.3	300	383	12
O2/R2	102.7	300	403	14
O2/R3	85.1	300	385	13
O2/R4	80.3	300	380	11
O2/R5	104.1	300	404	15
O2A/R1	63.1	461	524	18
O2A/R2	74.3	461	535	19
O2A/R3	56.4	461	517	17
O2A/R4	50.5	461	512	16
O2A/R5	75.3	461	536	20

5.2.4 Centralized Treatment - Option 1

Option 1 assumes that all sewerage flows, regardless of origin, will be conveyed to the CVWPCC. In this scenario, all flows presently tributary to the Courtenay River pump station (with the exception of Crown Isle which is to be redirected long term), in addition to all future flows from Cumberland, Area A, and the RID/UBID LWMP area will be pumped by the Courtenay River pump station. The total peak wet weather flow tributary to the Courtenay pump station in this scenario is projected approach 2.3 m^3/s, on a 50 year horizon.

Long term, the Jane Street catchment would remain essentially as is, with only minor infill development over time. The total long term peak wet weather flow tributary to the Jane Street pump station, in the absence of any gravity diversions, will approach 0.4 m^3/s.

Sewerage flows generated in the existing development nodes of Saratoga/Miracle Beach and Kitty Coleman, would be conveyed to the CVWPCC via connection to the Greenwood trunk system. The total long term peak wet weather flow tributary to the CFB system would approach 0.8m^3/s over time.

The primary advantage of option 1 is the maximization of existing infrastructure, and resultant relative ease of corresponding approvals/permitting. A great deal of capital has been invested in the existing system. Conveyance and treatment infrastructure components have been designed/sized to accommodate future growth within the core area.

Two significant disadvantages exist with Option 1. The first, which becomes apparent when observing system schematic mapping, is in the large distances that sewage must be pumped from outlying areas to the CVWPCC. The Saratoga Beach development node is over 23km from the furthest reach of the proposed Greenwood trunk system. Similarly, Ships Point is over 28 km from the Courtenay River pump station. Secondly, the Courtenay River pump station will be grossly undersized. Construction of a pump station capable of conveying upwards of 2.3m3/s, against a TDH of up to 90 m (depending on route selection) may be considered prohibitively costly.

5.2.5 Centralized Treatment – Option 1a

Option 1a is similar in most respects to the preceding option. Flows tributary to the CFB Comox and Jane Street systems would be unchanged from Option 1. However, Option 1a provides relief to the Courtenay River pump station via a new pump station located in the Royston area, and submarine crossing of Comox Harbour.

The option was explored in modest detail in the 1992 NovaTec study, "Impact of Connecting Cumberland to the Comox-Strathcona Regional Collection System and Wastewater Treatment Plant". However, the study neither recommended in favour of, or against the submarine crossing.

5.2.6 De-Centralized Treatment – Option 2

The fundamental premise of Option 2 is that a second major treatment facility will be constructed to service Cumberland, Area A, and the RID/UBID LWMP area. Such a facility would be suitably sized to allow for the various development nodes, south of the current Courtenay pump station catchment area, (and possibly portions of it) to connect as the need arises.

A location has not been selected for the treatment facility. Ideally, the treatment plant location would be central to the majority of population growth, to which flows tributary by gravity would be maximized. The general Royston Improvement District area is a likely starting point in this regard. Locating the STP in an industrial district is typically preferable, as residential development adjacent to sewage treatment facilities could lead to complaints stemming from odour issues. Adjacent industrial land use would also provide increased opportunities to explore Integrated Resource Recovery (IRR) options.

Joint use of an upgraded outfall from the CVWPCC appears feasible, and may capitalize on discharge permitting already in place. On the basis of a recent high flow event, the result of which was reported to us by CVRD operations staff, the CVWPCC outfall and effluent pump station appear to be operating very near or at capacity (refer to 3.3.5 Treatment Plant Capacity Analysis). Future upgrades to the outfall and pump station could allow for the inclusion of flow from the new treatment plant. In this case, treated effluent from the proposed treatment facility would be pumped via submarine forcemain through Comox harbour.

It may be possible to utilize the existing Goose Spit forcemain to convey treated effluent from the tip of the spit to the Comox foreshore, in the short term. The Goose Spit forcemain was the former Town of Comox outfall, and is presently used by HMCS Quadra to convey sewerage to the CVWPCC, via connection to the foreshore forcemain. We understand that negotiations are ongoing between the CVRD and HMCS Quadra to replace the existing 10" AC forcemain. The relatively large diameter forcemain, and modest sewerage flows generated at the HMCS Quadra facility, lead to excessive pump times, and resultant hydrogen sulphide issues. Thus, in the foreseeable future, the Goose Spit forcemain may be redundant. We understand that the condition of the Goose Spit forcemain is fair to poor. Slip lining the conduit may increase the utility of this conduit. However, utilization of this infrastructure, should it prove feasible, would only be considered for the short term, allowing for the incremental construction of other system components.

Assuming the Willemar Bluffs section of forcemain is rendered redundant, it may be possible to utilize the abandoned section to convey treated effluent to the CVWPCC outfall. Although susceptible to exposure due to erosion, the forcemain may be decided acceptably suited to conveying treated effluent.

Treatment for the Hamlet of Saratoga Beach would be provided via a new facility. Similarly, a small standalone facility could be constructed to service the Kitty Coleman area.

5.2.7 De-Centralized Treatment – Option 2a

Option 2a considers the use of satellite treatment facilities at multiple development nodes. Locations of satellite facilities have been assumed to correspond with the Saratoga Beach, Kitty Coleman, Cumberland, Royston, Union Bay, and Ships Point development nodes. The CVWPCC would continue to service the municipalities of Comox and Courtenay.

This option provides the benefit of being "modular", i.e., construction of each nodal treatment facility could proceed as development dictates, and funding allows. The latter item is of particular importance, as it would appear the probability of receiving higher level government grants for funding of system upgrades in their entirety is low. Smaller satellite facilities could potentially be funded, at least in part, by major private sector developments requiring the service. For instance, Kensington Properties has an agreement in place with the CVRD to provide a treatment plant capable of being expanded to provide service to the Union Bay Improvement District. We understand that a developer in the Saratoga Beach Area has made a similar offer.

Option 2a has the potential to capitalize on the broadest range of Integrated Resource Recovery initiatives. In general, the greater the number of treatment facilities, the higher the potential for reuse of treated effluent. Additionally, pump distances are generally decreased as the number of treatment facilities increases.

However, the operating and maintenance costs associated with multiple small facilities are much greater than with centralized treatment, on an equivalent volumetric basis.

Effluent disposal options in some areas of the CVRD are limited. For instance, ocean discharge into Baynes Sound is likely to be contested by the shellfish industry, and large tracts of waterfront have soils that are unsuitable for ground discharge. The Ships Point area appears to be affected by both of these conditions.

The satellite treatment model could also be used to limit growth within specific geographic areas. Treatment capacity within a given development node or area could be limited to a predetermined value, beyond which development would not be able to proceed. Alternatively, development beyond that envisioned at the time of treatment plant design could be attended to via private, onsite treatment.

5.2.8 System Configuration Discussion

Provided below is a brief summary of the apparent advantages and detractions of the four overall system configuration options. The list is not exhaustive, but indicates the general scope and relative magnitude of issues anticipated to arise, for each option considered. A more comprehensive assessment of overall system configuration options follows.

Centralized Treatment (Options 1 and 1A) – Apparent Advantages

- Lowest cost option on a system-wide basis (when considering 50 year NPV).
- Maximizes use of existing infrastructure.
- Does not require siting of new treatment facility or outfall.
- Allows for the use of anaerobic digestion for the recovery and use of biogas.
- Utilizes permitting already in place.

Centralized Treatment (Options 1 and 1A) – Apparent Disadvantages

- Requires pumping of all wastewater flows from Courtenay River pump station catchment (includes the majority of Courtenay, Cumberland, UBID/RID and Ships Point areas) to the CVWPCC.
- Some odour sensitivity associated with existing treatment plant site.
- Outlying areas (e.g. Ships Point and Saratoga/Miracle Beach) require long pressure or gravity mains to convey sewage to the CVWPCC.
- Potential use of reclaimed water may be limited.
- Cost of servicing in most remote areas is high.

De-centralized Treatment (Option 2) – Apparent Advantages

- Maximizes gravity flow to reduce energy demand for pumping.
- New South STP would be located in the area anticipated to absorb the majority of new development, outside of the core area (Kensington, Cumberland, etc.)
- Satellite treatment plants increase potential (local) water reuse options.
- Allows potential use of anaerobic digesters at the CVWPCC and new southern treatment plant for production and use of biogas.
- Compatible with existing composting strategy for solid waste.

De-centralized Treatment (Option 2) – Apparent Disadvantages

- Requires siting of up to three new treatment facilities and two new outfalls, which will require extensive public/ stakeholder consultation and regulatory approvals.
- Operation of four treatment plants (three new plants plus existing CVWPCC) would be more costly than operation of a single large plant (Option 1 and Option 1a).
- Some areas are remote from their treatment plants (e.g., Ships Point is remote from the new South STP). Long forcemains and gravity sewers are required.
- More costly than Option 1.

De-centralized Treatment (Option 2a) – Apparent Advantages

- Avoids the need for major pumping station and forcemain to connect flow from Saratoga/Miracle Beach area to the CVWPCC system.
- Avoids the need for major pumping stations and forcemain connection Ships Point/RID/UBID area to the CVWPCC (or new southern treatment plant) systems.
- May increase the potential for use of reclaimed water and heat extraction.

De-centralized Treatment (Option 2a) – Apparent Disadvantages

- Requires siting of five new treatment facilities and outfalls.
- Operation of additional treatment plants would add to system complexity and operating costs.
- For the UBID, RID and Ships Point water reclamation plants, 100% use of reclaimed water will be difficult to achieve. Three new outfalls into Baynes Sound for disposal of effluent that cannot be reclaimed for beneficial reuse will require environmental impact studies, and will likely meet with public and stakeholder opposition, regardless of effluent quality. Discharge into Baynes Sound will require environmental impact studies.
- For the Cumberland water reclamation plant, 100% use of reclaimed water will be difficult to achieve, unless discharge to Maple Lake Creek (for low flow augmentation) is allowed. Discharge to Maple Lake Creek may be considered contentious, and public opposition may result.
- Smaller satellite treatment facilities are not large enough for cost effective production of biogas.
- Much more costly that all other options, when considering 50 year NPV.

5.3 Evaluation Criteria and Weighting – Matrix Comparison

The intent of the evaluation matrices is to provide a numeric ranking of the various system upgrading options, utilizing a set of unbiased, predetermined criteria. Criteria were grouped into the following categories:

- Technical Feasibility and Construction Considerations.
- Community and Environmental Considerations, and
- Cost Considerations.

Each criterion has been assigned a maximum weighting, based on the client group's evaluation of relative importance. The matrices have undergone several revisions, based on input from the client team. This input included both the selection of evaluation parameters and weighting of each parameter.

IRR concepts were added to the evaluation criteria in late 2008, at the request of CVRD staff. We have only touched on analysis of the viability / feasibility of incorporating IRR concepts into an overall system master plan design, specific detail being beyond the scope of this report. However, CVRD staff and politicians may well find it worthy of further analysis, in light of recent and on-going debate regarding the composition of proposed sewerage facilities in the Capital Regional District, for example.

The evaluation matrices only rank options based on tangible or quantifiable properties. We therefore caution that the outcome of these evaluation "tools" should be considered in conjunction with the other, less tangible considerations discussed below.

The first matrix is intended to identify the preferred core area routing option. Overleaf is a copy of the completed matrix. Additional information used in the evaluation of core area routes can be found on drawings S-11A through S-11E (Appendix R).

Based on the matrix evaluation, core area route 6 is preferred, even after being penalized for potential social and environmental impacts.

The second matrix, double overleaf, evaluates the four overall CVRD system configuration options presented. Based on the evaluation matrix, Option 1 ranks highest based on social/environmental and cost considerations, primarily due to the utilization of the CVWPCC, and existing outfall. Option 2a ranked highest in the technical feasibility category, largely due to "modular" nature of the system, and ability to reduce the relative sizing of system components.

Based on the matrix evaluation, overall system Option 1 is preferred. However further analysis is warranted as several equally important evaluation criteria not covered in the matrices could bear on ultimate system selection.

Table 18 - Overall System Ranking by Matrix Evaluation

	Technical Merit	Social & Environmental	Cost Considerations	Overall Ranking
Option 1	3	1	1	1
Option 1a	4	2	3	3
Option 2	2	3	4	2
Option 2a	1	4	4	4

Non Tangible Evaluation Criterion

The ability to sequentially fund a given overall system configuration, vs. the need for large, possibly unattainable sums of money required to fund a centralized treatment system, is not considered. The pros-

Comox Valley Regional District
Sanitary Sewer Master Plan

Core Area Route Selection Matrix

10-Nov-08

DRAFT
Rev 2 - Modified by MCSL

McElhanney

Route 1 =	McDonald/Idiens alignment
Route 2 =	Beaufort alignment
Route 3 =	Block 71 alignment
Route 4 =	Guthrie alignment
Route 5 =	Robb alignment
Route 6 =	Foreshore alignment

Points to be assigned:

1 = Least desirable
5 = Most preferred

				Route Alternate 1		Route Alternate 2		Route Alternate 3		Route Alternate 4		Route Alternate 5		Route Alternate 6 (Forshore Route)		
	Decision Criterion	Weighting Factor	Points Available	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points	Route Ranking (high to low
	1. TECHNICAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS															
Pressure Sewers	Maximum elevation of route	10	5	2	4	3	6	2	4	2	4	2	4	5	10	
	Number of high points (air valves required)	6	5	4	4.8	2	2.4	4	4.8	4	4.8	4	4.8	5	6	
	New ROW required over private lands	8	5	2	3.2	4	6.4	3	4.8	2	3.2	4	6.4	4	6.4	
	Potential for conflict with existing subsurface infrastructure	8	5	4	6.4	1	1.6	3	4.8	4	6.4	2	3.2	4	6.4	
Gravity Sewers	Depth of pipe is minimized	10	5	4	8	4	8	1	2	2	4	1	2	4	8	
	New ROW required over private lands	8	5	4	6.4	4	6.4	2	3.2	4	6.4	4	6.4	4	6.4	
	Geotechnical suitability	5	5	4	4	5	5	2	2	4	4	4	4	5	5	
	Potential overlap with future municipal infrastructure projects	3	5	2	1.2	4	2.4	2	1.2	4	2.4	4	2.4	4	2.4	
	Potential for conflict with existing subsurface infrastructure	8	5	4	6.4	1	1.6	2	3.2	4	6.4	2	3.2	1	1.6	
	Subtotal (43%)		45	30	44.4	28	39.8	21	30	30	41.6	27	36.4	36	52.2	
	2. COMMUNITY AND ENVIRONMENTAL CONSIDERATIONS															
	Maximization of gravity potential (length)	10	5	4	8	1	2	5	10	4	8	5	10	1	2	
	Disruption to existing commercial areas	6	5	4	4.8	2	2.4	2	2.4	3	3.6	4	4.8	5	6	
	Disruption to existing residences (traffic/access/boulevard restoration/etc.	5	5	4	4	2	2	4	4	3	3	2	2	4	4	
	Vehicular and pedestrian traffic disruption during construction	5	5	4	4	1	1	2	2	3	3	3	3	4	4	
	Potential impact to riparian areas	5	5	4	4	3	3	4	4	4	4	3	3	0	0	
	Potential conflict with other organizations	6	5	4	4.8	3	3.6	4	4.8	4	4.8	2	2.4	2	2.4	
	Regulatory approvals required (includes ALR and FOC)	7	5	2	2.8	4	5.6	2	2.8	2	2.8	4	5.6	0	0	
	Potential for Integrated Resource Management	4	5	3	2.4	3	2.4	3	2.4	3	2.4	3	2.4	3	2.4	
	Subtotal (38%)		40	29	34.8	19	22	26	32.4	26	31.6	26	33.2	19	20.8	
	3. COST CONSIDERATIONS															
	Overall expected capital cost	10	5	4	8	3	6	1	2	2	4	2	4	5	10	
	Financial risks associated with uncertainty in route, construction methodology	10	5	3	6	4	8	2	4	2	4	2	4	3	6	
	ROW acquisition costs	4	5	2	1.6	3	2.4	2	1.6	2	1.6	3	2.4	4	3.2	
	Operating and maintenance costs (including energy)	10	5	3	6	3	6	3	6	3	6	3	6	3	6	
	Subtotal (19%)		20	12	21.6	13	22.4	8	13.6	9	15.6	10	16.4	34	46	
	Totals		105	71	100.8	60	84.2	55	76	65	88.8	63	86	89	119	
					1		3		5		2		4			

Note: High score to reflect a lesser degree of negative impact or a higher degree of positive impact.

Comox Valley Regional District
Sanitary Sewer Master Plan
Overall System Configuration
Rev 2 - Modified by MCSL March 25, 2009

McElhanney

Option 1 =	Centralized Treatment at CVWPCC Via Courtenay River PS
Option 1a =	Centralized Treatment at CVWPCC Via South Courtenay PS
Option 2 =	De-centralized Treatment, Large Facility Option
Option 2a =	De-centralized Treatment, Multiple Small Systems

Points to be assigned:
1 = Least desirable
5 = Most preferred

				Centralized Treatment				De-centralized Treatment			
				Option 1		Option 1a		Option 2		Option 2a	
	Decision Criterion	Weighting Factor	Points Available	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points	Points Given	Weighted Points
	1. TECHNICAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS										
	Scour Velocity (Short term) - per change in population density over time	8	5	2	3.2	1	1.6	3	4.8	4	6.4
	Route encumbrances	5	5	2	2	2	2	3	3	4	4
	Potential for conflict with existing subsurface infrastructure	2	5	1	0.4	2	0.8	3	1.2	4	1.6
Gravity Sewers	Depth of pipe is minimized	2	5	2	0.8	1	0.4	3	1.2	4	1.6
	Route encumbrances	5	5	2	2	1	1	3	3	4	4
	Potential for conflict with existing subsurface infrastructure	6	5	1	1.2	2	2.4	3	3.6	3	3.6
Other	Potential overlap with future infrastructure projects	6	5	3	3.6	2	2.4	1	1.2	4	4.8
	Number of pump stations minimized	10	5	2	4	1	2	3	6	4	8
	Pumping distance minimized	8	5	2	3.2	3	4.8	4	6.4	5	8
	Maximizes use and utility of existing infrastructure	8	5	5	8	4	6.4	2	3.2	1	1.6
	Ease of effluent disposal approvals	9	5	5	9	5	9	2	3.6	1	1.8
	Infrastructure is incrementally expandable	8	5	1	1.6	2	3.2	3	4.8	4	6.4
	Maximizes LWMP outcomes as previously approved via referendum	6	5	2	2.4	2	2.4	4	4.8	3	3.6
	Subtotal (45%)		65	30	41.4	28	38.4	37	46.8	45	55.4
	2. COMMUNITY AND ENVIRONMENTAL CONSIDERATIONS										
General	Disruption to existing commercial areas	4	5	1	0.8	2	1.6	3	2.4	3	2.4
	Disruption to existing residences (traffic/access/boulevard restoration/etc.	2	5	2	0.8	3	1.2	3	1.2	4	1.6
	Potential impact to riparian/environmentaly sensitive areas	8	5	4	6.4	3	4.8	3	4.8	1	1.6
	Regulatory approvals required (includes ALR and FOC)	8	5	4	6.4	3	4.8	3	4.8	1	1.6
	Proximity of treatment facilities to urban areas	4	5	4	3.2	4	3.2	3	2.4	1	0.8
	Sensitivity of aquatic receiving environment	9	5	5	9	5	9	2	3.6	1	1.8
	Availability of land (treatment plant location)	4	5	5	4	5	4	3	2.4	2	1.6
IRM	Potential for heat exchange	8	5	2	3.2	2	3.2	3	4.8	4	6.4
	Potential for water reclamation/reuse	8	5	2	3.2	2	3.2	3	4.8	5	8
	Potential for off-gas collection	8	5	4	6.4	4	6.4	2	3.2	1	1.6
	Potential for avoidance of big trunk sewers	8	5	2	3.2	2	3.2	4	6.4	4	6.4
	Subtotal (38%)		55	35	46.6	35	44.6	32	40.8	27	33.6
	3. COST CONSIDERATIONS										
	Overall expected capital cost (NPV)	10	5	3	6	3	6	2	4	1	2
	Financial risks associated with uncertainty, construction methodology	10	5	4	8	2	4	2	4	2	4
	ROW acquisition costs	5	5	3	3	3	3	3	3	3	3
	Operating and maintenance costs	8	5	5	8	4	6.4	3	4.8	2	3.2
	Relative potential for cost recovery through IRM	7	5	3	4.2	3	4.2	3	4.2	3	4.2
	Subtotal (17%)		25	18	29.2	15	23.6	13	20	11	16.4
	Totals	0	145	83	117.2	78	106.6	82	107.6	83	105.6

Note: - High score to reflect a lesser degree of negative impact or a higher degree of positive impact.

pect of Sewerage Commission borrowing large sums of money to fund a centralized treatment system, with little or no guarantee of revenue stream [directly proportional to new development and/or new system users] is not preferred by some members of the client team. Similarly, the ability to support, or otherwise encourage development in rural areas is not addressed by the decision matrices. The CVRD may decide that the advancement of in- stream developments is a deciding factor is assessing preferred system configuration.

The four overall CVRD system configuration options described thus far have provided a basis for comparison. However, each of the option considered, [1, 1a, 2 and 2a], has significant detractors. For instance:

- Centralized treatment Option 1 represents a very large initial capital outlay, and would involve pumping sewage to the CVWPCC from the farthest reaches of the CVRD, likely beyond the reasonable service area.
- Centralized treatment Option 1a has similar detractors: large initial capital outlay, and long distance pumping/conveyance requirements.
- De-centralized treatment Option 2 calls for a small treatment facility in the Kitty Coleman area. Service may not be required in this area, and more cost effective servicing options exist.
- De-centralized treatment Option 2a implies onerous O&M requirements, and far exceeds the cost of other options, based on 50 year net present value.

The preferred overall system configuration should optimally account for:

- Sequential cash flow needed to fund the system construction, and later operation and maintenance;
- Relative potential to exploit IRR concepts;
- Accommodation of in-stream development and funding potential;
- Avoid short term capital outlays for treatment and disposal works to be rendered redundant over the longer term;
- And provide consistency with commitments/agreements previously developed with major land developers to construct treatment facilities in outlying areas.

In order to provide a recommended overall system configuration and servicing strategy, in the absence of resolution of the issues identified in the Governance Discussion Paper (Appendix O), a number of simplifying assumptions were required. The following list of assumptions and limitations has been developed and agreed upon with the client team:

1. Population estimates completed as part of interim progress memo number 1 are to be utilized in the development of the sewerage master plan. The Region Growth Strategy, commenced subsequent to the sewerage system master plan study, may ultimately dictate differing population projections, and, equally importantly, differing spatial distribution of new populations. The greatest uncertainty appears to be in the areas south of the core area, i.e.: Union Bay, Cumberland and remaining portions of Electoral Area A.
2. Governance and operational issues as noted in discussion paper Appendix O, will be resolved, and will be compatible with the draft system master plan.
3. Environmental Impact Studies (EIS) will be undertaken, and will support:

a. Continued discharge into the Strait of Georgia at the CVWPCC,

b. The construction of a new outfall into Baynes Sound, or further out, to a point roughly coincident with the point of existing outfall discharge.

c. The construction of a new outfall serving the Saratoga Beach area.

4. The Village of Cumberland LWMP, now underway, will include connection to the Regional system, within the timelines noted herein. The Ministry of Environment has not yet accepted the Village's Constructed Treatment Wetland concept, given the large increase in population expected.

5.4 Hybrid Options 3 and 3A

Based on the above assumptions and limitations, two preferential hybrid configurations emerge. These hybrid configurations, Option 3, and 3a, are discussed in following sections. The 11x17 drawings entitled 'O6', overleaf, and drawing 'O7', double overleaf, indicate the schematic layout of Options 3 and 3a respectively. The component numbering indicated thereon corresponds to descriptions in cost estimates which follow.

5.4.1 Component Descriptions – Core Area

The existing Comox Valley Water Pollution Control Center (Brent Road) facility will continue to provide sewage treatment for the core area under both Options 3, and 3a. All present day tributary areas, as well as future core are expansion areas, per the "Blue/Green" memorandum of understanding will be treated at Brent Rd.

If warranted by development pressure, or health concerns, the Kitty Coleman area could connect to the Greenwood system. For the sake of comparison in this study, we have assumed this connection will be made.

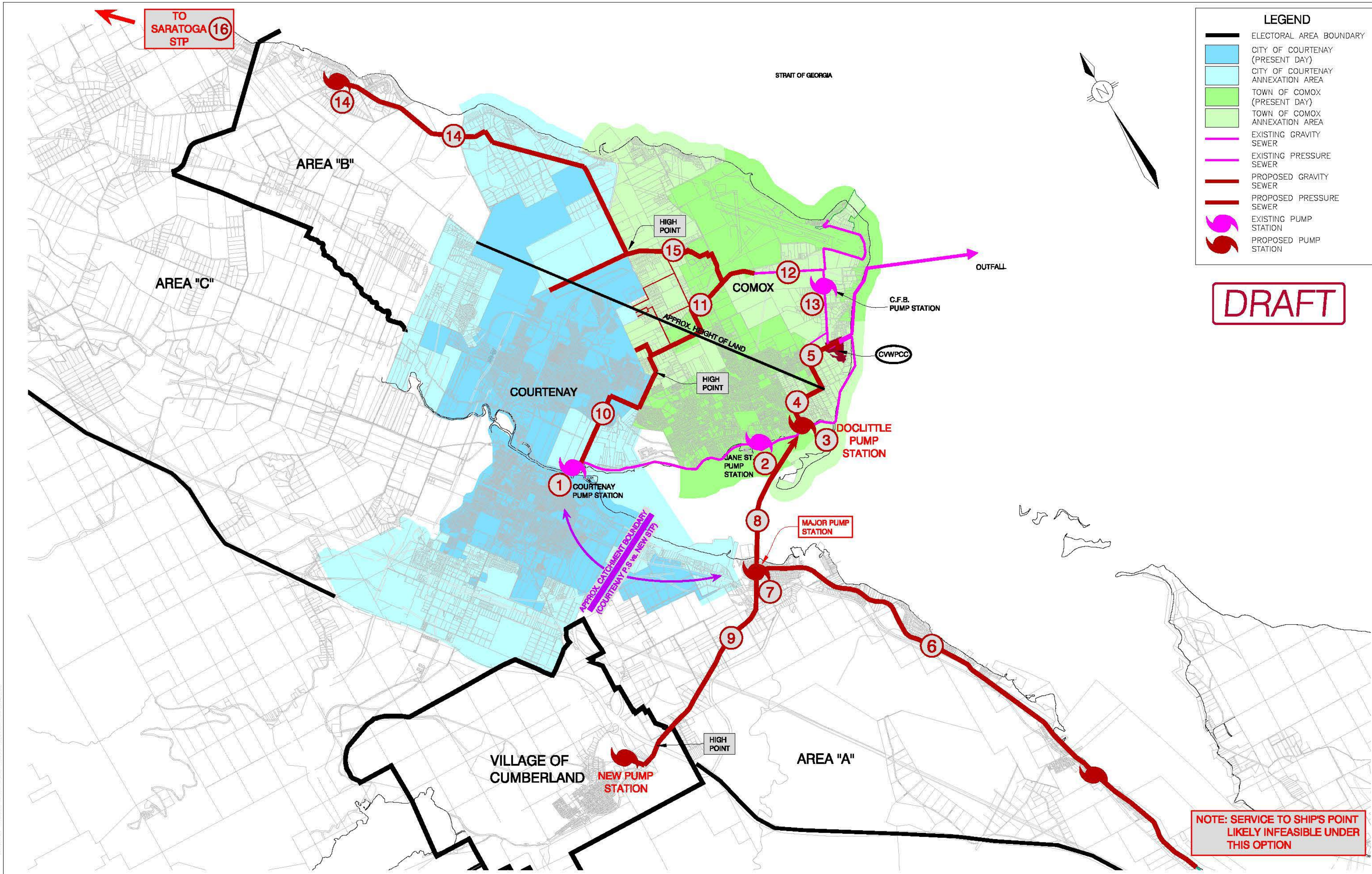
Both options, 3, and 3a, have assumed the construction of core area route 6, the default foreshore alignment. Each of these scenarios would necessitate the construction of the Docliddle station, though design flows and corresponding station sizing would vary greatly. Tables 19 and 20 contain major component listings and cost estimates for options 3 and 3a. These tables can be found in Appendix S. Note contingencies and engineering costs have not been incorporated into the overall servicing costs presented in Tables 19 and 20.

5.4.2 Component Description - North Area [Saratoga Beach]

Options 3 and 3A include identical servicing concepts for the northernmost areas of the study, Saratoga and Miracle Beach. The Saratoga/Miracle Beach development node should be serviced via a standalone treatment facility, sized to ultimately accommodate a population of roughly 14,000.

5.4.3 Component Description - Areas South of Courtenay

Options 3 and 3A propose to direct sewage from Union Bay, Cumberland, Royston, and the remaining portions of Electoral Area A to a central point, likely near the intersection of Hwy 19a and Royston Road.



No.	Date	Revision	Dr.	Chk'd

McElhanney

McElhanney Consulting Services Ltd.

495 SIXTH STREET
COURTENAY, B.C. V9N 6V4
PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A	Checked: IW/BH	Date:04/DEC/2008
Drawn: RC	Surveyed:N/A	

SCALE N.T.S.

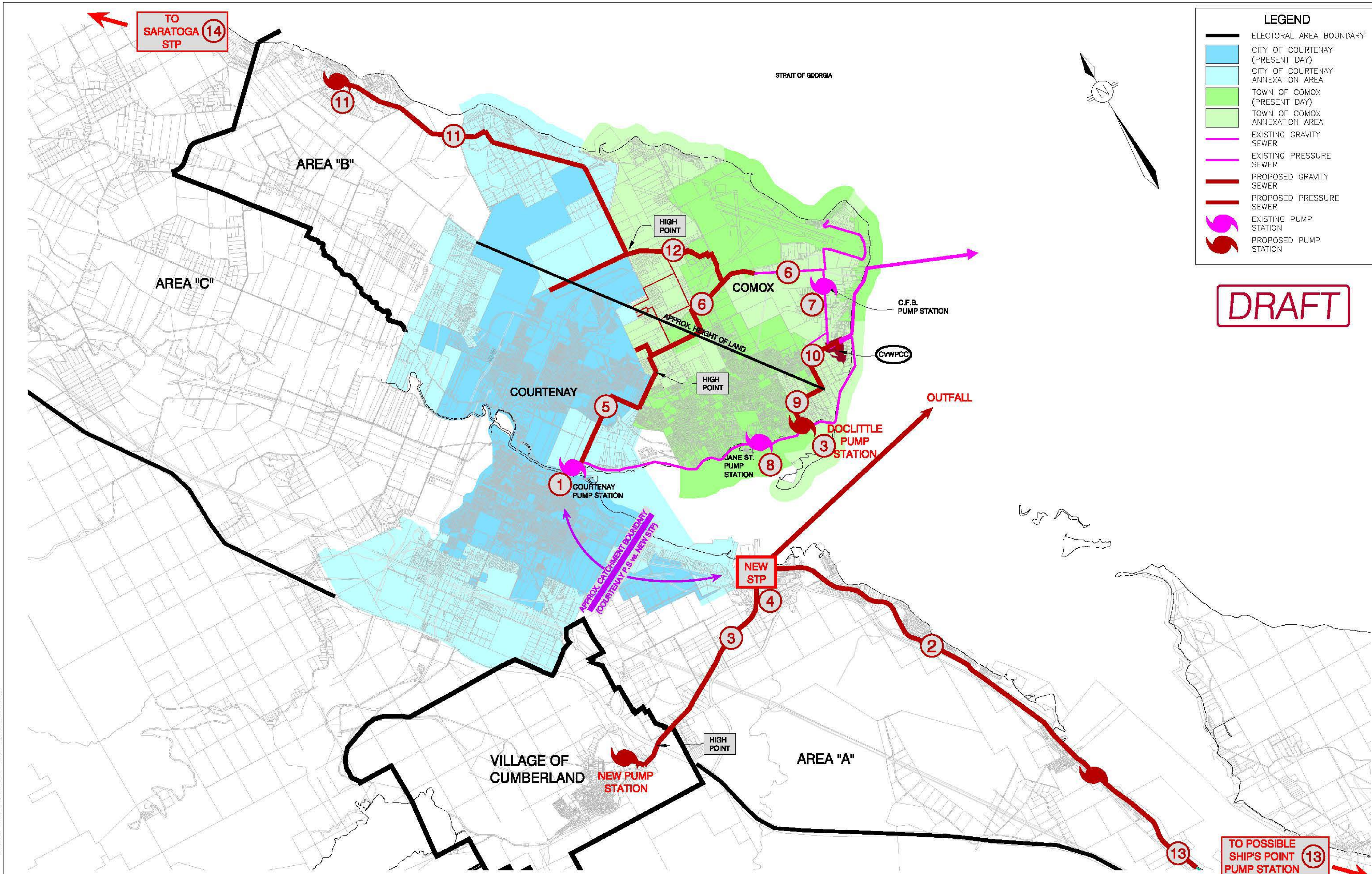
Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

SYSTEM COMPONENT SCHEMATIC
OVERALL MASTER PLAN OPTION 3
CVRD MASTER SEWERAGE STUDY
COMOX VALLEY, BC

Client Drawing No
MCSL Project No. 2211-46970-0
Drawing No. O-6
Sheet 1 of 2 Revision 2

Destroy all prints bearing previous number



No.	Date	Revision	Dr.	Chk'd

McElhanney
McElhanney Consulting Services Ltd.
495 SIXTH STREET
COURTENAY, B.C. V9N 6V4
PH (250) 338-5495
FAX (250) 338-7700

Designed: N/A | Checked: IW/BH | Date: 04/DEC/2008
Drawn: RC | Surveyed: N/A
SCALE N.T.S.
Approved Sealed

COMOX VALLEY REGIONAL DISTRICT

SYSTEM COMPONENT SCHEMATIC
OVERALL MASTER PLAN OPTION 3A
CVRD MASTER SEWERAGE STUDY
COMOX VALLEY, BC

Client Drawing No
MCSL Project No. 2211-46970-0
Drawing No. O-7
Sheet 2 of 2
Revision 2
Destroy all prints bearing previous number

Plotted: May 19, 2011, 14:39:48 Filename: K:\ENG\46970\final emp\46970 FINAL\MEMO MAY 2011.dwg 'O-7

The primary variation in Options 3 and 3a, lies in the location of treatment facilities accommodating projected flows from south of Courtenay.

Under Option 3, a large pump station would convey raw wastewater toward the CVWPCC for treatment. The routing of flow could be either via a submarine crossing to Comox, or toward the existing Courtenay pump station. We have assumed under Option 3, a submarine crossing will be utilized, and have based cost estimates on this scenario. This said, at the pre-design stage, consideration should also be given to pumping southern sewerage flows toward the Courtenay pump station. Later, more detailed costing analysis of this scenario may justify further consideration. Similarly, more comprehensive evaluation of Option 3 at the time of detailed design may determine the gravity conduit between Cumberland and the Southern "Major Pump Station" is better suited as a pressure line, utilizing potential energy to decreasing overall pumping costs to the CVWPCC.

By contrast, Option 3a proposes to site a new treatment facility in the UBID/RID area. This treatment plant would be designed to incrementally accommodate long term development projections, and would discharge treated effluent (which is not reclaimed for reuse) via a new outfall into Baynes Sound, or potentially beyond into the Strait of Georgia. Option 3a provides the additional benefit of allowing feasible service to the Ships Point area, which is at or beyond the reasonable limit of the CVWPCC service area.

Under Option 3, Ships Point will continue to be serviced by individual ground disposal systems. We note the CVRD's recent efforts, through Payne Engineering Ltd, toward proving the ongoing viability of existing small on-site systems in the RID and UBID areas. Similar effort is needed in the Ships Point area, in order to assess need for planning of a community based system there.

It has been assumed Cumberland will connect to the CVRD system when the municipal population reaches 5000 people. This assumption is predicated on the constructed treatment wetland concept not being favoured as a long term solution by the Ministry of Environment.

It is recommended that the southern treatment facility be located so as to capitalize on gravity flow from the Village of Cumberland. The majority of the southern STP's tributary area (outside of Cumberland) will likely need to be pumped, regardless of location. By locating the new STP such that Cumberland flows need not be pumped a second time, construction of a major (0.5m3/s) pump station can be avoided.

5.4.4 Sewage Treatment

5.4.4.1 Option 3

The treatment plants and areas serviced under Option 3 are summarized in Table 21.

Table 21 - Option 3 Treatment Plants				
Plant	**Tributary Areas**	**Ultimate Service Population**	**Discharge**	**Treatment Standard**
CVWPCC (existing plant expanded)	Comox, Courtenay, RID, UBID Cumberland, Kitty Coleman	160,000	Georgia Strait	Secondary for marine discharge
Saratoga STP (new plant)	Saratoga	14,300	Georgia Strait	Secondary for marine discharge
Total Ultimate Population Served		174,300		

CVWPCC UPGRADING – OPTION 3

The total useable area for construction of treatment facilities at the CVWPCC site is estimated to be approximately 9 hectares, assuming a 30 meter buffer zone around the property perimeter. The site is sufficiently large to house treatment facilities for the ultimate service population of 160,000 people. A new treatment train and second outfall would be required to service the populations greater than 47,000 people. The plant would continue to meet secondary treatment standards for open marine discharge.

The timing of decommissioning of the existing Cumberland STP and connecting this system to the CVWPCC is dependent on developments in Cumberland, but is assumed to occur in the next 5 to 10 years, at a threshold population of 5000 people tributary.

Saratoga STP – OPTION 3

A satellite treatment plant would be constructed in Saratoga. Treated effluent would be required to meet secondary treatment standards for open marine discharge, unless reclamation of some or all of the effluent for irrigation or other purposes was implemented. An outfall for the plant would extend out into the Georgia Strait. The new facility should be located in an area zoned for industrial use if possible, away from residential development.

An area of approximately 3 hectares would be required for the proposed Saratoga Beach treatment plant, inclusive of a 30 m perimeter buffer.

5.4.5 Option 3a

Option 3a includes expansion of the existing CVWPCC and construction of two new treatment plants, with 50-year tributary populations as shown in Table 22.

Table 22 – Option 3a Treatment Plants

Plant	Tributary Areas	Ultimate Service Population	Discharge	Treatment Standard
CVWPCC (existing plant expanded)	Comox, Courtney, Kitty Coleman	117,000	Georgia Strait	Secondary for marine discharge
South STP (new plant)	Cumberland, RID, UBID	43,000	Georgia Strait	Secondary for marine discharge
Saratoga STP (new plant)	Saratoga	14,300	Georgia Strait	Secondary for marine discharge
Total Ultimate Population Served		174,300		

CVWPCC UPGRADING – OPTION 3a

The CVWPCC would continue to treat wastewater from the core areas of Comox and Courtney, with the addition of the Kitty Coleman/Bates Beach area. The site is large enough to accommodate infrastructure requirements to service the full build out population under Option 3a.

As with Option 3, a second outfall would be required to service the populations greater than 47,000 people. The plant would continue to meet secondary treatment standards for open marine discharge.

South STP

It has been assumed that a suitable site will be located for the South STP somewhere in the Royston/Union Bay area. Ideally, the new facility would be located in an area zoned for industrial use, thus avoiding construction of a treatment plant directly adjacent to residential development.

Two outfall configurations have been considered at the South STP:

1. Treated sewage from the South STP would be pumped across the Comox Harbour to the existing CVWPCC outfall. A second outfall would be required at the CVWPCC once the combined service population for the two plants exceeds 47,000 people.
2. A separate outfall could be constructed specifically for the South STP. The new outfall would extend through Baynes Sound and into the open waters of Georgia Strait. An interim condition, shorter outfall may be possible, depending on effluent quality and flow rates.

The preferred option would be selected based on the location of the South STP, environmental impacts and costs. For the sake of comparison in this study, it has been assumed a new outfall would be constructed. Detailed study, beyond the scope of this Master Plan, will be required prior to design.

As with Option 3, the timing of decommissioning of the existing Cumberland STP (lagoons) and connecting this system the CVWPCC is assumed be deferred for 5 to 10 years at a minimum, recognizing total decommissioning may never be achieved. The Village of Cumberland has indicated a preference for utilizing the existing lagoon system, perhaps indefinitely, as a means of attenuating peak wet weather flows tributary to a regional system. Analysis of the practical implications of utilizing sewerage storage basins exposed to precipitation and ground water influence is beyond the current scope of study.

The South STP would have to meet secondary treatment standards for open marine discharge, unless reclamation of some or all of the effluent for irrigation or other purposes was provided for. An area of approximately 5 hectares would be required for this treatment plant. This includes a 30 m buffer.

Saratoga STP

Sewage treatment in Saratoga Beach is identical under both options.

5.4.6 Integrated Resource Recovery

5.4.6.1 Option 3

The CVWPCC, currently recovers resources through composting of waste solids. This practice could likely continue into the future, regardless of the breadth of expected upgrades to the plant, as composting is carried out at the CVRD's solid waste facility.

Anaerobic digestion for production of biogas can be considered for the future at the CVWPCC. This would require the use of space-efficient technologies for liquid treatment, due to land shortage. The biogas collected could potentially be used for generation of electricity, firing boilers, or as a vehicle fuel, although the latter use requires prior scrubbing of the gas.

As the facilities are upgraded and expanded, on-site use of reclaimed water for non-potable applications at the plant should be maximized. Production of reclaimed water for off-site use will depend on the proximity of potential users. If markets are identified, portions of the effluent from the secondary treatment facilities could be treated to reclaimed water standards.

5.4.6.2 Option 3a

Under Option 3a, the potential for recovery and beneficial use of waste solids at the CVWPCC and the South STP would be similar to those for Option 3 (i.e., continue with composting, and consider anaerobic digestion for the future). Space limitations at the CVWPCC would be less restrictive for Option 3a (i.e., use of a more space-efficient technology for liquid treatment may not be required). Use of multiple plants would potentially access a wider market for use of reclaimed water. There is more undeveloped land proximal to the proposed southern STP, and thus the cost effective potential for re-use would be greater.

5.4.7 Overall Treatment & Conveyance Capital Cost Estimates, Net Present Value – Options 3 & 3A.

The capital construction costs for Options 3 and 3a have been estimated to be $208 million and $204 million, respectively (a differential of less than 2%). Given the relative magnitude of the costs, and the "Class D" estimation method used to derive these costs, the totals are essentially indistinguishable. Tables 19 and 20, (Appendix S) provide a breakout of component capital costs for each option. Total treatment and conveyance capital costs for each option are summarized as follows:

Table 23 - Options 3 & 3a Conveyance and Treatment Cost Breakout (Millions of Dollars)

Component	Option 3	Option 3a
Treatment	108.6	134.6
Conveyance	99.4	69.6
Total	208.0	204.2

Based on the capital construction cost estimates for options 3, and 3a, and expected operational and maintenance costs, we have determined the following net present values for each option:

OPTION 3 Net Present Value = $222.5 Million

OPTION 3a Net Present Value = $233.9 Million

As with the variation in capital construction costs, the relative difference in NPV is modest, particularly with consideration given to the magnitude of costs, and conceptual nature of cost estimates to date.

5.5 Option 3 & 3A Matrix - Analysis

In order to further evaluate the relative merits of options 3, and 3a, the same matrix evaluation process used to evaluate overall system options 1 through 2a was utilized. The completed matrix can be found overleaf.

Based on the matrix evaluation, option 3a is preferred. This preference is based largely on Option 3a's technical feasibility. However, option 3 was ranked nearly identically to option 3a in the community/environmental and cost considerations sections, garnering 60 of 80 possible points, vs Option 3a's 61.4 of 80. As was undertaken for options 1 and 2, the following is a further comparative discussion of options 3and 3A, intended to differentiate beyond (or in addition to) the numeric matrix evaluations.

Comox Valley Regional District
Sanitary Sewer Master Plan

Overall System Configuration

Feb 01 2011

DRAFT

Rev 2 - Modified by MCSL

McElhanney

Points to be assigned:
1 = Least desirable
5 = Most preferred

	Decision Criterion	Weighting Factor	Points Available	Hybrid Treatment – Option 3: Points Given	Hybrid Treatment – Option 3: Weighted Points	Hybrid Treatment – Option 3a: Points Given	Hybrid Treatment – Option 3a: Weighted Points
	1. TECHNICAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS						
Pressure Sewers	~~Maximum elevation of route~~						
	Scour Velocity (Short term) - per change in population density over time	8	5	1	1.6	4	6.4
	Route encumbrances	5	5	4	4	4	4
	Potential for conflict with existing subsurface infrastructure	2	5	4	1.6	4	1.6
Gravity Sewers	Depth of pipe is minimized	2	5	4	1.6	4	1.6
	Route encumbrances	5	5	4	4	4	4
	Potential for conflict with existing subsurface infrastructure	6	5	4	4.8	4	4.8
Other	Potential overlap with future infrastructure projects	6	5	2	2.4	5	6
	Number of pump stations minimized	10	5	3	6	4	8
	Pumping distance minimized	8	5	1	1.6	5	8
	Maximizes use and utility of existing infrastructure	8	5	4	6.4	2	3.2
	Ease of effluent disposal approvals	9	5	4	7.2	1	1.8
	Infrastructure is incrementally expandable	8	5	3	4.8	3	4.8
	Maximizes LWMP outcomes as previously approved via referendum	6	5	2	2.4	4	4.8
	Subtotal (45%)		65	40	48.4	48	59
	2. COMMUNITY AND ENVIRONMENTAL CONSIDERATIONS						
General	Disruption to existing commercial areas	4	5	3	2.4	3	2.4
	Disruption to existing residences (traffic/access/boulevard restoration/etc.	2	5	3	1.2	4	1.6
	Potential impact to riparian/environmentaly sensitive areas	8	5	2	3.2	2	3.2
	Regulatory approvals required (includes ALR and FOC)	8	5	2	3.2	1	1.6
	Proximity of treatment facilities to urban areas	4	5	2	1.6	3	2.4
	Sensitivity of aquatic receiving environment	9	5	4	7.2	1	1.8
	Availability of land (treatment plant location)	4	5	4	3.2	4	3.2
IRM	Potential for heat exchange	8	5	2	3.2	3	4.8
	Potential for water reclamation/reuse	8	5	2	3.2	3	4.8
	Potential for off-gas collection	8	5	4	6.4	3	4.8
	Potential for avoidance of big trunk sewers	8	5	2	3.2	4	6.4
	Subtotal (38%)		55	30	38	31	37
	3. COST CONSIDERATIONS						
	Overall expected capital cost (NPV)	10	5	2	4	2	4
	Financial risks associated with uncertainty, construction methodology	10	5	3	6	5	10
	ROW acquisition costs	5	5	3	3	3	3
	Operating and maintenance costs	8	5	3	4.8	2	3.2
	Relative potential for cost recovery through IRM	7	5	3	4.2	3	4.2
	Subtotal (17%)		25	14	22	15	24.4
	Totals	0	145	84	108.4	94	120.4

Note:
- High score to reflect a lesser degree of negative impact or a higher degree of positive impact.
- Refer to MCSL drawings 2211-46970-0 sheets O1 through 01 for further information regarding overall system configuration options

5.6 System Selection Criteria Not Accounted for in Matrix Evaluations

5.6.1 Variation in Cash Flow Implications/Requirements

It has been assumed thus far that funds obtained via borrowing bylaw for construction of sanitation systems will be amortized over a period of 25 years. The 50 year study horizon exceeds this. The implication of these differing timelines is that, where components cannot be incrementally expandable, funds may potentially need to be recovered in full from a population that is less than the population for which the infrastructure was designed to accommodate. This is the scenario that was used to fund the existing system, in the early 1980's. However, this may prove to be contentious in the current context, given the magnitude of servicing costs, and the perception of subsidized rural growth.

The CVRD's financial experts may decide that adopting multiple, phased borrowing bylaws is preferred to a single large bylaw. Depending on the required timing of service to each specific service area, repayment under these bylaws may need to overlap, leading to multiple charges being levied against some users. However, the aggregate cost of these charges per dwelling unit may be less than a single large fee, as the costs of construction are then more proportionate to the number of users.

Alternatively, infrastructure could be sized to accommodate a growth horizon coincidental with the amortization of loans. The primary detractor in this scenario is that servicing costs, particularly conveyance, would be greatly increased, due to the need to install duplicate infrastructure over time. Depending on the timing of upsizing, public perception relative to what might be seen as wasteful duplication of past construction could also be negative. This scenario would however, in some circumstances, reduce the O&M costs associated with large infrastructure components being initially underutilized (large diameter pipelines, for example).

The need to recover costs from residents in outlying areas, who will benefit from system expansions and improvements occurring nearer to treatment, in advance of these outlying areas being able to connect to the system, also needs consideration. Collection of fees for eventual service will, in our opinion, bind the CVRD to providing the service. If a tiered cost recovery mechanism is implemented (see Appendix O), it may be acceptable to begin collection of the incremental costs of downstream works, from outlying areas, immediately. The percentage benefit to these areas is quite small, in proportion to the core areas. This would translate to a modest levy.

We anticipate that a number of cost recovery methods will be used, regardless of the master plan system selected. We further anticipate, at a minimum, costs will be recovered through both initial connection fees (taxation) for existing properties, and a deferred charge, such as DCCs for later development. In the case of the latter, where debt repayment is based on population growth, we stress the need to regularly reassess charges/connection fees, based on actual growth rates. In the event that growth is not materializing as anticipated, these rates must be increased to allow debt retirement as planned for.

Large land developments may have a significant impact on system cash flow. The Regional Growth Strategy, we presume, will dictate the extent to which large developments in rural areas are endorsed or dissuaded. Development agreements need to be negotiated which are complimentary to the overall system configuration selected. Such development agreements should address the necessary components, the costs of system expansion, as well as the timing of these expansions, such that larger area service can be planned for.

5.6.2 Sequential Cash Flow Projections – Dates

The sequential cash flow requirements of the two options, closely parallel each other. In order to estimate cash flow requirements for each option considered, assumptions have been made regarding the required timing of service, in each major catchment area. Table 19 and 20, introduced above, indicate construction timing assumptions, on an individual component basis.

These construction timing assumptions are based on:

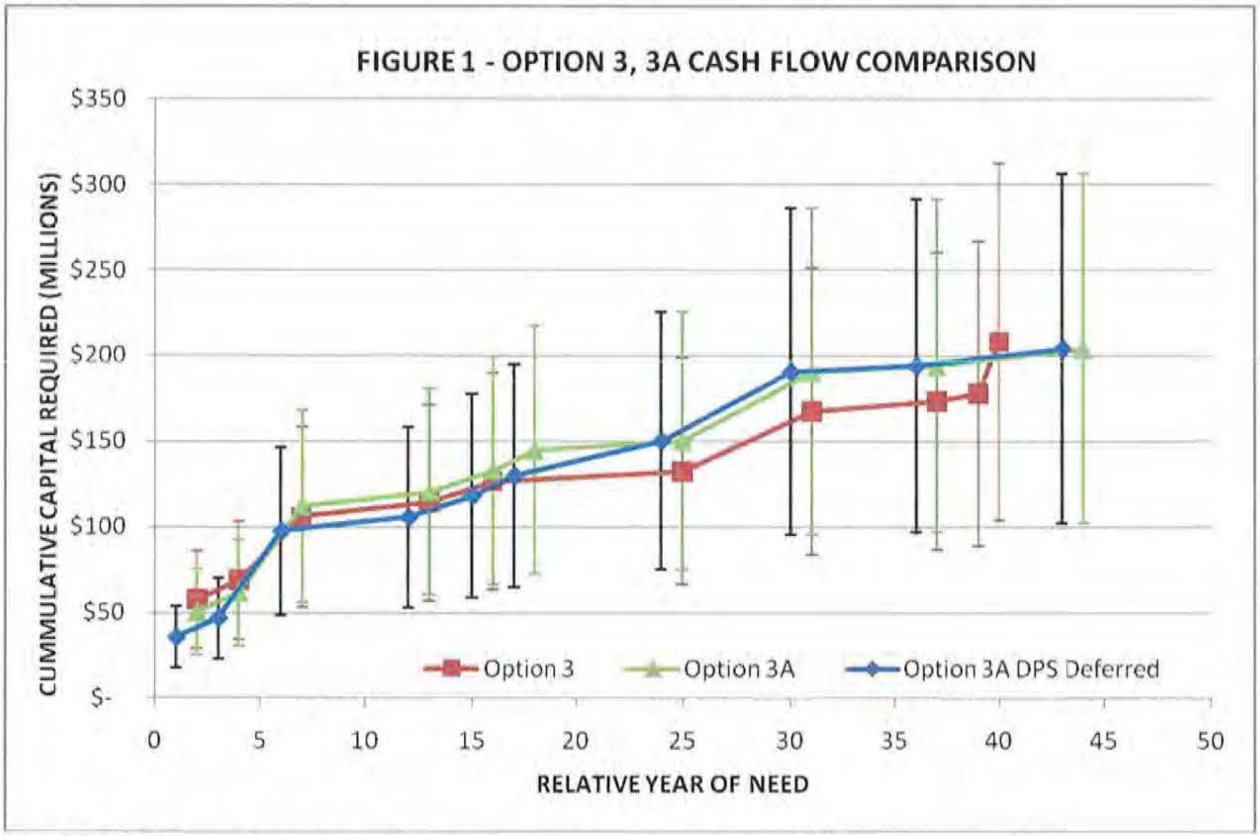
- Saratoga STP required by 2013
- Service in southern areas [UBID, Cumberland, and RID] is required by 2015
- Construction of the Docliddle pump station, and core area route 6, will be required immediately. Note this assumption has been made as the relative need/date of replacement for the foreshore pressure sewer is not known with certainty.

Treatment plant upgrading is usually undertaken at intervals corresponding to increments of roughly 10,000 new users. The following treatment plant phasing for Options 3 and 3a is:

Table 24 – Overall System Options 3, 3a Treatment Plant Upgrade Phasing

Location	Option 3a Cumulative Population	Option 3a Staged Capital Cost	Option 3 Cumulative Population	Option 3 Staged Capital Cost
CVWPCC				
Existing	36,000		36,000	
Expansion 1	65,000	$32.2 M	65,000	$32.2 M
Expansion 2	117,072	$33.3 M	110,000	$28.3 M
Expansion 3	n/a	n/a	160,039	$30.0 M
SARATOGA/MIRACLE BEACH				
Initial	7,000	$11.2 M	7,000	$11.2 M
Expansion 1	14,309	$6.9 M	14,309	$6.9 M
SOUTH STP				
Initial	15,000	$29.3 M	n/a	n/a
Expansion 1	30,000	$11.7 M		
Expansion 2	42,967	$10.0 M		

Based on required component construction timing, a cash flow diagram Figure 1 has been generated for the comparison of Options 3 and 3a.



Note:: Error bars on graphic indicate the range of contingency inherent in Class D cost estimates.

The cash flow curves of Options 3 and 3a are very similar, however, any cash flow curve is sensitive to discount rate, and relative year of need/construction. Variation of cash flow based on interest rate has not been presented herein. As a general rule, a decrease in interest rates produces a lesser differential in cost between options, over time. However, the total NPV increases rapidly as discount rates are reduced.

Note deferral of the core area route option 6 pressure sewer and the Docliddle pump station costs may be possible under Option 3a, for perhaps 20 years. However, this implies significant upgrades would be required at the Courtenay River pump station, some of which may be redundant. Following a more detailed assessment of forcemain protection measures by a coastal engineering specialist, a more accurate assessment of route 6 need can be made. Deferral of route 6 and Docliddle pump station costs could dramatically change cash flow requirements for Option 3a.

To illustrate the impact of construction timing on cash flow, a third scenario has been included on the above graphic. Data series "Option 3a DPS Deferred" indicates cash flow requirements if the Docliddle pump station and core area route 6 are deferred for 20 years. Deferral timing is largely dependent on the actual progression of erosion along the existing foreshore alignment, and population growth.

5.6.3 Flexibility to Accommodate In stream Development

At present there are two major developments outside of existing municipal boundaries that are considered "in stream"; Kensington Properties in Union Bay, and Saratoga Beach Estates, in Saratoga Beach.

Several other large scale land development projects are thought to be advancing, although no formal applications for these have yet been made. Per client team directive, we have not considered the implications of any development for which a formal application has not been received by the Regional District.

Option 3a provides greater flexibility to accommodate a range of development scenarios.

Saratoga/ Miracle Beach treatment facilities can be sized to accommodate any growth scenario eventually supported by the Regional Growth Strategy (RGS), without impact on existing CVRD infrastructure or proposed system expansions elsewhere.

Similarly, sanitation service to areas south of Courtenay can be provided for numerous development scenarios, provided that sufficient development is encouraged by the RGS to achieve the "critical mass" needed to support this infrastructure. In the event that development does not materialize in the southern portions of the study area, conveyance/treatment infrastructure need not be constructed (pending the outcome of more detailed, localized long term onsite system viability analysis).

The flexibility afforded by Option 3a insofar as its ability to provide for a number of development scenarios in Electoral Area "A" is not without bounds. Wastewater treatment facilities are designed to service specific tributary population, and although scheduled upgrades can be advanced, the ultimate capacity of the plant may be fixed.

Speculation as to development timing is not appropriate in a sewerage system master plan. However, it can be reasonably assumed, given the magnitude of the infrastructure proposed, and the likely challenges in procuring funding, that developer demand for service will precede construction of sanitation systems otherwise needed beyond the core area. This developer driven demand for advancement of service potentially provides the CVRD an opportunity to secure seed monies for construction of large portions of the sanitation system. It is of utmost importance in the negotiation of development and/or servicing agreements that the CVRD dictate to developers specific system requirements, else run the risk of taking over ownership of substandard plant. For instance, it is not unreasonable to expect the CVRD to name specific technologies to be utilized in wastewater treatment facilities, ultimate capacity of such plant, and to require dedication of sufficient lands on which to construct treatment facilities.

Cost estimates have been prepared (by others) to upgrade the Village of Cumberland plant for 5,000 people and 10,000 people. Such upgrades would accommodate projected "In-Stream" development including the Trilogy, Coal Valley and possible Bell Group projects. These estimates include upgrading the existing lagoon system with screening, physical-chemical phosphorus removal and constructed treatment wetlands. For 5,000 people the estimate is $11.7 million. To further upgrade the plant for 10,000 people the estimate is an additional $5.5 million. Depending on the outcome of the Cumberland LWMP, these upgrades may serve as an interim step in eventually connecting to a regional system as Cumberland develops.

5.6.4 Expected Timing of Major Component Need

5.6.4.1 Conveyance - Option 3

Under Option 3, the need for sanitary service in southern areas would necessitate conveyance system construction within the core area, sooner than may otherwise be required due to capacity shortfall or serviceability issues.

It has been assumed that service to the UBID and Cumberland will be required by year 2015. The existing foreshore forcemain is expected to have capacity until approximately 2024. However, in order to convey sewage flows from areas south of Courtenay to the CVWPCC, the Docliddle pump station, forcemain, gravity sewer and siphon, as well as the RID pump station and submarine forcemain will need to be constructed. Option 3 would also require the construction of the Courtenay River pump station upgrade, and route 6 forcemain at this time. Note Jane Street and Courtenay pump station replacement timing will likely be driven by the need to provide 50% redundancy in capacity, per the MSR. The additional (theoretical) capacity created through the construction of the Docliddle station will likely not meet the legislated redundancy requirements under options 3 or 3A. General conveyance system construction timing for Option 3 is as follows:

Table 25 - Option 3 Major Component Construction Chronology

Component Descriptions	Estimated Year of Need	Approx. Population to Trigger Need
Courtenay River and Jane Street Pump Station upgrades, Docliddle Pump Station and forcemain.	2011	40,000
RID Pump Station and submarine forcemain, UBID Pump Station and forcemain, Cumberland Pump Station and forcemain, Greenwood trunk sewer (driven by construction of new regional hospital at Crown Isle).	2015	Existing
Kitty Coleman Pump Station and forcemain.	2018	Existing
Replace Courtenay River Pump Station.	2020	36,000
Replace/Upgrade CFB Pump Station, gravity sewer and forcemain.	2029	7,000
Docliddle Pump Station upgrade.	2036	70,000
Royston Pump Station upgrade.	2040	24,000

5.6.4.2 Conveyance - Option 3a

Option 3a better allows conveyance infrastructure to be constructed as needed to service specific development nodes. General conveyance system construction timing is as follows:

Table 26 - Option 3a Major Component Construction Chronology

Component Descriptions	Estimated Year of Need	Approx. Population to Trigger Need
Courtenay River and Jane Street Pump Station upgrades, Docliddle Pump Station and forcemain.	2011	40,000
Kitty Coleman Pump Station and forcemain.	2018	Existing
Replace Courtenay River Pump Station.	2020	36,000
Replace/Upgrade CFB Pump Station, gravity sewer and forcemain.	2029	7,000
Docliddle Pump Station upgrade.	2038	48,000

5.6.4.3 Treatment Facilities – Option 3

The existing capacity of the CVWPCC is believed to be approximately 40,000 people. This population corresponds to the specific capacity of the initially encountered limiting unit process at the plant (the aeration basins, refer to Tech Memo No.1). Three major plant expansions are envisioned with appropriate design populations as shown in Table 27. We note these are major plant expansions and it is likely that the plant would have smaller intermediate upgrades between each major expansion. The costs of intermediate expansions are covered in the major expansions.

The Saratoga STP would be constructed for an initial population of 7,000 people. This is approximately twice the current summer population (3,260 people in 2005 as provided in the area's LWMP). One major expansion would increase the capacity to the ultimate 50-year population of 14,300. As with the CVWPCC, there will likely be smaller intermediate upgrades required.

Table 27 – Option 3 Treatment Plant Phasing

Plant Expansion	Service Population	Year of Construction
CVWPCC		
▪ Existing	40,000	N/A
▪ Expansion 1	65,000	2010
▪ Expansion 2	110,000	2033
▪ Expansion 3	160,000	2041
Saratoga		
▪ Initial	7,000	2013
▪ Expansion 1	14,300	2033

5.6.4.4 Treatment Facilities - Option 3a

Phasing of treatment plant upgrades for Options 3a is presented in Table 28. Based on the same simplifying assumptions noted in Option 3, two major CVWPCC expansions are required, as noted in Table 28.

The Saratoga STP does not vary from Option 3.

The South STP is projected to be constructed with an initial capacity of 15,000 people in 2015. The service population at that time (if Cumberland is included) is projected to be approximately 8,900 people (approximately 5,400 without Cumberland).

If a treatment plant is constructed by a developer to advance service to any portion of the southern STP catchment area, the plant should be constructed with the intention of being decommissioned after a relatively short service life (+/-5 years), unless suitable treatment technologies can be utilized allowing for expansion to suit ultimate population projections. Careful short term (interim) treatment plant siting will allow the plant to be converted to a pump station, allowing for conveyance of future sewage flows to the CVRD's South STP.

Table 28 - Option 3a Treatment Plant Phasing		
Plant Expansion	**Population**	**Year**
CVWPCC		
▪ Existing	40,000	N/A
▪ Expansion 1	65,000	2010
▪ Expansion 2	117,000	2033
Saratoga		
▪ Initial	7,000	2013
▪ Expansion 1	14,300	2033
South STP		
▪ Initial	15,000	2015
▪ Expansion 1	30,000	2022
▪ Expansion 2	43,000	2045

6.0 RECOMMENDED SOLUTION – MASTER PLAN OUTLINE

With consideration given to all criteria noted herein, core area route 6 (the Foreshore alignment) is preferred over other candidate routes analyzed in this study.

Overall system configuration Option 3a is preferred over Option 3, for the following reasons:

- If core area route 6 is utilized, the existing section of forcemain from the Courtenay pump station to Docliddle could be utilized for approximately 20 years before capacity shortfall necessitated replacement. However, the actual timing of replacement will be driven by population growth and the ongoing condition of the Willemar Bluffs pressure sewer section (construction of the forcemain from the Courtenay station to Docliddle may be most cost effective if completed concurrent with Docliddle station construction).
- Construction of the Docliddle pump station, and new pressure/gravity sewers from the pump station to the CVWPCC would provide a level of redundancy if the Willemar Bluffs section of forcemain was maintained.
- The opportunity to provide more cost effective servicing to the Ships Point area exists under Option 3a; long pumping distances are minimized.
- A greater potential to incorporate Integrated Resource Recovery concepts, due to the addition of a treatment facility south of Courtenay.
- Initial construction could be partially funded by large land developers due to the reduced front end cash requirement, particularly in areas south of Courtenay, and Cumberland.
- Infrastructure installed in order to service areas beyond the existing sewage commission mandate will largely benefit only these lands.
- Existing development agreements adopted by the CVRD are consistent with the requirements of Option 3a, i.e. construction of treatment facilities in Saratoga Beach and the UBID/RID area.

6.1 Phasing Considerations, In-Stream Development Implications

We understand Kensington Island Properties intends to advance their development in Union Bay as early as 2011. We further understand specific sewage treatment and discharge plans have not been finalized, or made available to the CVRD. It is recommended the CVRD aggressively works towards finalizing these details with KIP, such that overall sewerage system planning can be undertaken, and higher level government approvals and funding can be pursued. If development agreements are not finalized in advance of the CVRD sewerage planning process concluding, the CVRD risks accepting technologies, plant locations, etc, that are not consistent with its long term objectives.

The CVRD has also advised development negotiations in the Saratoga Beach area are progressing, and a servicing agreement, similar to that negotiated with KIP could be produced in the foreseeable future.

Development of funding strategies is beyond the scope of this study. It is therefore recommended the CVRD takes appropriate, immediate action (including grant funding enquiries) to begin procuring funding, particularly for the southern treatment plant and associated infrastructure.

6.2 IRM/IRR Considerations

Evaluation of proposed system components, in terms of IRR suitability, was not included in the original project scope. However, at CVRD staff request, we have provided a brief initial consideration of IRR, in the CVRD system planning context.

The concept of recovering resources from wastewater for beneficial use is strongly supported by the Province. This may include effluent reclamation for non-potable use (irrigation, toilet flushing, stream augmentation, onsite use at wastewater treatment facilities), heat recovery from wastewater (mainly for space heating), biogas production from anaerobic digestion and/or combustion of waste solids, soil fertilization using treated solid residuals (biosolids), and phosphate recovery from wastewater. Studies are required to assess the costs and benefits of resource recovery on a site-specific basis, taking into consideration factors such as potential local markets for the recovered resources, energy and GHG inputs and outputs, service population, capital and operating costs versus expected economic benefits, and long-term sustainability. These site-specific studies should be undertaken once the approximate location and size of wastewater treatment facilities has been identified. An initial assessment of resource recovery opportunities may be also be used to assist in identifying locations for treatment facilities.

Additional considerations related to IRR include:

- A market for the recovered products must normally exist in close proximity to the treatment and reclamation facility, to avoid excessive transportation or transmission costs.
- Recovery of biogas from anaerobic digestion of waste solids (e.g., for heating, generation of electrical power, or use as a vehicle fuel) can be cost effective for larger facilities (at least 20,000 service population). However, the financial feasibility of biogas generation should be evaluated on site specific basis at the pre-design stage.
- There may be site-specific opportunities for use of resources such as reclaimed water and recovered heat, either by local industrial users or residents.
- In general, recovery and use of reclaimed water and heat from wastewater will be more cost-effective in new developments, where the required infrastructure for transmission and use of the recovered resource can be installed during initial construction, rather than retro-fitting existing structures.
- A de-centralized treatment strategy involving smaller, localized treatment facilities may lend itself to more opportunities to reuse treated effluent. However, increasing the number of treatment facilities will in general increase the capital and operating costs of the system.
- Recovery of resources often cannot be justified on purely financial terms, i.e. the costs of resource extraction may exceed the commercial value of these resources.
- Inclusion of strategies for recovery of resources from wastewater may increase the probability of obtaining facility infrastructure funding from senior government.
- Social and environmental benefits may potentially be realized through this approach. However, it is important to consider the energy required for extraction of resources from wastewater and transportation to end users and their associated greenhouse gas emissions.

- The need, or desire, to include specific IRR concepts could lead toward preference of one system option over another. This said, IRR concepts could be incorporated into any of the four proposed system configurations, to a varied extent.

6.3 Core Area DCC Bylaw Review

The 2006 Comox Valley Sewerage System Development Cost Charge Report has been reviewed, resulting in the following observations:

The Capital Improvement Cost Charge (CICC) concept is intended to allow recovery of DCCs in kind, from areas around the periphery of the sewerage commission [City and Town] boundaries, such that development in these areas are not allowed to escape DCC fees that would otherwise be payable, subsequent to imminent municipal annexation(s). Depending on the jurisdictional framework under which future expansion of the CVRD system into presently unincorporated areas is implemented, something akin to CICCs will continue to be appropriate as an interim measure.

Benefit to existing users is indicated as very small. This reflects the understanding that new system components will predominantly benefit new users. CVRD sanitary sewer DCCs are now established to recover the full cost of system extensions, as required by new users of the system, including the value of treatment upgrades/expansion.

A 'Benefit to Existing Users' is indicated when the DCC bylaw includes existing elements expected to require replacement, such as the foreshore forcemain and related intermediate pumping station. In these cases, existing users will benefit from replacement, as it has been indicated there is a need to replace (for reasons other than capacity shortfall) prior to the service life expiration of these components. If these components are sized larger than initially required to suit additional new population growth or increases in flow, then there is shared benefit with new users.

The benefit to existing users was set at 50% of overall value for foreshore [Willemar Bluffs] replacement and accompanying Docliddle pumping station. This was based on the assumption that the existing pipe was operating, as of 2006, at about 50% of capacity. This assumes replacement trunk mains and pumps are to be designed to accommodate roughly double this flow/population, in keeping with the original service area [per the original 1981 Associated Engineering design report].

There is no benefit to existing users for system components constructed beyond the core areas, where new system extensions into outlying areas are contemplated. There are, however, social, environmental and potentially economic benefits associated with sewerage extensions beyond the core area. These include protection of recreational and tourism values, protection of public health, and protection of shellfish beds.

A suggested Development Cost Charge Bylaw summary sheet is found in Appendix M. This document was prepared, based on the following assumptions:

- A second, (and possibly third) bylaw will be developed specifically for the Saratoga and UBID/RID areas, based on the preferred, adopted system servicing strategy. Draft copies of these documents are included in Appendix M.
- Recommended project inclusions in the existing, core area DCC bylaw are based on servicing Option 3a.
- The recommendations of the forthcoming "10 year Capital Plan" will be immediately adopted, superseding previous project listings

A summary of DCC related recommendations is as follows:

- The 2006 DCC cost estimates should be updated to current (2011) dollars.
- Population projections utilized in the 2006 study are slightly higher than the corresponding estimates made in the current study. We estimate there could be 12,986 new users by 2021, as compared to the 14,211 noted in the 2006 study. The effect of overestimating population projections is a net shortfall of funds being collected, within the specified timeframe. We recommend at the next major update of the DCC bylaw, population projections be reconsidered.
- Docliddle pump station, forcemain and gravity sewer costs should be added to the bylaw.
- Comox (Jane Street) pump station upgrades required to suit Dodliddle pump station construction should be added to the bylaw.
- Longer term, we recommend the rolling format of the bylaw be reconsidered. Dependent upon ultimate system configuration, the current 15 year rolling format may not be suitable for the collection of funds required to service long term debt. I.e., if borrowing bylaws utilized to fund system improvements/expansion are amortized over a 25 year period, sufficient funds may not be collected within the 15 year DCC recovery cycle to retire the debt.
- Similarly, longer term, the assessment of DCCs may be more equitably made by varying the charge by service area, to account for the increased cost of servicing outlying areas. This implies the creation of multiple DCC bylaw areas, or distinct bylaws.
- We recommend that assumptions regarding expected higher level government grants be re-evaluated following the completion of the RGS process, and this study.
- The costs of local collection have not been included in the suggested DCC bylaw update. These costs generally do not meet the legislated requirements for inclusion in such a bylaw. Means of funding local collection should be identified and pursued at the time of conceptual design.

7.0 CONCLUSIONS

7.1 General

- The sanitation system master plan must not recommend servicing which is unaffordable.
- Required phasing of Options 3 and 3a will likely differ, to some extent, from the assumptions indicated herein. Cash flow requirements will, therefore, vary between the options. Cash flow requirements do not, at this stage, differ sufficiently to serve as a definitive means of establishing preference.
- The value of Integrated Resource Recovery extends beyond the potential financial returns that are often used to justify initial capital investments. It is increasing understood that the likelihood of receiving higher level government funding, is dependent upon a thorough review of IRR potential, for a given project. It is recommended the CVRD commission a comprehensive IRR study, prior to initiating conceptual, or preliminary designs of major sewerage conveyance and/or treatment components.
- The overall master plan system, if decided upon and built in response to RGS outcome, could profoundly affect the encouragement, or the restriction, of further development activity and regional population growth.
- The past Kensington agreement with the CVRD outlines a plan for satellite treatment and disposal, to serve this development and specific surrounding unincorporated areas. The CVRD would be expected to take ownership of this system, once commissioned, per the agreement. The treatment facility constructed by KIP should be designed for ultimate conversion to a pump station, unless sited in a location conducive to regional treatment, (i.e., where gravity flow from Cumberland is possible), and expandable up to the ultimate service population of the southern outlying area.
- Concurrent with the design of the southern treatment facility, a feasibility study of flow diversion potential from West Courtenay should be undertaken. Consideration should be given to treatment plant location, outfall location (and feasibility), conveyance costs, etc.
- Discharge feasibility studies should be undertaken for each new treatment facility. Studies should examine the discharge options, impediments, and relative costs of marine, freshwater, in ground, and reuse options.
- There is merit to the concept of varied DCCs, covering distinct rural service areas, depending on the decided cost allocation model.
- Data regarding the age, composition and function of smaller on-site systems within the region is not universally available. A macro level overview of onsite system suitability has been compiled as part of this study. The cataloguing of viability of these systems, perhaps broken out on a watershed basis, is necessary. This has recently been undertaken by Payne Engineering Geology Ltd., covering the Royston and Union Bay areas, as part of LWMP update efforts. Provision of service to the Ships Point area should be assessed based on the outcome of detailed hydrogeological assessments.

- Developer demand for service will likely precede procurement of funding (grants) or mandated community treatment system construction due to public health concerns, in areas south of Courtenay.
- Upgrades to the Komox First Nation's pump station will be required as a result of proposed upgrades/replacement of the Courtenay and Jane Street pump stations. The CVRD should coordinate with the Komox First Nations.

7.2 Core area

- As an interim condition, the "Blue/Green" Courtenay / Comox MoU map is a reasonable boundary for system planning, in the context of the existing sewerage commission mandate.
- The Willemar Bluffs section of forcemain will be rendered unusable at some point in the future, not necessarily due to capacity constraints, but rather due to condition deterioration and serviceability issues prior thereto.
- Twinning of the pressure sewer leaving the Courtenay pump station, at least as far as the proposed Docliddle pump station, appears to be a viable alternate for core area trunk main routing. The study scope identified a need to examine all potential routes. Twinning and / or replacement of the line along the beach, from Courtenay pump station to Docliddle, would be the most cost effective means of providing capacity, assuming environmental issues can be attended to successfully.
- Need for upgrading of the Courtenay pump station is imminent.
- Upgrading of the Jane Street pump station's pumps will be required, likely concurrent with the construction of the Docliddle pump station, in order to meet the MSR requirement for 50% redundancy in capacity. Required upgrade timing should be assessed at the time of detailed design, and account for potential redirection of gravity flows to the Docliddle Station.
- We conclude that need for upgrading and system expansion within the core area should be advanced under Option 3a. Option 3a will better match timing of need and location of component construction is more proximal to the population base to be serviced.

7.3 Expanded area

- Hybrid Option 3a appears, based on the full range of evaluation criterion, to be the most technically feasible option.
- Options 3 and 3a have nearly identical initial construction costs, and net present values.
- Option 3a more readily allows for the servicing of the Ships Point area, which has been determined to be at the practical limit of service for the CVWPCC.
- Providing service to Ships Point would cost approximately $10. Million.
- Cash flow requirements of both options are sensitive to component construction timing, particularly at this high level of analysis.
- The timing of Cumberland's incremental treatment needs remains unclear. Cumberland's existing lagoon system will require significant upgrading, along with separation of the existing combined collection network in order to maintain compliance with provincial requirements. The

capital cost of sewage treatment facilities, as currently contemplated by Cumberland, is approximately $17.2 million, for an ultimate service population of 10,000. Cumberland's contribution to fund a regional system cannot be ascertained until such time as the governance and operational issues discussed in Appendix O have been addressed.

- It is premature to enact DCC bylaws in outlying areas, in the absence of resolution of all governance issues noted in Appendix O. Upon establishing ownership, funding and operational structure, DCC bylaws can be implemented.

8.0 RECOMMENDATIONS

8.1 General

- Action items, per the Discussion Paper (Progress Memo 3, Appendix O), should be pursued.
- The CVRD should adopt per capita and I&I rates established in the Sewer Master Plan.
- A five year capital plan report should be commissioned, with the focus being a more detailed assessment of required short term upgrades. (This is now underway).
- Relevant portions of this study should be updated following the completion of the CVRD's five year capital plan (component replacement timing, etc).
- Flow monitoring at key points within the municipal collection systems should be undertaken on-going, so as to confirm flow rate assumptions made herein, peaking factors, etc.
- Integrated Resource Recovery should be further considered, toward potential incorporation into the overall CVRD servicing plan. This initiative should be undertaken upon adoption of the Sewerage Master Plan.
- Recommendations of the Comox Valley Sustainability Strategy should be referenced in forthcoming concept and pre-design effort, for major system components.
- Metering station locations should be adopted as required to suit the yet to be determined governance structure, essentially to be located at points of discharge upstream of which are service areas unique to a single municipality. These will be used to equitably apportion on-going O&M costs.
- The CVRD should pursue ROW agreements where required, to suit construction of Option 3a, including core area route 6.
- O&M costs should be further refined at pre-design stage of each component.
- The Sewerage Master Plan will require periodic updating in order to ensure that development projections, (densities, spatial distributions, growth rates, etc.) are materializing as assumed. We recommend that updates be undertaken once every three years.
- The CVRD should aggressively pursue higher level government grants/funding for system expansion/construction and detailed study, as recommended herein.
- The Village of Cumberland's Liquid Waste Management plan should be consistent with the recommendations of the Sewer Master Plan.

8.2 Core area

- Core area route 6, i.e., a duplication of the existing foreshore alignment is preferable amongst alignment options considered. Pre-design initiatives should be commissioned by the CVRD.
- The Docliddle pump station should be designed and located at 12m geodetic. The CVRD should look to acquire property to site the station.

- The CVRD should exploit all possible opportunities for gravity diversion of Jane Street catchment flows to the Docliddle station.
- Pre-design of upgrade requirements at the Courtenay pump station should be commissioned now. Short term pump replacement, to suit initial construction of the Docliddle Station would cost in the order of $2.5 million.
- Final determination of catchments tributary to the Courtenay pump station and to the Royston/UBID treatment plant is necessary. This should be included as part of the Courtenay pump station preliminary design assignment forthcoming and the South Courtenay STP planning process.
- If the Willemar Bluffs portion of the Courtenay pump station pressure sewer is not expected to survive to the year 2024, with minimal expenditures to control erosion, etc., then the CVRD may need to advance expenditures (route option 6 and Docliddle pump station) in order to divert away from this section of pressure sewer.
- The DCC Bylaw should be updated. The CVRD and member municipalities should confer, agree on scope, refine the draft update costing presented herein, and proceed to bylaw amendment as soon as practical.
- The DCC 'benefit to existing users' needs to be further evaluated in respect to core area [within the mandate of the existing Sewerage Commission] upgrade components.
- Costs for infrastructure required to service the core areas of Courtenay and Comox should continue to be assessed at a common rate, per the existing sewage commission mandate.
- Flow monitoring/logging equipment should be installed on the inlet side of the Jane Street pump station, in order to more accurately evaluate influent flow rates.
- Periodic flow monitoring should be undertaken immediately upstream of the Courtenay River siphon, to confirm tributary flows are as expected.
- The CVRD should engage a coastal engineering specialist to review remaining service life of the Willemar Bluffs section of forcemain, and provide recommendations for operation and maintenance.

8.3 Expanded area

- Based on the assumptions noted herein, overall system configuration hybrid "Option 3a" is preferred amongst the alternatives considered. Concept and pre-design initiatives should be advanced for Option 3a. However, Option 3 should not be ruled out until it has been confirmed that a new outfall into Baynes sound, or beyond, is feasible.
- The long term viability of existing/future onsite disposal systems should be investigated in more detail on a localized basis, particularly in the Saratoga area, the rural west Courtenay area, the Kitty Coleman area, the Huband/Meadowbrook area and the Ships Point area. This analysis should include reference to ground water table and seasonal hydrogeologic fluctuations, soil depths and permeabilities, topography, development density, etc. It should include both collection of open water [roadside ditch] sampling, as well as the development of selected monitoring well sites. Prediction of probability of % overall system failure rates should be included in this work.

- The CVRD should develop policy regarding smaller onsite privately owned sanitation facilities. Reference Memo No. 3, section 2.3.1 and Appendix "O" "Discussion Paper" sections.
- The CVRD should undertake a regional biosolids handling strategy, following completion of the RGS process, and the crystallization of the sewage system master plan. This process may be best undertaken cooperatively with other local government agencies.
- Future preliminary design efforts in the southerly and northerly outlining service areas should include consideration of CVRD system scope limits [vs. local area collection system scope] and means of cost recovery.

McElhanney