S U M M A R Y   R E P O R T

City of Prince Rupert

Stage 2 - Liquid Waste Management Plan

MAY 2010

Associated Engineering

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May 19, 2010
File: 20062891.02.E.05.00

Mr. Keith Cameron
Engineering Services Manager
City of Prince Rupert
424 - 3rd Avenue West
Prince Rupert, BC V8J 1L7

Re: CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN FINAL REPORT

Dear Mr. Cameron:

Please find enclosed two bound and one unbound copies of the final Stage 2 Liquid Waste Management Plan (LWMP) report. This report summarizes the discussion papers submitted for this project. It is prepared based on the comments received and the discussion held with the Local and Technical Advisory Committee (LAC and TAC) members.

Mr. Cameron, we like to thank you for providing us with the opportunity to work on this project. We look forward to working with the City on the Stage 3 LWMP.

If you have any questions, please do not hesitate to call us.

Yours truly,

Prepared by:

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Executive Summary

1 INTRODUCTION

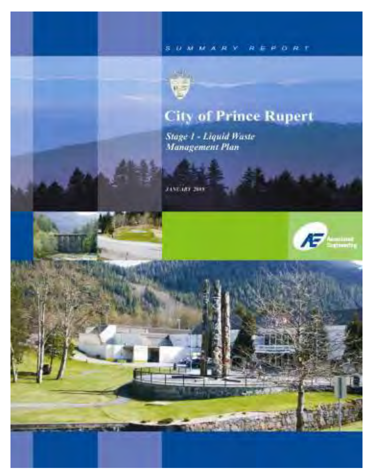
The City of Prince Rupert (City) is located in coastal northern British Columbia, just north of the Skeena River. Picturesque mountains, islands, and water surround the City.

The current sewerage system within the City's urban area dates back to the early 1900s and is divided into ten areas, each with a piped discharge into Prince Rupert Harbour. Of these ten areas, six are combined sewers and four are separated sanitary and storm sewers. The majority of the wastewater is currently discharged without any treatment.

The City has an existing Wastewater Discharge Permit, PE-5577, issued by the Ministry of Water, Land and Air Protection (currently the Ministry of Environment, MoE) that covers all of the discharge points. This permit was updated in year 2000 with the condition that the City develop a wastewater system upgrading plan. This plan was completed by the City and submitted to the MoE in May 2004. Upon review of the Plan, the MoE recommended the City undertake the development of a Liquid Waste Management Plan (LWMP) to address the City's future wastewater management.

As requested by the MoE, the City is in the process of developing a Liquid Waste Management Plan (LWMP). The LWMP will include all of the liquid waste management issues within the boundaries of the City, with the exception of industrial operations that operate under a separate Provincial Waste Management Permit and the City's solid waste landfill and leachate management system (covered under an approved Solid Waste Management Plan).

2 STAGE 1 - LIQUID WASTE MANAGEMENT PLAN



The development of a LWMP is undertaken in three stages and requires consensus building with all stakeholders. Stage 1 involves identifying existing wastewater management systems, issues, and available options for managing liquid waste. Stage 2 involves further development and evaluation of the management options identified in Stage 1. Stage 3 uses the information developed in Stages 1 and 2 to produce the strategic direction the City will follow to manage its wastewater in the future.

The City has successfully completed and received approval from MoE for Stage 1 of the LWMP. The City has continued its commitment to the environment and undertaken the development of Stage 2 of the LWMP process

3 STAGE 2 – REQUIREMENTS

Stage 2 of the LWMP builds upon the wastewater management options identified in Stage 1. The City's Stage 2 LWMP involved the following key objectives:

- Establishing and working with a Technical Advisory Committee to obtain technical and regulatory input for the LWMP.
- Establishing and involving the public through a Local Advisory Committee and public information meetings and open house(s).
- Addressing ideas received from the public information meetings.
- Confirming the waste volume production (wastewater flows and resulting solids).
- Providing details regarding options presented in Stage 1.
- Confirming wastewater conveyance methods.
- Investigating the land requirements and availability for each option.
- Investigating the sustainability and resource recovery options.
- Providing a concept level cost estimate for the short-listed options.
- Identifying a preferred direction for short and long term wastewater management.

Stage 2 LWMP for the City consisted of the following major tasks:

- Waste Volumes and Facility Sizing Criteria
- Wastewater Treatment Facility Options
- Treatment Technology Options
- Land Requirements and Availability
- Wastewater Conveyance and Disposal Methods
- Sustainability and Resource Recovery Options
- Cost Estimate for Short Listed Options
- Public Involvement
- Final Report for Stage 2 LWMP

4 STAGE 2 – SUMMARY

Based on the major tasks for this Stage 2 study, seven discussion papers were written and presented to the LWMP LAC and TAC. Synopses of each of the discussion papers developed for Stage 2 are presented below.

View of Sunken Gardens

4.1 Waste Volumes and Facility Sizing Criteria

Waste volumes and facility sizing criteria were established for the City using estimated design populations based on 1.5 percent growth. For design year 2030, the design population is approximately 18,000. For design year 2050, the design population is approximately 25,000. These values are conservative and consistent with the City's maximum target population of 25,000.

As a voluntary measure, the City will develop a wastewater treatment regime to exceed the treatment requirements specified in the British Columbia Municipal Sewage Regulations. The self-imposed treatment requirements outlined below are based on the estimated average dry weather flow (ADWF) for Year 2030 and Year 2050:

- Up to two times the ADWF will be treated to secondary treatment standards (182 L/s and 245 L/s for design years 2030 and 2050 respectively).
- Up to four times the ADWF will be treated to primary treatment standards (363 L/s and 491 L/s for design years 2030 and 2050 respectively).
- All flows greater than four times the ADWF will be treated as combined sewer overflows.

Treating only two times the ADWF to secondary treatment level is based on the principle of providing the City with a cost effective treatment scheme that would provide efficient use of capital investment, minimize expenditures on facility and related equipment that would be used infrequently, and provide the required level of environmental protection.

4.2 Wastewater Treatment Facility Options

Potential options for managing the City's wastewater have been explored.

Option 1 involves having a single wastewater treatment facility (centralized treatment); whether that is at Hays Creek, Port Edward, or the Industrial Park.

Option 2 involves having two wastewater treatment facilities (decentralized treatment), whether they are at Hays Creek and Ritchie Point, or Hays Creek and Morse Creek.

Option 3 involves having three separate wastewater treatment facilities (decentralized treatment), one each at Hays Creek, Ritchie Point, and Morse Creek.

4.3 Treatment Technology Options

Feasible treatment options, using representative technologies, were investigated. The short-listed wastewater treatment options consist of vortex separator for potential preliminary treatment, microscreens for primary treatment, activated sludge or sequencing batch reactor technologies for secondary treatment, and UV irradiation for disinfection.

The treatment technologies selected are representative technologies useful for planning purposes. Actual technology selection will be made at the preliminary design stage. Land availability and conditions will also play an important role in treatment technology selection.

4.4 Land Requirements and Availability

Approximate footprint requirements for centralized and decentralized treatment facility options were determined to range from approximately 6000 m^2 to 18,000 m^2 for two to three decentralized wastewater treatment facilities to 25,000 m^2 for one centralized wastewater treatment facility.

General locations to place one or more treatment facilities are in the Hays Creek, Morse Creek, and Ritchie Point areas. Currently, the City does not own any property large enough to site one, two or three treatment facilities in any of these areas. The City will continue to explore potential properties within the City.

The availability of adequately sized property to meet treatment facility footprint requirements will impact the City's decision to build one centralized treatment facility or two or three decentralized treatment facilities in the future.

4.5 Wastewater Conveyance and Disposal Methods

Potential conveyance and discharge options for the three wastewater treatment facility options are discussed.

Option 1 involves having a single wastewater treatment facility at Hays Creek. Conveyance requirements for this option include four pump stations to convey flows from four catchment areas, with the remaining five catchments using gravity flow. Outfall I has sufficient capacity to discharge Year 2050 treated flows.

Option 2 involves having two wastewater treatment facilities, one at Hays Creek and one at Morse Creek. Conveyance requirements for this option include three pump stations - two pump stations to convey flows to the Hays Creek Wastewater Treatment Facility and one pump station to convey flows to the Morse Creek Wastewater Treatment Facility. The remaining catchments would use gravity flow. Outfall I would have the necessary capacity to meet the Year 2050 design flow requirements (treated flow only. For Outfall B, a longer and larger diameter outfall is recommended.

Option 3 involves having three separate wastewater treatment facilities, one each at Hays Creek, Morse Creek, and Ritchie Point. Conveyance requirements for this option include two pump stations - one pump station to convey flows to the Morse Creek Wastewater Treatment Facility and one pump station to convey flows to the Ritchie Point Wastewater Treatment Facility. The remaining catchments would use gravity flow. Initial evaluation of Outfall I indicates that it has sufficient capacity to handle the Year 2050 Design Flows (treated and wet weather). Outfalls B and L are short outfalls, discharging effluent to shallow water. Therefore, new larger diameter and longer Outfalls B and L are recommended.

4.6 Sustainability and Resource Recovery Options

The City has significant opportunity to manage wastewater flow and conveyance in a manner that minimizes energy consumption. Siting the distributed wastewater treatment / resource recovery facilities at low elevations and implementing operational and policy strategies can contribute to reduced energy requirements.

Technology currently exists to recover heat from both raw wastewater and treated effluent. While there are more challenges in the operation and maintenance of raw wastewater heat recovery systems, relative to effluent applications, continued technology development will likely mitigate these challenges to some extent in the future. The potential heat energy available in wastewater/effluent should be considered as the City develops its LWMP.

Hays Creek

Biosolids probably provide the most significant potential for resource recovery for the City. Depending on the treatment facility option, the following options will be available for the City to take advantage of the wastewater biosolids:

- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion at the largest site.
- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion off site (e.g. at the City's landfill).
- Composting the dewatered aerobically digested or raw biosolids and possible combining with other organic waste offsite at a location away from the City centre.

The feasibility of the resource recovery options should be investigated during the preliminary design stage, when the preferred treatment approach is known. In considering all of the presented possible opportunities, the key is to evaluate the issue of practical scale.

4.7 Cost Estimates

Class D, planning level, capital and operation and maintenance (O&M) cost estimates for the three wastewater management options were prepared.

The cost estimates are in 2010 dollars and include contingency and engineering allowances of 35 and 15 percent, respectively. The capital costs provided are for the maximum design, Year 2050 design criteria, and represent the amount of capital that the City could potentially spend, should the City grow to the maximum design population of 25,000. The capital costs for the wastewater treatment options range from $86 M to $91 M.

Net present value (NPV) analysis of the capital and O&M cost estimates for each of the wastewater treatment options were conducted using an interest rate of 3.5 percent and an analysis period of 40 years. NPV analysis for the options ranges from $118 M to $125 M.

4.8 Public and Agency Consultation

During the Stage 2 LWMP planning process, two meetings were held with the Technical and Local Advisory Committees (TAC and LAC) to present discussion papers and to receive comments and direction from committee members.

The first meeting with the TAC and LAC was held on November 25, 2009 at the City's Council Chambers. At this meeting, Wastewater Volumes and Facility Sizing Criteria, Wastewater Treatment Facility Options, and Treatment Technology Options were discussed.

The second meeting with the TAC and LAC was held on March 12, 2010 at the City's Council Chambers. At this meeting Land Requirements and Availability, Wastewater Conveyance and Disposal Methods, Sustainability and Resource Recovery Options, and Cost Estimates were presented. The minutes of both the Technical and Local Committee meetings are provided in **Appendix H**.

The public meeting for the Stage 2 LWMP Report was held on March 11, 2010 in Prince Rupert. The consensus from the TAC and LAC is for the Stage 3 LWMP to move forward with Option 3, three decentralized wastewater treatment facilities. Collectively, the TAC and LAC value the flexibility that Option 3 provides the City. With Option 3, the City can ultimately decide to build one, two, or three treatment facilities to meet their long term wastewater management needs. The City can phase the implementation of the treatment facilities, starting with the implementation of the Hays Creek Treatment Facility and then later, implementing the Morse

Creek Treatment Facility, and if required, implementing the Ritchie Point Treatment Facility. This option also provides the City with the greatest opportunity to phase capital expenditures and to minimize disruption within the community that may result from the construction of new sewers and treatment facilities.

4.9 Next Steps

Following approval of the LWMP Stage 2 Final Report, Stage 3 of the LWMP will involve further examination of waste management options and their associated costs. LWMP Stage 3 will involve completion of the following steps:

- Confirm the Stage 3 Study objectives based on the findings of the approved Stage 2 Final Report;
- Complete LWMP Stage 3 study;
- Prepare LWMP Stage 3 Draft Report;
- Integrate comments from LAC and TAC on LWMP Stage 3 Draft Report;
- Release the second draft of LWMP Stage 3 Report for public review;
- Prepare LWMP Stage 3 Final Report; and
- Obtain approval of the LWMP Stage 3 Final Report by the MoE Regional Environmental Protection Manager.

Provincial Court Building

Table of Contents

1 Introduction

1.1 BACKGROUND

The City of Prince Rupert (City) is located in coastal Northern British Columbia, just north of the Skeena River. Picturesque mountains, islands, and water surround the City. The City has developed in a region where First Nations communities have lived for thousands of years. Charles Hays, a railway executive founded the town in 1906. The City is a centre for fishing activities which serve as a valuable resource and economic base for the community.

The current sewerage system within the City's urban area dates back to the early 1900s and is divided into ten sewerage areas, each with a piped discharge into Prince Rupert Harbour. Of these ten areas, six are combined sewers and four are separated sanitary and storm sewers. The majority of the wastewater is currently discharged without any treatment.

Cow Bay Area

Prince Rupert Harbour has been the scene of industrial activity for over a century. As with other industrial harbours around the world, historic activities have shaped the development of the shoreline. In addition, activities such as bilge dumping, log sort, and storage debris and waste disposal have led to an impact on the bottom sediments (Associated Engineering, 2002). The movement of tides, the circulation of water, and the stratification of the ocean are all important factors affecting the dilution and dispersion of the City's wastewater discharge to Prince Rupert Harbour (Associated Engineering, 2004).

The City has an existing Wastewater Discharge Permit, PE-5577, issued by the Ministry of Water, Land and Air Protection (currently the Ministry of Environment, MoE) that covers all of the discharge points. This permit was updated in year 2000 with the condition that the City develop a wastewater system upgrading plan. This plan was completed by the City and submitted to the MoE in May 2004. Upon review of the Plan, the MoE recommended the City undertake the development of a Liquid Waste Management Plan (LWMP) to address the management of the City's wastewater in the future.

As requested by the MoE, the City is in the process of developing a Liquid Waste Management Plan (LWMP). The LWMP will include all of the liquid waste management issues within the boundaries of the City, with the exception of industrial operations that operate under a separate Provincial Waste Management Permit and the City's solid waste landfill and leachate management system (covered under an approved Solid Waste Management Plan). Figure 1-1 shows the LWMP boundary.

The development of a LWMP is undertaken in three stages and requires consensus building with all stakeholders. Stage 1 involves identifying existing wastewater management systems, issues, and available options for managing liquid waste. Stage 2 involves further development and evaluation of the management options identified in Stage 1. Stage 3 uses the information developed in Stages 1 and 2 to produce the

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
LIQUID WASTE MANAGEMENT PLAN BOUNDARY

FIGURE 1-1

SOURCE: CITY OF PRINCE RUPERT COMMUNITY PLAN

Associated Engineering

strategic direction the City will follow to manage its wastewater in the future.

The City has successfully completed and received approval from MoE for Stage 1 of the LWMP. The City has continued its commitment to the environment and undertaken the development of Stage 2 of the LWMP process.

1.2 STAGE 2 OBJECTIVES

The City has already completed significant background work for the Stage 2 LWMP. This work includes the "Long Range Plan for Sewage Disposal" (Associated Engineering 1977), "Comprehensive Monitoring Program – Impacts of Wastewater Discharge on Prince Rupert's Harbour" (Associated Engineering, 2003), "City of Prince Rupert Wastewater System Upgrading Plan" (Associated Engineering, 2004), and the Stage 1 LWMP (Associated Engineering, 2009). These documents provide the groundwork and overall technical direction for the Stage 2 LWMP work.

Stage 2 of the LWMP builds upon the wastewater management options identified in Stage 1. The development of the City's Stage 2 LWMP involved the following key objectives:

- Establishing and working with a Technical Advisory Committee (TAC) to obtain technical and regulatory input in the LWMP.
- Establishing and involving the public through a Local Advisory Committee (LAC) and public information meetings and open house(s).
- Addressing ideas received from the public information meetings.
- Confirming the waste volume production (wastewater flows and resulting solids).
- Providing details regarding options presented in Stage 1.
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- Investigating the land requirements and availability for each option.
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- Providing a concept level cost estimate for the short-listed options.
- Identifying a preferred direction for short and long term wastewater management.

Cow Bay Area

This Summary Report provides an overview of the work that was completed for the City's Stage 2 LWMP. Based on the seven major tasks which comprised the Stage 2 LWMP work, the following seven discussion papers were prepared and presented to both the LWMP TAC and LAC:

- Discussion Paper 2-1: Waste Volumes and Facility Sizing Criteria
- Discussion Paper 2-2: Wastewater Treatment Facility Options
- Discussion Paper 2-3: Treatment Technology Options
- Discussion Paper 2-4: Land Requirements and Availability
- Discussion Paper 2-5: Wastewater Conveyance and Disposal Methods
- Discussion Paper 2-6: Sustainability and Resource Recovery Options
- Discussion Paper 2-7: Cost Estimates

Each of the abovementioned discussion papers covers a specific topic or area of interest pertaining to the City's future wastewater management strategy.

Sections 2 through 8 of this Summary Report provide consolidated reviews of each of the discussion papers. For the reader's information, full versions of each discussion paper are provided in the **Appendices A to G**.

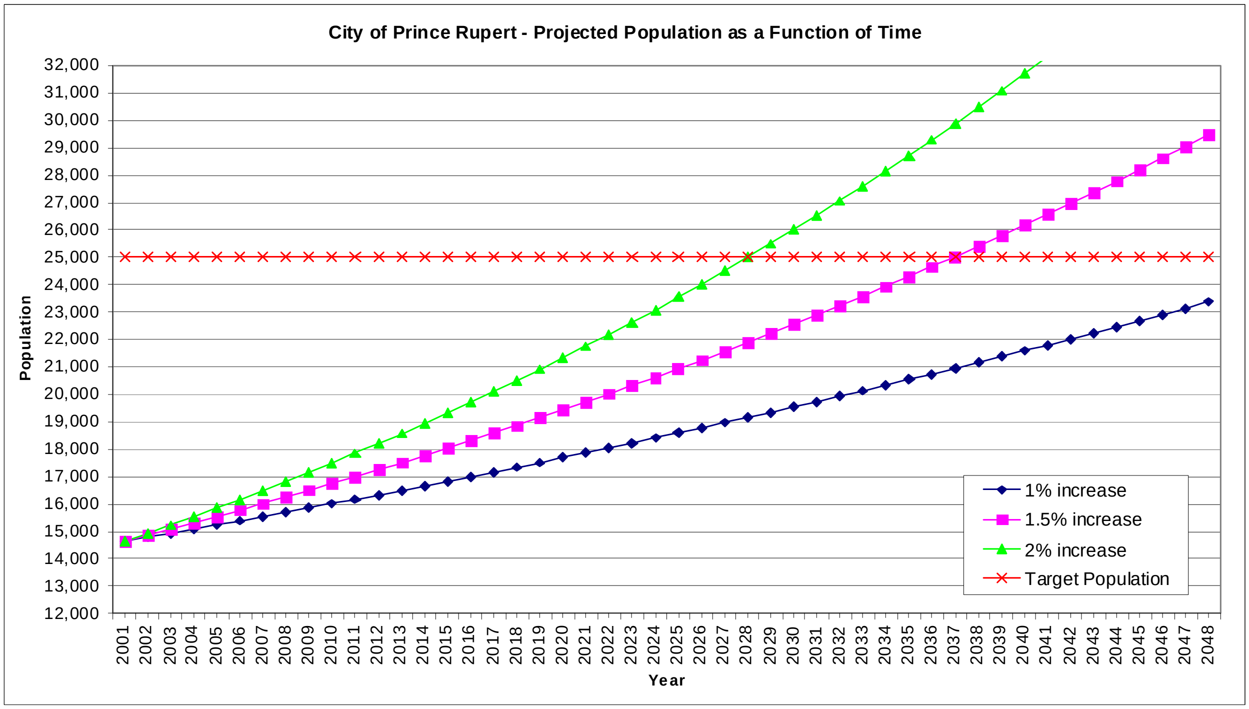
1.3 ACKNOWLEDGEMENTS

This report has been prepared by Associated Engineering for the City of Prince Rupert. Associated Engineering thanks the staff at the City of Prince Rupert for their assistance and dedication to this project. The City of Prince Rupert and Associated Engineering would like to thank members of Technical and Local Advisory Committees for their time and contributions to the development of the Stage 2 LWMP.

2 Waste Volumes and Facility Sizing Criteria

Historically, the City has experienced a fairly transient population due to seasonal work opportunities. Like many small northern British Columbia communities, a few employers employ many residents. As a result, the population of the City is greatly impacted by the economic conditions of industries and businesses operating in the City. Over the time period from 1961 to 2006, the average rate of growth has been less than 0.5 percent. The recommended design population for the City is based on 1.5 percent growth and includes a design population of approximately 18,000 in design year 2030 and 25,000 in design year 2050. These values are conservative and consistent with the City's maximum target population of 25,000.

The average dry weather flow (ADWF) is the average flow occurring over a 24-hour period under dry weather conditions (typically late May through June and July to the beginning of August in Prince Rupert). It is made up of both the average sanitary flow and the average dry weather inflow/infiltration. The ADWF is generally based on annual flow rate data. However, the City does not have complete flow records available and as such; the ADWF rates for the LWMP design years 2030 and 2050 were calculated by multiplying the projected population in both year 2030 and year 2050 by the projected unit wastewater flow contribution for the respective design year. The projected unit wastewater flows were established based on average dry weather flow data provided in the City of Prince Rupert Final Report: Comprehensive Monitoring Program – Impacts of Wastewater Discharges on Prince Rupert Harbour (2003).The total ADWF for year 2030 is estimated to be 8 ML/day (91 L/s). The total ADWF for year 2050 is estimated to be 11 ML/day (123 L/s).



The maximum daily flow is the maximum flow occurring over a 24-hour period under wet weather condition. The maximum daily flow for the City was calculated by using the design year ADWF and multiplying it by a calculated peaking factor. A peaking factor is the ratio of peak wet weather flow rate to average flow rate. Peaking factor values for each catchment were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each catchment by the ADWF for that particular catchment. The 5-year return period rainfall peak flow event values were calculated by Associated Engineering (2000). The maximum daily flow rate for year 2030 is estimated to be 270 ML/day (3,199 L/s). The maximum daily flow rate for year 2050 is estimated to be 373 ML/day (4,317 L/s). The extensive difference between the ADWF and the maximum daily flow is due to the considerable rainfall that the City receives and also due to the aging sewer infrastructure that includes a high percentage of combined sewers which permit higher than normal amounts of infiltration and inflow to enter the sewer system.

In British Columbia, the Municipal Sewage Regulation (MSR) governs wastewater flows above 22.7 m^3/day and any discharges to surface waters, regardless of flow. The MSR specifies wastewater treatment requirements and required effluent quality based on the maximum daily flow to be treated and the effluent receiving environment. Based on the ADWF for Year 2030 and Year 2050 and the MSR requirements, the City will develop a wastewater treatment regime more stringent than required by the MSR. The City's voluntary, self-imposed treatment requirements are outlined below:

- Up to two times the ADWF will be treated to secondary treatment standards.
  - For year 2030, the wastewater flow to be treated is estimated to be 16 ML/day (182 L/s).
  - For year 2050, the wastewater flow to be treated is estimated to be 21 ML/day (245L/s).

- Up to four times the ADWF will be treated to primary treatment standards.
  - For year 2030, the wastewater flow to be treated is estimated to be 31 ML/day (363 L/s).
  - For year 2050, the wastewater flow to be treated is estimated to be 42 ML/day (491 L/s).
  - All flows greater than four times the ADWF will be bypassed as combined sewer overflows.

Treating only two times the ADWF to secondary treatment level and four times the ADWF to primary treatment level is based on the principle of providing the City with a cost effective treatment scheme that would provide efficient use of capital investment, minimize expenditures on facility and related equipment that would be used infrequently, and provide the required level of environmental protection. In this approach any flows above four times the ADWF will be low strength and would normally be considered combined sewer overflows (CSOs). Wastewater volume reduction may in part be achieved by water conservation and reduction of infiltration and inflow. Source control, the controlled discharge of highly toxic or nuisance pollutants at the source, is also an effective way to reduce the volume, flow, and pollutant load entering the collection system. Wastewater volumes may also be reduced through the rehabilitation or complete replacement of the City's aging collection systems. The amount of money required to build larger treatment facilities to treat larger flows will be better spent separating the combined sewers into designated sanitary and storm sewers.

In addition to the "liquid treatment" stream, the City will have to manage and/or treat the solids that are generated. Screenings, coarse solids that are removed from the wastewater, are typically sent to a landfill for disposal. In addition, non-biodegradable solids and biodegradable solids (sludge) will be generated. Non biodegradable solids consist of materials such as sand, gravel, cinders, eggshells, bone chips, seeds, and coffee grinds which have subsiding velocities or specific gravities much greater than those characterized by organic solids found in wastewater. Removal of grit prevents unnecessary abrasion and wear of mechanical treatment equipment. Biodegradable solids are typically the substances responsible for the offensive character of untreated wastewater. After biological treatment the biodegradable solids are largely organic material from the wastewater, which still can decompose and have offensive odour that require disposal.

Based on an ADWF of 8 ML/day for design year 2030, the typical amount of grit generated is calculated to be 0.12 m^3/day. Based on an ADWF of 11 ML/day for design year 2050, the typical amount of grit generated is calculated to be 0.16 m^3/day.

The amount of biodegradable solids (sludge) that may be generated in design year 2030 is 33 m^3/day at 4% (thickened) sludge and 5.3 m^3/day at 25% (dewatered) sludge. The estimated amount of sludge that may be generated in design year 2050 is 45 m^3/day at 4% (thickened) sludge and 7.2 m^3/day at 25% (dewatered) sludge.

Civic Centre, Prince Rupert

3 Wastewater Treatment Facility Options

There are several potential options for the number and general location of wastewater treatment facilities that may be considered by the City. In the past, the standard approach was to convey collected wastewater to a single, large treatment facility, commonly referred to as "centralized" treatment. Presently, the concept of "decentralized" treatment is gaining acceptance. Decentralized treatment basically refers to the treatment of wastewater using several "local" wastewater treatment facilities. The use of decentralized treatment may be driven by a number of factors, including the inability to locate a centralized facility because a large enough suitable property is not available. In other cases, topography and wastewater conveyance requirements may dictate decentralized treatment as an easier and less expensive alternative.

Hays Creek

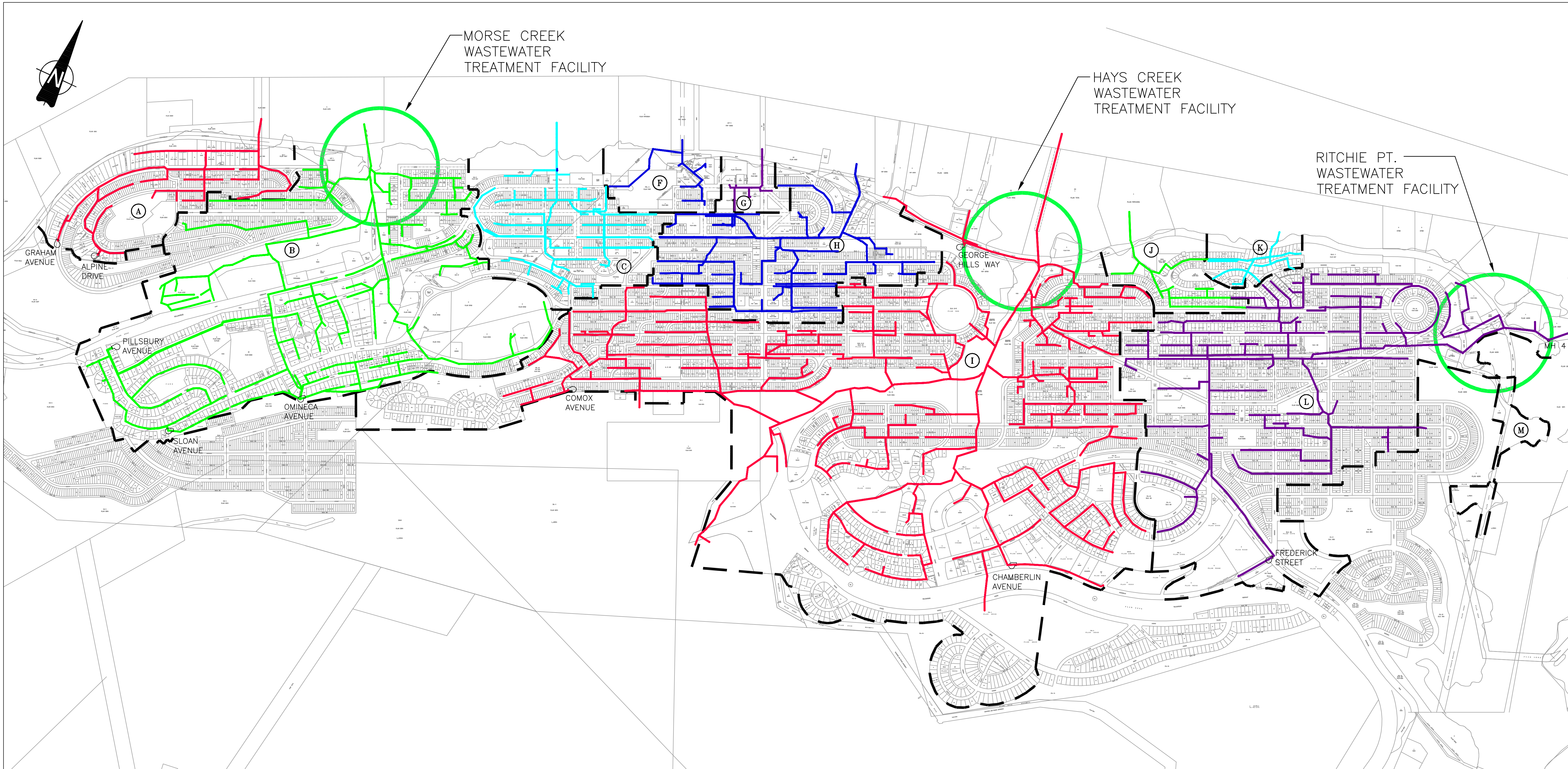
In the City's case, it would not be economical or practical to build wastewater treatment facilities for each of the ten sewer catchments. The most cost effective approach will be to consolidate the wastewater collection system by constructing a major trunk sewer interceptor system along the City's waterfront to direct wastewater flows to between one and three wastewater treatment facilities. The treated effluent would then be discharged to the marine environment through outfalls at each facility.

To assist the City in deciding its future wastewater management path, the wastewater treatment facility options available to the City have been broken down into three potential options shown on **Figure 3-1**.

3.1 OPTION 1 - SINGLE WASTEWATER TREATMENT FACILITY (CENTRALIZED TREATMENT)

If a central treatment facility is selected, the flows from the various pump stations, gravity sewers, and force mains could potentially be consolidated so that all wastewater is directed to one wastewater treatment facility. Consolidation of the collection system could occur by constructing a major sewer interceptor system, which will consist of gravity sewers and pump stations with force mains along the City's waterfront that would direct the wastewater from all ten existing catchment areas to the centralized treatment facility. Three potential locations for a single treatment facility were investigated.

A potential location for a single treatment facility could be near the harbour front, in the vicinity of Hays Creek area. Approximately 40 percent of the City's total wastewater flow is discharged through Outfall I (Hays Creek area), which is the City's deepest outfall. If this option were selected, there would certainly be requirements for the installation of new pump stations and gravity sewers to convey the wastewater along the City's waterfront to the treatment facility. Conveyance using gravity alone would not be possible due to the topography of the area.



LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 3-1

N.T.S.

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The former pulp mill at Port Edward, located about 15 km outside the City is another potential location for a wastewater treatment facility. The Port Edward site is a possible location considering that the existing tankage at the former pulp mill industrial wastewater treatment facility could potentially be converted to a secondary municipal wastewater treatment process. For this option to work, the entire City's wastewater would need to be conveyed initially to a central location (most likely the location proposed in Option 1A, i.e., the Hays Creek area). It would then be pumped to the Port Edward facility via a major pump station and force main. It should be noted that the existing tankage is not sized for the City and, therefore, may present challenges in retrofitting.

The Prince Rupert Industrial Park, located approximately 5 km outside the City core area is another potential site for a municipal wastewater treatment facility. Similar to Option 1B – Port Edward, this option would require the entire City's wastewater to be conveyed initially to a central location (most likely the location proposed in Option 1A, i.e., the Hays Creek area) and then pumped to the Industrial Park facility via a major pump station and force main.

3.2 OPTION 2 - TWO WASTEWATER TREATMENT FACILITIES (DECENTRALIZED TREATMENT)

Decentralized treatment using two wastewater treatment facilities would split the flows from the various pump stations, gravity sewers, and force mains so that wastewater is directed to one of two wastewater treatment facilities. These facilities would be located near the harbour front, in the vicinity of either Hays Creek and Morse Creek or Hays Creek and Ritchie Point, for example. The Hays Creek facility is included for both Option 2 sub-options because approximately 40 percent of the City's total wastewater flow is discharged through Outfall I (Hays Creek area), which is also the City's deepest outfall. These potential treatment facility locations have been selected because they correspond with the areas generating the largest sanitary flows and therefore, it is more economical to pump wastewater from the smaller areas to the larger areas, rather than vice versa.

Cruise Ship at the City Port

3.3 OPTION 3 - THREE WASTEWATER TREATMENT FACILITIES (DECENTRALIZED TREATMENT) AT HAYS CREEK, RITCHIE POINT, AND MORSE CREEK

In this option, the flows from the various pump stations, gravity sewers, and force mains could potentially be directed to one of three wastewater treatment facilities. These facilities would be located near the harbour front, likely in the vicinity of Morse Creek, Hays Creek, and Ritchie Point. These treatment facility locations have been selected because they correspond with the areas generating the largest sanitary flows and therefore, it is more economical to pump wastewater from the smaller areas to the larger areas, rather than vice versa

4 Treatment Technology Options

4.1 TREATMENT REQUIREMENTS

In British Columbia, wastewater treatment is governed by the Ministry of Environment's 1999 Municipal Sewage Regulation (MSR). The MSR sets out requirements for wastewater treatment for a variety of situations including wet weather flows and dry weather flows. The MSR and CCME National Performance requirements for primary and secondary treated effluent is provided in **Table 4-1**.

Table 4-1
Summary of Regulatory Effluent Quality Requirements for Primary and Secondary Treatment

Parameter	MSR Compliance Criteria[1] Primary Treatment	MSR Compliance Criteria [1] Secondary Treatment	CCME National Performance
Biochemical Oxygen Demand (BOD_5)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Total Suspended Solids (TSS)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Fecal Coliforms	Not applicable (N/A)	N/A	N/A
Turbidity	N/A (at this time)	N/A (at this time)	N/A
Nitrogen	N/A (at this time) [2]	N/A (at this time) [2]	1.25 mg N/L [3]

[1] Schedule 7, Municipal Sewage Regulations, 1999.

[2] Based on ammonia toxicity at the edge of the initial dilution zone.

[3] Maximum allowable end-of-pipe ammonia (T=15°C).

The MSR requirements in **Table 4-1** are "never-to-exceed" values for single samples. In contrast, the up-coming compliance criteria for BOD_5 and TSS proposed by the Canadian Council of Ministers of the Environment's Canada-Wide strategy process would likely be somewhat more stringent than the above numbers, but would be based on "average" values over a certain period of time. The federal government announced on February 2010 that the draft Wastewater Systems Effluent Regulations are now available for public consultation. The Strategy essentially calls for secondary treatment of all discharges to receiving waters. Specific standards are for Carbonaceous BOD_5, total suspended solids (TSS) and total chlorine residual (TCR). The $CBOD_5$ and TSS standards are 25 mg/L, defined on an averaging period. This varies, but for medium to large discharges, is 30-days. The maximum allowable end-of-pipe unionized ammonia is 1.25 mg N/L (T = 15°C). Most mechanical treatment systems treating typical municipal wastewater, even if not providing any nitrification (i.e. ammonia removal), should be able to meet this requirement given the normally near-neutral pH of the effluent. Regardless, the target values for secondary treatment design and operation are normally set on a lower level than the above numbers, e.g., less than 25 mg/L $CBOD_5$ and 25 mg/L TSS.

The future steps and implementation planning for the City will take into consideration both the MSR requirements and new amendments to the Fisheries Act, as required. The need for disinfection is based on water contact recreation needs and shellfish harvesting. If any recreational activities or shellfish harvesting is to be considered in the future, treatment specifically targeting a reduction in pathogenic organisms would most likely be required by the City.

4.2 PRELIMINARY TREATMENT TECHNOLOGIES

Screening Equipment

Preliminary treatment is the first level of treatment which involves the removal or reduction of coarse solids and easy to settle materials. For the City's wastewater, preliminary treatment would be applied to all flows less than four times the ADWF. Technologies that would provide preliminary treatment include various types of screens and vortex separators. A screen consists of openings that are typically uniform in size, which retain material larger than the size of the screen openings. The purpose of screening is to remove coarse, non-degradable debris from raw wastewater, such as sticks, rags, plastics, food wastes, etc. Vortex separation uses a swirling action to move particles to a centre drain and the liquid to the outside effluent channel. Centrifugal movement, together with higher specific gravity of the solids result in solids concentration and removal.

4.3 PRIMARY TREATMENT TECHNOLOGIES

Primary treatment consists of unit processes that can effectively remove floating, and settleable solids from wastewater. Primary treatment leaves a portion of the non-soluble organics and most of the soluble organics in the wastewater. Primary treatment technologies include primary clarification, chemically-enhanced primary treatment (CEPT), and micro screens.

Primary Clarifier

Primary clarification is based on the principles that liquids containing solids in suspension, at a relatively quiescent state, will tend to allow solids with a higher specific gravity to settle and those with a lower specific gravity to rise. Primary clarification is sometimes unable to provide sufficient treatment to meet the permit requirements during the summer when there is lower infiltration and inflow into the sewer systems, which results in a more "concentrated" wastewater. In these cases, treatment is improved via chemical addition. This treatment process is known as CEPT. Micro screens use a mesh filter with openings that range from 1 to 350 µm (microns) to capture solids.

4.4 SECONDARY TREATMENT TECHNOLOGIES

Secondary treatment removes soluble and insoluble organic matter that is left in primary effluent. Without secondary treatment, organic matter discharged to the receiving environment (rivers, lakes or the ocean) would use the dissolved oxygen in the water for degradation, leading to oxygen depletion and thus contributing to the loss of an habitable environment for fish. Additionally, secondary treatment helps to remove contaminants of emerging concern such as some endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs). Among several others, secondary treatment processes include the following: activated sludge, sequencing batch reactors, membrane bioreactors, trickling filter/solids contact, rotating biological contactors, and integrated fixed film activated sludge/moving bed biofilm reactors.

The activated sludge process is a type of process in which microorganisms (bacteria, fungi, rotifers, protozoa, and algae) responsible for wastewater treatment are maintained in suspension within the liquid.

The sequencing batch reactor (SBR) process is a type of suspended growth treatment process similar to the activated sludge process, with some variations. The main difference between an SBR and a conventional activated sludge treatment process is all of the wastewater treatment processes occur in one tank.

Sequencing Batch Reactor

Membrane bioreactors (MBRs) also use a single tank system similar to the SBR process; however, a membrane system is used to provide a physical barrier between the biomass and the effluent.

Trickling filters consist of a media bed of highly permeable material such as rock or plastic on to which microorganisms are attached. Wastewater is percolated or trickled down onto this media bed. Wastewater treatment occurs when the wastewater comes in contact with the rock or plastic media and microorganisms begin to degrade the organic material in the wastewater.

Rotating biological contactors (RBCs) are virtually identical to that of the trickling filter, except that instead of the media sitting passively and the primary effluent trickled over it as in the trickling filter process, with an RBC; the media rotates through the wastewater alternately picking up fresh wastewater and fresh air.

The integrated fixed-film activated sludge process is a variation of the conventional activated sludge process. In this process, synthetic materials, i.e., polyethylene, foam, or polyvinyl chloride are used within the activated sludge tank to provide additional surface area for the growth of microorganisms to treat the wastewater.

4.5 DISINFECTION

Disinfection is a process used to kill most disease-causing organisms (Metcalf and Eddy, 1991). The disinfection of wastewater provides a degree of protection from contact with pathogenic organisms including those causing cholera, polio, typhoid, hepatitis and a number of other bacterial, viruses, and parasitic diseases. There are a number of chemicals and processes that will disinfect wastewater, but none are universally applicable. Chlorination/dechlorination and ultraviolet (UV) irradiation are the most widely used disinfection technologies, although UV is becoming the industry standard.

Chlorination disinfects by inactivating pathogenic organisms. Contact time is important to reduce the bacteria count and for virus inactivation. Chlorine resistant microorganisms (e.g., *Giardia*, *Cryptosporidium*, *staphylococcus aureus*, viruses, etc.) should also be considered.

Ultraviolet (UV) irradiation is a very common disinfection alternative to chlorination. UV irradiation does not require chemical addition for disinfection or dechlorination. UV irradiation is a physical disinfection process, which uses electromagnetic radiation at wavelengths ranging from 100 to 400 nanometers. The typical UV irradiation wavelength of 254 nm damages cellular DNA, which makes organisms unable to replicate.

UV Irradiation Equipment

5 Land Requirements and Availability

The estimated footprints of the building and tankage area, as well as the estimated footprint of the building and tankage inclusive of access roads and buffer space for Year 2030 and 2050 design flows are provided in Table 5-1 and Table 5-2. Footprint requirements for the treatment facilities are based on Year 2030 and Year 2050 design criteria, wastewater management approach, and preferred technologies. Due to potential future changes in wastewater treatment regulations and treatment technology, the footprints provided in the tables below may vary, depending on when the treatment facilities are built. These numbers provide a conservative estimate for the total area required.

Table 5-1
Summary of Estimated Footprint Requirements for Proposed Wastewater Treatment Facility Options (Year 2030 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	7,600	19,000
2A – Two facilities	Hays Creek	5,400	13,500
	Morse Creek	1,600	6,400
3 – Three facilities	Hays Creek	3,900	9,800
	Morse Creek	1,600	6,400
	Ritchie Point	1,100	4,400

Table 5-2
Summary of Estimated Footprint Requirements for Proposed Wastewater Treatment Facility Options (Year 2050 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	10,000	25,000
2A – Two facilities	Hays Creek	7,200	18,000
	Morse Creek	2,100	8,400

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
3 – Three facilities	Hays Creek	5,300	13,300
	Morse Creek	2,100	8,400
	Ritchie Point	1,400	5,600

Available land for siting one, two or three wastewater treatment facilities in the City is sparse due to the current development of the City's waterfront properties. Historically, the City's wastewater management strategy consisted primarily of wastewater collection and disposal (Associated Engineering, 1977). In the past, wastewater treatment was not required and the implementation costs too expensive to justify the environmental benefit. Due to more recent changes in wastewater legislation, the City is now required to treat its wastewater. As such, the City needs to select and acquire properties to site one or more treatment facilities.

Generally, wastewater treatment facilities are preferred to be located away from or screened from residential areas. This helps to minimize nuisance effects in regards to the potential for noise, odour, and aesthetics. At the same time, the treatment facility should be located such that it is close to the gravity trunk sewers and the outfalls at the downstream ends in order to minimize pumping costs

Presently, the City does not own any parcels of land that are large enough to build all three of the smaller decentralized wastewater treatment facilities, or one large centralized treatment facility. The City will have to acquire one or more properties for this purpose. Potential locations for siting the treatment facilities include the areas of Hays Creek, Morse Creek, and Ritchie Point.

View of Sunken Gardens

6 Wastewater Conveyance and Disposal Methods

Conventional wastewater collection systems consist of gravity sewers to transport sewage from homes or other sources of wastewater via gravity flow through buried piping systems to a wastewater treatment facility. Gravity sewers have no power requirements because they rely on the slope of the land and gravity force to carry wastewater through the network of sewer pipes.

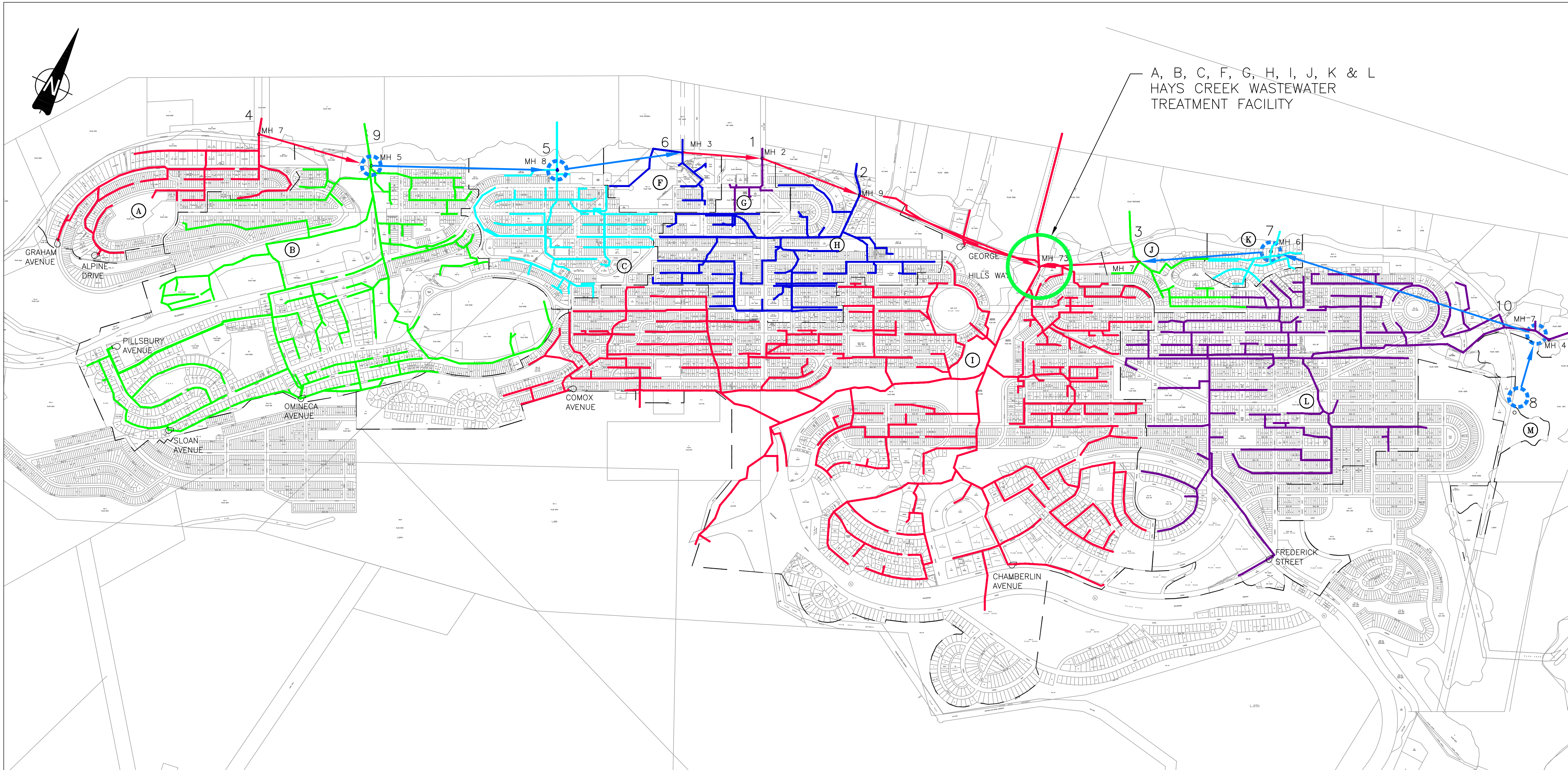
In catchments where gravity conveyance is not feasible due to the slope of the land, excavations, and installation being too deep and costly, pump stations and force mains are an alternative. Pump stations are structures that contain one or more pumps, piping, valves and other related auxiliary equipment. The force main is the pipe that the pump discharges into. The piping is filled with liquid, in the City's case, wastewater that is under pressure. The pump stations will need to be sited and built strategically along the City's waterfront. The pump stations will be designed for four times the Year 2030 ADWF. The stations can be upgraded in the future to meet four times the Year 2050 ADWF. The force mains will be sized to convey four times the Year 2050 ADWF.

Hays Creek Sewer System

Currently, the City's wastewater is discharged to the ocean via a designated outfall from each catchment. The City's future wastewater management program would require consolidation and treatment of the wastewater at one, two, or three treatment facilities and the treated effluent would be discharged to the ocean via an outfall corresponding to the catchment in which the treatment facility is located. The outfalls corresponding to Options 1 (Hays Creek – Outfall I), 2 (Hays Creek - Outfall I and Morse Creek – Outfall B), and 3 (Hays Creek - Outfall I, Morse Creek – Outfall B, and Ritchie Point – Outfall L) would be potential discharge points for the consolidated treated flows, and also the flows captured in that particular catchment that are diverted away from the treatment facility because they are greater than four times ADWF.

6.1 OPTION 1 - SINGLE WASTEWATER TREATMENT FACILITY – HAYS CREEK

Conveyance requirements for this option, shown in **Figure 6-1**, include four pump stations to convey flows from four catchment areas, with the remaining five catchments using gravity flow. Conveyance for Option 1, conveying the entire City's wastewater to one central treatment facility at Hays Creek, requires the maximum number of pump stations of all three wastewater treatment options. As the number of pump stations increase, so does the cost of acquiring suitable land to site the stations and the capital and operational costs of the station itself. Outfall I has sufficient capacity to discharge Year 2050 treated flows. If Outfall I is also to handle the wet weather flow component, an additional 1 m of static head is required. This can be achieved by pumping. Alternatively, the wet weather flow component can be diverted and discharged via the overflow weir in Catchment I.



LEGEND

POTENTIAL PUMP STATION

FORCE MAIN

GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 1 CONVEYANCE
AND DISPOSAL OPTIONS

FIGURE 6-1

N.T.S.

Associated Engineering

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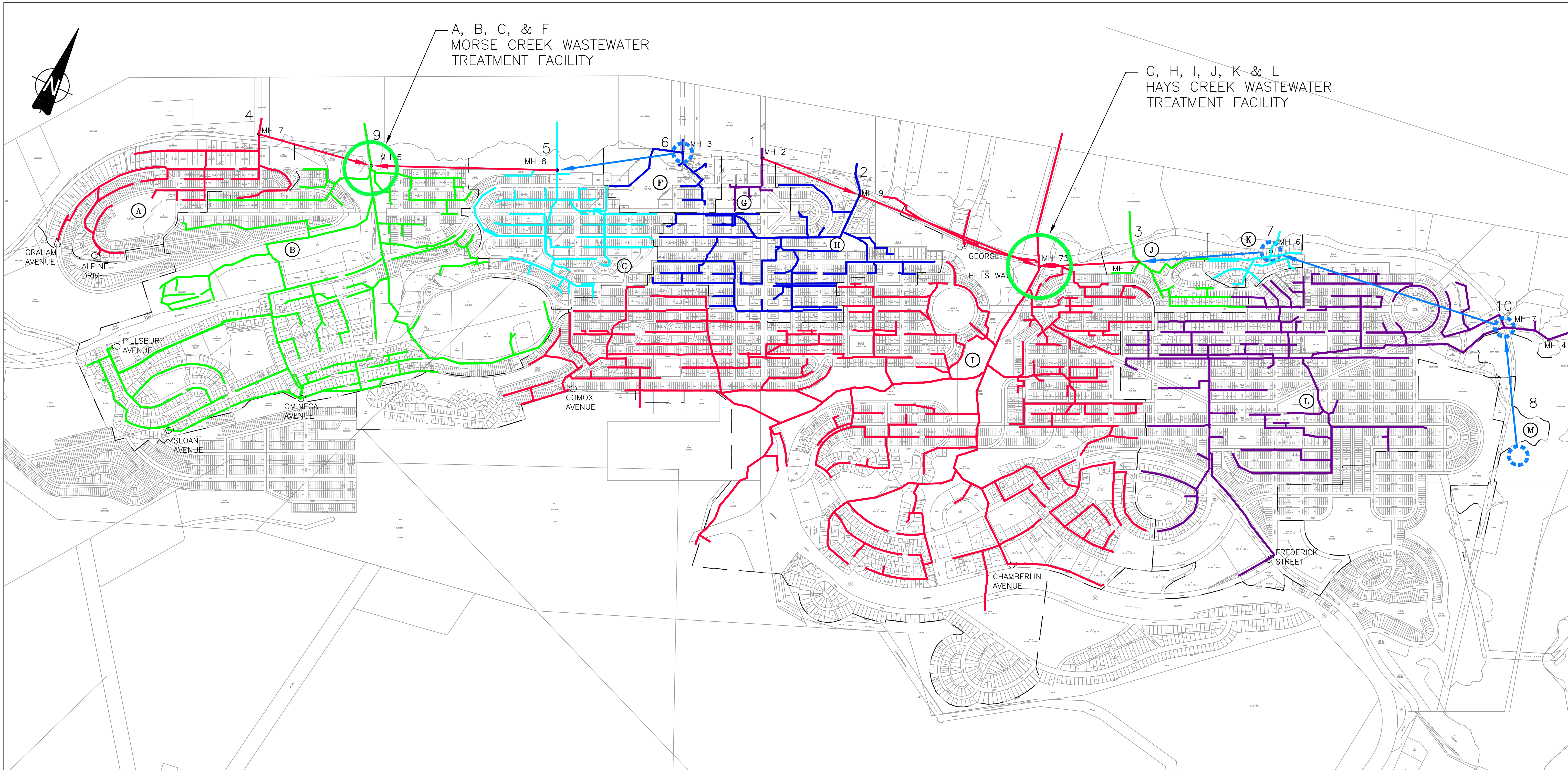
6.2 OPTION 2 - TWO WASTEWATER TREATMENT FACILITIES – HAYS CREEK AND MORSE CREEK

Option 2A involves having two wastewater treatment facilities, one at Hays Creek one at Morse Creek. Conveyance requirements for this option, shown in **Figure 6-2**, include three pump stations - two pump stations to convey flows to the Hays Creek Wastewater Treatment Facility and one pump station to convey flows to the Morse Creek Wastewater Treatment Facility. The remaining catchments would use gravity flow. Due to one less pump station required, Option 2, treatment facilities at Hays Creek and Morse Creek, would have lower conveyance costs than Options 1. Based on the assumptions stated in Section 4, Outfall I would have the necessary capacity to meet the Year 2050 design flow requirements (treated flow only). Similar to Option 1, the wet weather flow component can be diverted and discharged via the overflow weir in Catchment I. For Outfall B, a longer and larger diameter outfall is recommended. For conceptual level planning purposes, cost estimates will assume a new Outfall B is designed and installed.

6.3 OPTION 3 - THREE WASTEWATER TREATMENT FACILITIES - HAYS CREEK, MORSE CREEK AND RITCHIE POINT

Option 3 involves having three separate wastewater treatment facilities, one each at Hays Creek, Morse Creek, and Ritchie Point. Conveyance requirements for this option, shown in **Figure 6-3**, include two pump stations - one pump station to convey flows to the Morse Creek Wastewater Treatment Facility and one pump station to convey flows to the Ritchie Point Wastewater Treatment Facility. The remaining catchments would use gravity flow. Even though Option 3, treatment facilities at Hays Creek, Morse Creek and Ritchie Point, requires one less pump station than Option 2 and two less than Option 1, it is not as favourable. The small fraction of wastewater generated by the Ritchie Point area may be more cost effectively conveyed and treated at the Hays Creek Wastewater Treatment Facility, than build and operate a separate treatment facility at Ritchie Point. Initial evaluation of Outfall I indicates that it has sufficient capacity to handle the Year 2050 Design Flows (treated and wet weather). Outfalls B and L are short outfalls, discharging effluent to shallow water. Therefore, new larger diameter and longer Outfalls B and L are recommended.



LEGEND

- POTENTIAL PUMP STATION
- FORCE MAIN
- GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 2 CONVEYANCE
AND DISPOSAL OPTIONS

FIGURE 6-2

N.T.S.

Associated Engineering

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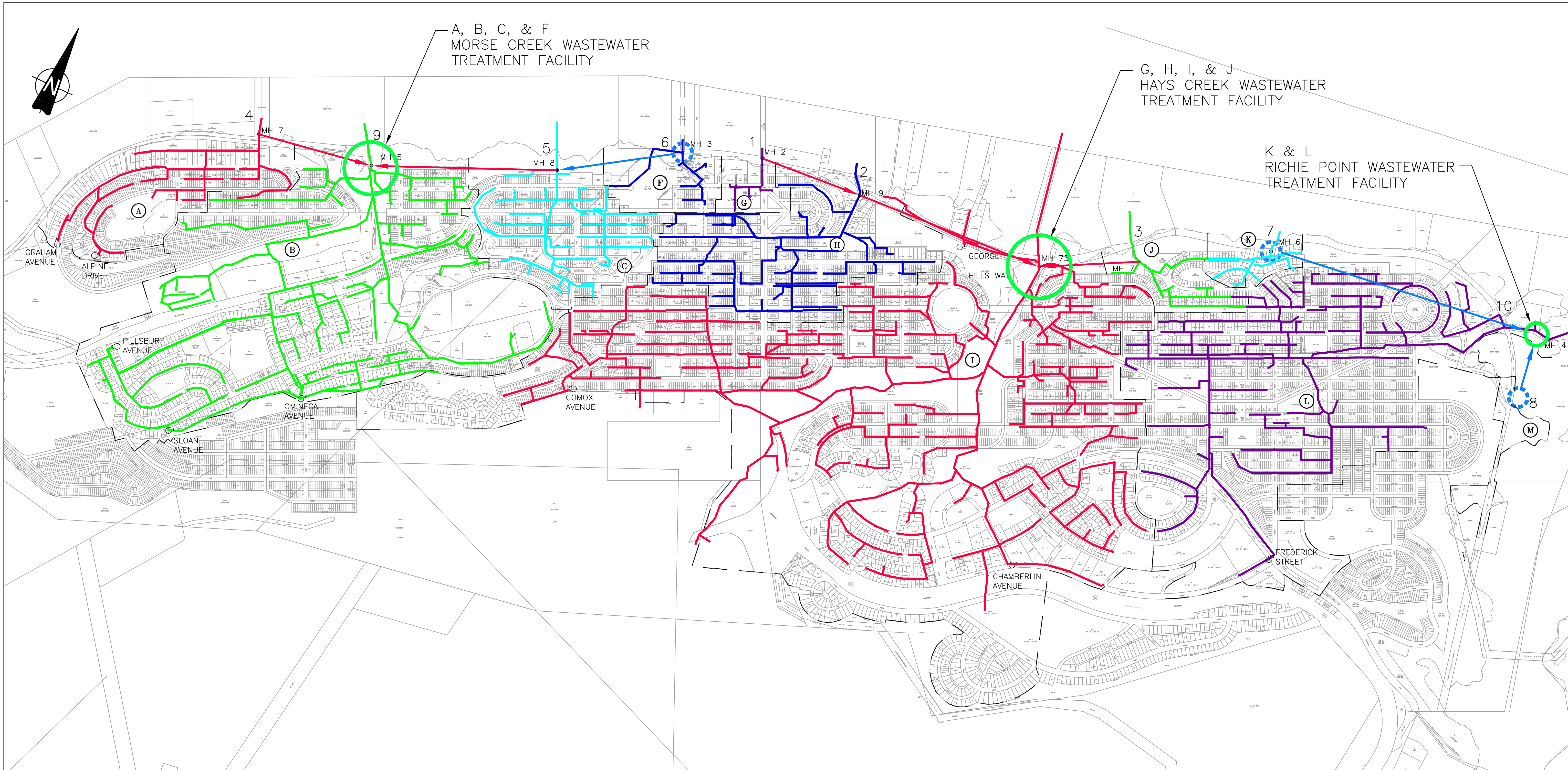

LEGEND

- POTENTIAL PUMP STATION
- FORCE MAIN
- GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 3 CONVEYANCE AND DISPOSAL OPTIONS

FIGURE 6-3

N.T.S.

Associated Engineering

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7 Sustainability and Resource Recovery Options

The City has significant opportunity to manage wastewater flow and its conveyance in a manner that minimizes energy consumption. Siting the distributed wastewater treatment / resource recovery facilities at low elevations and implementing operational and policy strategies can contribute to notably reduced energy requirements.

Although a relatively new technology application, the recovery of pressure energy from flowing wastewater / effluent can potentially be technically feasible within the City's planned wastewater infrastructure. With currently available technology, and at existing household electricity consumption rates, the relative amount of recoverable pressure energy is minimal. However, as technology and associated recovery efficiency improves, and in combination with a decreasing trend in household electricity consumption, some gains in the relative significance of recovered energy may be achieved.

Technology currently exists to recover heat from both raw wastewater and treated effluent, with implemented examples found in Canada and elsewhere in the world. While there are more challenges in the operation and maintenance of raw wastewater heat recovery systems, relative to effluent applications, continued technology development will likely mitigate these challenges to some extent in the future. The potential heat energy available in wastewater/effluent should be considered as the City develops the LWMP.

Biosolids probably provide the most significant potential for resource recovery for the City. Biosolids can offer a resource for energy and/or soil amendments for the City. Depending on the treatment facility option, the following options will be available for the City to take advantage of the wastewater biosolids:

- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion at the largest site.
- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion off site (e.g. at the City's landfill).
- Composting the dewatered aerobically digested or raw biosolids and possible combining with other organic waste offsite at a location away from the City centre.

During the preliminary design stage the feasibility of all the presented resource recovery options should be investigated. For the purpose of Stage 2 LWMP, and to provide conservative numbers for land requirements and capital cost estimates, we have assumed that aerobic digestion will be carried out at one of the treatment facilities. For cost estimate purposes, capital costs for a typical composting facility will be provided as well.

Kelowna-Vernon Composting Facility

Photo: Courtesy of Maple Reinders Ltd.

In considering all of the presented possible opportunities, the key is to evaluate the issue of practical scale. This should be considered at the preliminary design stage of the preferred treatment approach.

8 Cost Estimates

For the City of Prince Rupert, three different wastewater management options have been investigated along with wastewater conveyance and disposal options. The costs provided in this section are Class D. A Class D cost estimate is used for planning studies and is strictly an indication (rough order of magnitude) of the final project cost, and should be sufficient to provide an indication of cost and allow for ranking all the options being considered. The capital cost estimate for each option includes the following items:

- Wastewater treatment facilities
- Pump stations
- Force mains
- Gravity trunk sewers
- Diversion chambers
- Outfalls
- Off-site composting facility (provided separately)

The cost estimates are in 2010 dollars and include contingency and engineering allowances of 35 and 15 percent, respectively. The capital costs provided are for the maximum design, Year

2050 design criteria, and represent the amount of capital that the City could potentially spend, should the City grow to the maximum design population of 25,000. Table 8-1 provides capital costs of Options 1, 2, and 3. Table 8-2 provides the capital cost for an off-site composting facility that could potentially be applied to all treatment facility options. The capital costs do not include the costs for local sewer systems, sewer system separation (mitigation measures for wet weather flow), and off-site infrastructure costs associated with resource recovery. Land acquisition costs are not included in the capital cost estimates or the net present value analysis.

Table 8-1
Capital Cost Estimates for Options 1A, 2A, and 3

Item	Cost ($ millions)
Option 1 – Hays Creek Treatment Facility	$86
Option 2 – Hays Creek and Morse Creek Treatment Facilities	$90
Option 3 – Hays Creek, Morse Creek, and Ritchie Point Treatment Facilities	$91

Table 8-2
Capital Cost Estimate for Off-site Composting Facility

Item	Cost ($ millions)
Composting Facility (Year 2030 Design Criteria)	$1.8
Composting Facility (Year 2050 Design Criteria)	$2.5

Net present value (NPV) analysis of the capital and O&M cost estimates for each of the options was conducted using an interest rate of 3.5 percent and an analysis period of 40 years. NPV analysis results are summarized in **Table 8-3**.

Table 8-3
Net Present Value Analysis Summary

Option	Total NPV ($ millions)
1 – Hays Creek Wastewater Treatment Facility	$118
2 – Hays Creek and Morse Creek Wastewater Treatment Facilities	$122
3 - Hays Creek, Morse Creek, and Ritchie Point Wastewater Treatment Facilities	$124

The values provided in **Table 8-3** indicate an insignificant economic difference between the three potential wastewater treatment options. As such, the overall cost of the option will not weigh heavily in the selection of the preferred option.

9 Public and Agency Consultation

9.1 TECHNICAL AND LOCAL ADVISORY COMMITTEE MEETINGS

During the Stage 2 LWMP planning process, two meetings have been held with the Technical and Local Advisory Committees to present discussion papers and to receive comments and direction from committee members. The local First Nation communities were also contacted and invited to attend the meetings.

The first meeting with the TAC and LAC was held on November 25, 2009 at the City's Council Chambers. At this meeting, Discussion Papers on Wastewater Volumes and Facility Sizing Criteria, Wastewater Treatment Facility Options, and Treatment Technology Options were presented.

The second meeting with the TAC and LAC was held on March 12, 2010 at the City's Council Chambers. At this meeting Discussion Papers on Land Requirements and Availability, Wastewater Conveyance and Disposal Methods, Sustainability and Resource Recovery Options, and Cost Estimates were presented. Public meeting summary, final report completion requirements and next steps were discussed during this meeting.

Minutes from both meetings are provided in **Appendix H**.

9.2 PUBLIC COMMUNICATION

A public Open House for the Stage 2 LWMP Report was held on March 11, 2010 from 4:30 p.m. to 7:30 p.m. in the City's Council Chambers. Advertisements had been placed in the local newspaper.

The initial part of the meeting was an open house format followed by the second part of the meeting that included a presentation by the consultant team. The presentation was formatted to allow questions and dialog with the members of the public.

Thirteen members of the public attended the meeting, including a reporter from the Daily News. A newspaper article summarizing the LWMP progress was published.

Cow Bay Area

A copy of the slide presentation and Open House Summary Report along with the handout and questionnaire is provided in **Appendix I**. The discussion with the public covered a wide range of issues in the presentation. There was also general support for the direction of the LWMP into Stage 3.

The public information meeting was considered successful. This coupled, with the posting of material on the City's LWMP web page (www.princerupert.ca under City plans and projects) and the cable television coverage of the discussion at Council meetings, has led to a reasonable degree of communication with the public in Stage 2.

10 Next Steps

The TAC and LAC recommend moving forward with Option 3, wastewater treatment facilities at Hays Creek, Morse Creek, and Ritchie Point. For this option, one treatment facility at Hays Creek will be built. If needed, one or two additional treatment facilities can be built in the Morse Creek and Ritchie Point areas, or the City can decide to expand the Hays Creek Treatment Facility to accommodate the City's entire wastewater volume. This option provides the City with the most flexibility. The treatment facilities; and therefore, the outfalls will be dispersed throughout and can be phased. Phasing of the treatment facilities would also enable the City to more effectively mitigate the environmental issues and social implications that may result.

Following approval of the LWMP Stage 2 Final Report, Stage 3 of the LWMP will involve using the information developed in Stages 1 and 2 to produce a plan for managing the City's wastewater. Once a LWMP is created by the City and approved by the MoE, an Operational Certificate is issued that replaces the previous Permit.

Stage 3 will involve completion of the following steps:

- Confirm the Stage 3 Study objectives based on the findings of the approved Stage 2 Final Report;
- Complete a detailed implementation plan;
- Outline any financial plans needed to implement the LWMP;
- Prepare draft Operational Certificates for each facility;
- Complete LWMP Stage 3 Study;
- Prepare LWMP Stage 3 Draft Report;
- Involving the public through the LAC and public information meeting and open house;
- Integrate comments from LAC and TAC on LWMP Stage 3 Draft Report;
- Release the second draft of LWMP Stage 3 Report for public review;
- Prepare LWMP Stage 3 Final Report; and
- Obtain approval of the LWMP Stage 3 Final Report by the MoE Regional Environmental Protection Manager.

Views in Downtown Prince Rupert

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A Appendix A - DP2-1 - Waste Volumes and Facility Sizing Criteria

DISCUSSION PAPER 2-1

City of Prince Rupert
Liquid Waste Management Plan - Stage 2

Waste Volumes and Facility Sizing Criteria

Issued:	April 23, 2010
Previous Issue:	March 10, 2010

1 Introduction

1.1 Background

The current sewerage system within the City of Prince Rupert's (City) urban area dates back to the early 1900s and is divided into ten sewerage areas, each with a piped discharge into Prince Rupert Harbour. Of these ten areas, six are combined sewers and four are separated sanitary and storm sewers. The majority of the wastewater is currently discharged without any treatment.

The City has an existing Wastewater Discharge Permit, PE-5577, issued by the Ministry of Water, Land and Air Protection (currently the Ministry of Environment, MOE) that covers all of the discharge points. This permit was updated in year 2000 with the condition that the City develop a wastewater system upgrading plan. This plan was completed by the City and submitted to the MOE in May 2004. Upon review of the Plan, the MOE recommended the City undertake the development of a Liquid Waste Management Plan (LWMP) to address the management of the City's wastewater in the future.

As requested by the MOE, the City is in the process of developing a Liquid Waste Management Plan (LWMP). The LWMP will include all of the liquid waste management issues within the boundaries of the City, with the exception of industrial operations that operate under a separate Provincial Waste Management Permit and the City's solid waste landfill and leachate management system (covered under an approved Solid Waste Management Plan).

The development of a LWMP is undertaken in three stages and requires consensus building with all stakeholders. Stage 1 involves identifying existing wastewater management systems, issues, and available options for managing liquid waste. Stage 2 involves further development and evaluation of the management options identified in Stage 1. Stage 3 uses the information developed in Stages 1 and 2 to produce the strategic direction the City will follow to manage its wastewater in the future.

The City has successfully completed and received approval from MOE for Stage 1 of the LWMP. As such, the City is continuing on with the LWMP process by initiating Stage 2.

1.2 Stage 2 Liquid Waste Management Plan Objectives

The objective of Stage 2 of the LWMP is to build upon the wastewater management options identified in Stage 1. Sufficient information, including the advantages and disadvantages and a cost analysis of the available options are to be presented. The options will be compared against one another using the available information.

The management options will be presented to the LWMP Local and Technical Advisory Committees (LAC and TAC) for their feedback. The LAC and TAC will select their "Preferred Solutions" and these will be presented to the public at an advertised Stage 2 public information meeting. The City Council must approve presentation of Stage 2 to the public. After feedback from the public is received, the "Preferred Solutions" will be presented to the City Council for approval. Once approval from the Board is received, the Stage 2 LWMP will be submitted to the MOE for approval.

Stage 2 of the LWMP will consist of the following seven discussion papers:

- Discussion Paper 2-1: Waste Volumes and Facility Sizing Criteria
- Discussion Paper 2-2: Wastewater Treatment Facility Options
- Discussion Paper 2-3: Treatment Technology Options
- Discussion Paper 2-4: Land Requirements and Availability
- Discussion Paper 2-5: Wastewater Conveyance and Disposal Methods
- Discussion Paper 2-6: Sustainability and Resource Recovery Options
- Discussion Paper 2-7: Cost Estimates

Each of the abovementioned discussion papers covers a specific topic or area of interest pertaining to the City's future wastewater management strategy.

The objectives of this discussion paper, Discussion Paper 2-1, are the following:

- Confirm the population projection developed in Stage 1.
- Estimate wastewater volumes while considering:
  - population growth,
  - domestic, industrial, as well as dry weather and wet weather flows,
  - portions to be treated to certain treatment levels,
  - portions to be bypassed, and
  - potential for volume reduction.

- Define the portions of wastewater that need to be treated to secondary and primary treatment requirements and portions of wet weather flows that can be bypassed, if required.
- Estimate the amount of non-biodegradable solids.
- Estimate the amount of sludge.

The information provided in this discussion paper will serve as a reference tool for forthcoming Stage 2 LWMP discussion papers.

2 Population Projections

2.1 Background

Historically, the City has experienced a fairly transient population due to seasonal work opportunities. Many people come to the City for a few months of employment and then leave. Like many small northern British Columbia communities, a few employers provide employment to many residents. As a result, the population of the City is greatly impacted by the economic conditions of industries and businesses operating or not operating in the City.

As shown by the historical population values provided in **Table 2-1**, over the past few decades, the population of Prince Rupert has increased and decreased, reflecting changes to the City's economy. Over the time period from 1961 to 2006, the average rate of growth has been less than 0.5 percent.

Table 2-1
Historical Population Values

Year	Population
1961	11,987*
1966	14,677*
1971	15,947*
1976	14,754*
1982	17,444**
1991	16,620***
1996	16,714***
2001	14,643***
2006	12,815***

Notes:
* Value taken from the City of Prince Rupert's *Official Community Plan*.
** Value taken from *General Development, Growth and Land Use – A Background Report for the Prince Rupert Official Community Plan*.
*** Value taken from Statistics Canada.

2.2 Methodology

The future population of the City depends on the current population, current level of economic stability, and potential future economic development opportunities. The future population of the City was calculated in Discussion Paper 1-2 – Community Development of the Stage 1 LWMP. The population projections developed in Discussion Paper 1-2, based on 1, 1.5, and, and 2 percent growth, have been revised to include 2006 Statistics Canada Census information. In order to determine the future population for the LWMP planning years 2030 and 2050, the historical population values were multiplied by 1, 1.5, and 2 percent per year. For reference, more detailed information regarding population projections is provided in **Appendix A**.

2.3 Estimated Population

The projected populations for the LWMP planning years 2030 and 2050 are provided in **Table 2-2** and shown in **Figure 2-1**.

Table 2-2
Projected Populations for Planning Years 2030 and 2050

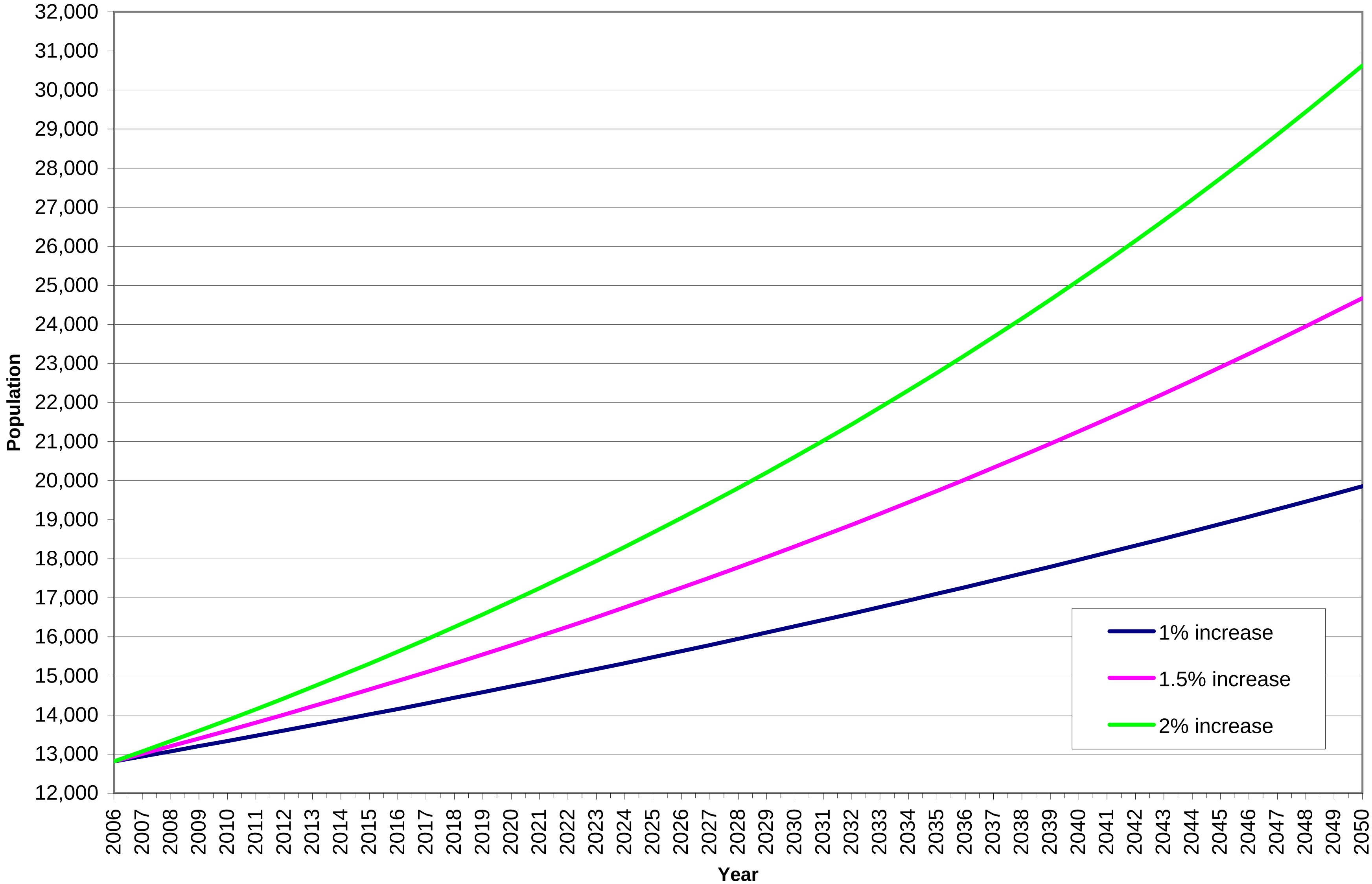
Growth (%)	Population - 2030	Population - 2050
1	16,272	19,855
1.5	18,319	24,673
2	20,612	30,629

According to the City (General Development, Growth and Land Use – A Background Report for the Prince Rupert Official Community Plan – DRAFT 1, 1994), the target population is projected to be 25,000, even though the City acknowledges that not enough land is available to accommodate the projected residential land demand for 25,000, at normal densities. At 1 and 1.5 percent growth, this target population is only reached well past year 2050. At 2 percent growth, this target population is reached in year 2040.

Based on 1 percent growth, the City reaches a population of about 16,270 by year 2030 and 19,860 by year 2050. Based on 1.5 percent growth, the City would reach a population of about 18,320 by year 2030 and about 24,670 by year 2050. Based on 2 percent growth, the City would reach a population of about 20,610 by year 2030 and about 30,630 by year 2050.

Considering the 2 percent growth rate exceeds the City's target population of 25,000 by year 2040 and the 1 percent growth rate may not be conservative enough for planning purposes, this report will recommend the use of the population values developed using the 1.5 percent growth rate. Therefore, the LWMP design population is approximately 18,000 in year 2030 and 25,000 in year

Figure 2-1 - City of Prince Rupert Projected Population as a Function of Time



2050. These values are conservative and consistent with the City's maximum target population of 25,000.

3 Facility Sizing Criteria

3.1 Wastewater Flows

3.1.1 Average Dry Weather Flow

The average dry weather flow (ADWF) is the average flow occurring over a 24-hour period under dry weather conditions (typically late May through June and July to the beginning of August in Prince Rupert (Ref: Environment Canada Climate Norms). It is made up of both the average sanitary flow and the average dry weather inflow/infiltration. The ADWF is generally based on annual flow rate data. However, the City does not have complete flow records available and as such; the ADWF rates for the LWMP design years 2030 and 2050 were calculated by multiplying the projected population in both year 2030 and year 2050 by the projected unit wastewater flow contribution for the respective design year. The projected unit wastewater flows were established based on average dry weather flow data provided in the City of Prince Rupert Final Report: Comprehensive Monitoring Program – Impacts of Wastewater Discharges on Prince Rupert Harbour (2003). For reference, the ADWF calculations are provided in **Appendix B**.

The total ADWF for year 2030 is estimated to be 91 L/s. The total ADWF for year 2050 is estimated to be 123 L/s.

3.1.2 Maximum Daily Flow

The maximum daily flow is the maximum flow occurring over a 24-hour period under wet weather condition. The maximum daily flow for the City was calculated by using the design year ADWF, provided in Section 3.1.1, and multiplying it by a calculated peaking factor. A peaking factor is the ratio of peak wet weather flowrate to average flowrate.

Peaking factor values for each catchment were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each catchment by the ADWF for that particular catchment. The 5-year return period rainfall peak flow event values were calculated by Associated Engineering (2000). For reference, the peaking factor and maximum daily flowrate calculations are provided in **Appendix B**.

The maximum daily flowrate for year 2030 is estimated to be 3,199 L/s. The maximum daily flowrate for year 2050 is estimated to be 4,317 L/s.

3.2 Wastewater Treatment Requirements.

In British Columbia, the MSR governs wastewater flows above 22.7 m^3/day and any discharges to surface waters, regardless of flow. The MSR specifies wastewater treatment requirements and required effluent quality based on the maximum daily flow to be treated and the effluent receiving environment.

Based on the ADWF for Year 2030 and Year 2050 (estimated in Section 4.2.1) and the MSR requirements, the City will develop a wastewater treatment regime to meet the self-imposed treatment requirements outlined below:

- Up to two times the ADWF will be treated to secondary treatment standards.
  - For year 2030, the wastewater flow to be treated is estimated to be 182 L/s.
  - For year 2050, the wastewater flow to be treated is estimated to be 245L/s.

- Up to four times the ADWF will be treated to primary treatment standards.
  - For year 2030, the wastewater flow to be treated is estimated to be 363 L/s.
  - For year 2050, the wastewater flow to be treated is estimated to be 491 L/s.

- All flows greater than four times the ADWF will be bypassed as combined sewer overflows.

Treating only two times the ADWF to secondary treatment level is based on the principle of providing the City with a cost effective treatment scheme that would provide efficient use of capital investment, minimize expenditures on facility and related equipment that would be used infrequently, and provide the required level of environmental protection. Considering very large peaking factors (i.e. over 100 times) and resulted dilution, all flows greater than four times the ADWF will be bypassed as part of an interim wet weather flow strategy.

3.3 Potentials for Volume Reduction

Wastewater volume reduction may in part be achieved by water conservation and reduction of infiltration and inflow.

Water conservation typically requires a public awareness program so that the general public may understand the overall importance of water conservation and the measures that they may use to conserve water. Water conservation measures may include the use of flow reduction devices for shower heads and faucets, using dual flush toilets, turning water off while shaving or brushing teeth, infrequently watering lawn and garden, etc.

Source control is also an effective way to reduce the volume, flow, and pollutant load entering the collection system. Source control measures may include the use of porous pavements to help reduce runoff by allowing storm water to drain through the pavement to the soil.

As mentioned in Section 3 above, Inflow and Infiltration (I&I) refers to rainwater and/or groundwater that enters the sewer system and represents additional flows above the base sanitary wastewater flows. Reductions in extraneous flow are equivalent to an increase in the capacity of the system. Capacity that is not needed to convey and treat wet weather flows can be utilized for sanitary wastewater flows.

Wastewater volumes may also be reduced through the rehabilitation or complete replacement of the City's aging collection systems. This includes sewer separation into sanitary and storm sewers and repairing or replacing non-repairable sewer pipes and manholes; thereby, reducing the amount of I&I entering the system and the amount of wet weather flows to be treated.

3.4 Non-biodegradable Solids

Non-biodegradable solids consist of materials such as sand, gravel, cinders, eggshells, bone chips, seeds, and coffee grinds which have subsiding velocities or specific gravities much greater than those characterized by organic solids found in wastewater (Metcalf and Eddy). Removal of grit prevents unnecessary abrasion and wear of mechanical equipment.

Grit quantities may range from 0.004 to 0.20 m^3 of grit per 1000 m^3, with 0.015 m^3 of grit per 1000 m^3 being a typical value (Metcalf and Eddy). The quantities of grit will be different depending on the location, the type of sewer system, the characteristics of the drainage area, etc. (Metcalf and Eddy). The grit quantities present in separate sewers can range from 0.004 to 0.037 m^3 of grit per 1000 m^3, while the grit quantities present in combined sewers can range from 0.004 to 0.2 m^3 of grit per 1000 m^3 (Metcalf and Eddy).

Based on an ADWF of 91 L/s (7,862 m^3/day) for design year 2030, the typical amount of grit generated is calculated to be 0.12 m^3/day. Based on an ADWF of 123 L/s (10,627 m^3/day) for design year 2050, the typical amount of grit generated is calculated to be 0.16 m^3/day. For reference, grit calculations are provided in **Appendix C**.

3.5 Biodegradable Solids (Sludge)

The amount of sludge that may be generated is based on the projected populations of design years 2030 and 2050 and the following assumptions:

- A Biochemical Oxygen Demand (BOD) load of 0.070 kg/capita/day,
- A total solids generation rate of 0.85 kg/kg BOD removed,
- 100 percent removal of BOD in the secondary process,
- 76 percent volatile solids in the total solids, and
- Maximum month values are 1.2 times the average values.

On this basis, the estimated amount of sludge that may be generated in design year 2030 is 33 m^3/day at 4% (thickened) sludge and 5.3 m^3/day at 25% (dewatered) sludge. The estimated amount of sludge that may be generated in design year 2050 is 45 m^3/day at 4% (thickened) sludge and 7.2 m^3/day at 25% (dewatered) sludge. For reference, sludge calculations are provided in **Appendix C**.

4 Conclusions

This discussion paper provides information that will assist in the development of the overall wastewater management scheme for the City's wastewater in design years 2030 and 2050. The recommended design population for the City is based on 1.5 percent growth and includes a design population of approximately 18,000 in design year 2030 and 25,000 in design year 2050. These values are conservative and consistent with the City's maximum target population of 25,000.

The ADWF is the average flow occurring over a 24-hour period under dry weather conditions (typically May through the beginning of September and more specifically July to August). The ADWF for design year 2030 is estimated to be 7,862 m^3/day (91 L/s). The ADWF for design year 2050 is estimated to be 10,627 m^3/day (123 L/s). The maximum daily flow is the maximum flow occurring over a 24-hour period under wet weather condition. The maximum daily flowrate for design year 2030 is estimated to be 276,394 m^3/day (3,199 L/s). The maximum daily flowrate for design year 2050 is estimated to be 372,989 m^3/day (4,317 L/s). Based on the ADWF for Year 2030 and Year 2050, the City will be required to meet the treatment requirements specified in the BC MSR as outlined below:

- Up to two times the ADWF will be treated to secondary treatment standards (182 L/s and 245 L/s for design years 2030 and 2050 respectively).
- Up to four times the ADWF will be treated to primary treatment standards (363 L/s and 491 L/s for design years 2030 and 2050 respectively).
- All flows greater than four times the ADWF will be bypassed as part of an interim wet weather flow strategy.

Treating only two times the ADWF to secondary treatment level is based on the principle of providing the City with an economical wastewater treatment scheme while still offering the required level of environmental protection. The type of treatment options used to treat the City's wastewater will be discussed in an upcoming discussion paper, Discussion Paper 2-3: Treatment Technology Options.

5 References

1. Associated Engineering. 2007. City of Prince Rupert Stage 1 Liquid Waste Management Plan, Discussion Paper 1-2 – Community Development.

2. Associated Engineering. 2003. Comprehensive monitoring program – impacts of wastewater discharges on Prince Rupert Harbour, City of Prince Rupert.

3. Associated Engineering. 2004. Sewage System Upgrading Plan, City of Prince Rupert.

4. Associated Engineering. 2000. City of Prince Rupert Comprehensive Monitoring Program - Impacts of Wastewater Discharges on Prince Rupert Harbour (Supplementary Data: Hydraulic Model Results For Pipe Network). Project Number: 002118.

5. British Columbia - Ministry of Environment. 1999. Municipal Sewage Regulations. Available from: http://www.env.gov.bc.ca/epd/epdpa/mpp/msreg.html

6. City of Prince Rupert. 1980. Official Community Plan.

7. City of Prince Rupert. 2008. Quality of Life – Official Community Plan, Bylaw 3236, 2007 Schedule "A". Available from: http://www.princerupert.ca/page.php?id_section=4&id_page=261

8. City of Prince Rupert. 1994. General development, growth and land use – a background report for the Prince Rupert official community plan – DRAFT 1.

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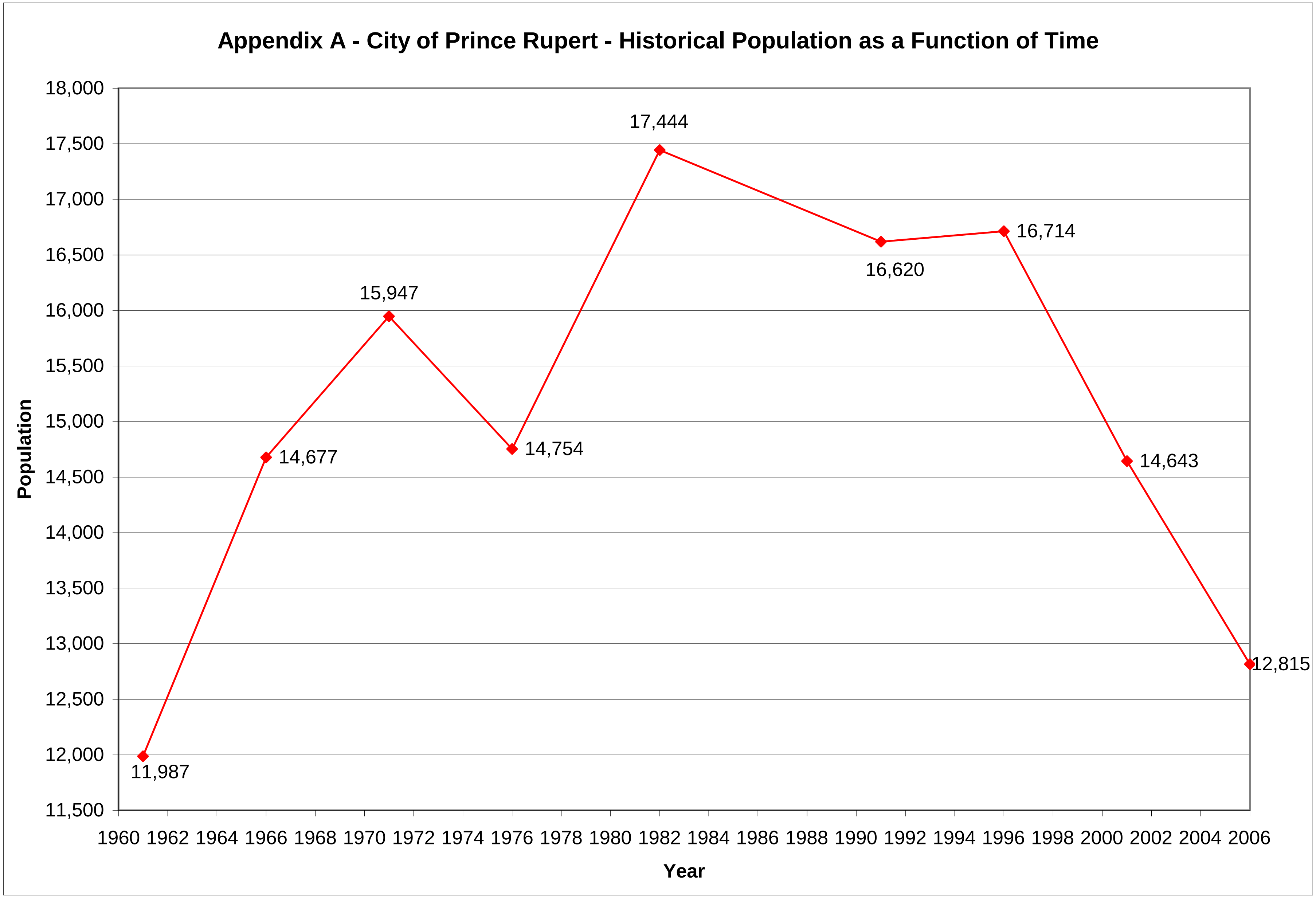
10. Statistics Canada. 2006 Census. Available from: http://www12.statcan.ca/census-recensement/2006/rt-td/index-eng.cfm

APPENDIX A - POPULATION PROJECTIONS


Appendix A - City of Prince Rupert - Historical Population as a Function of Time
18,000
17,500
17,000
16,500
16,000
15,500
15,000
14,500
14,000
13,500
13,000
12,500
12,000
11,500
Population
17,444
16,714
16,620
15,947
14,677
14,754
14,643
12,815
11,987
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006
Year

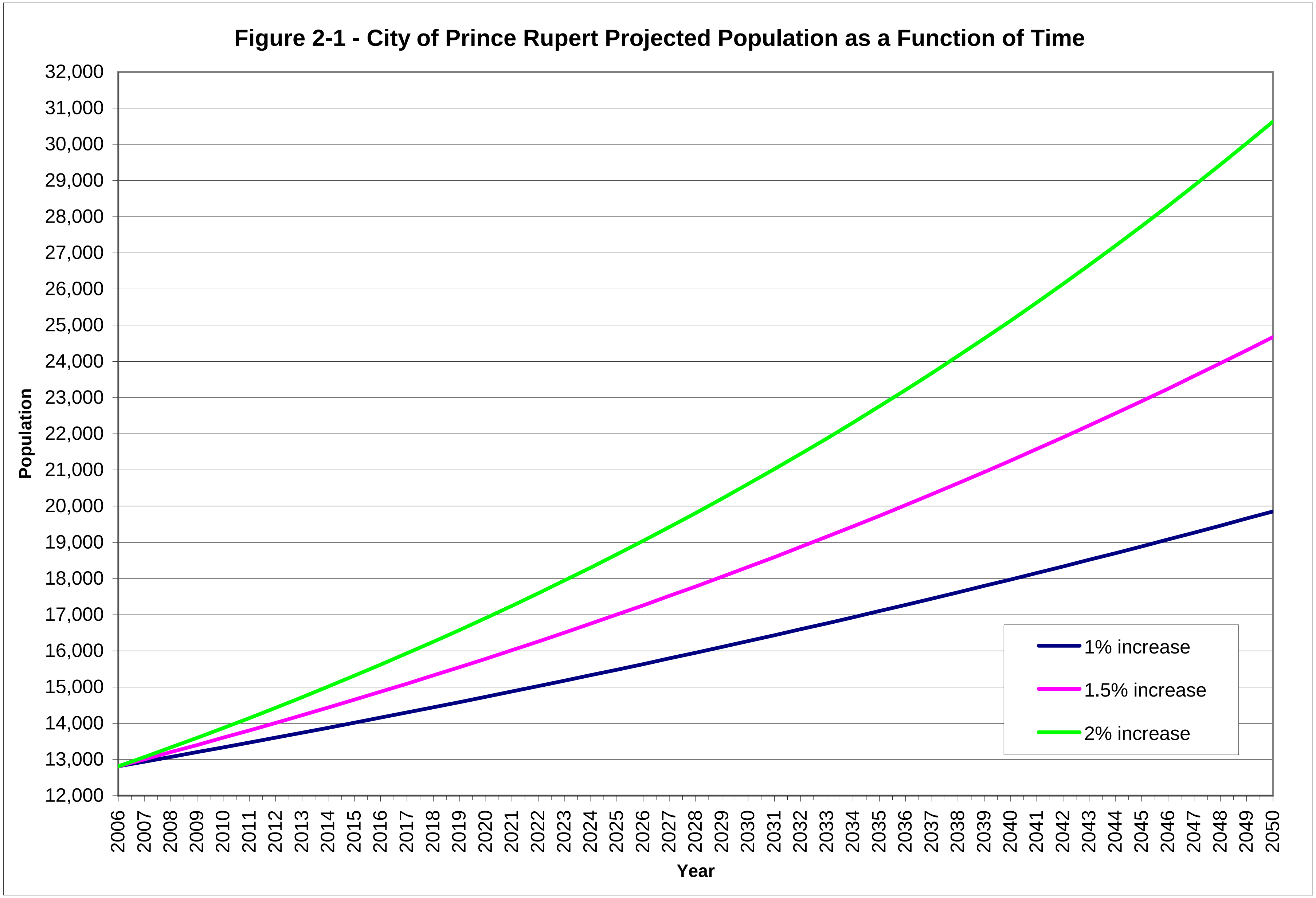


Figure 2-1 - City of Prince Rupert Projected Population as a Function of Time
Population
32,000
31,000
30,000
29,000
28,000
27,000
26,000
25,000
24,000
23,000
22,000
21,000
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Year
1% increase
1.5% increase
2% increase

Appendix A - Population Projections
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: August 26, 2009

		Population Projections		
Year	**Actual Population**	**1% increase**	**1.5% increase**	**2% increase**
1961	11,987	11,987	11,987	11,987
1966	14,677	14,677	14,677	14,677
1971	15,947	15,947	15,947	15,947
1976	14,754	14,754	14,754	14,754
1982	17,444	17,444	17,444	17,444
1991	16,620	16,620	16,620	16,620
1996	16,714	16,714	16,714	16,714
2001	14,643	14,645	14,645	14,645
2006	12,815	12,815	12,815	12,815
2007		12,943	13,007	13,071
2008		13,073	13,202	13,333
2009		13,203	13,400	13,599
2010		13,335	13,601	13,871
2011		13,469	13,805	14,149
2012		13,603	14,012	14,432
2013		13,739	14,223	14,720
2014		13,877	14,436	15,015
2015		14,016	14,653	15,315
2016		14,156	14,872	15,621
2017		14,297	15,095	15,934
2018		14,440	15,322	16,253
2019		14,585	15,552	16,578
2020		14,731	15,785	16,909
2021		14,878	16,022	17,247
2022		15,027	16,262	17,592
2023		15,177	16,506	17,944
2024		15,329	16,754	18,303
2025		15,482	17,005	18,669
2026		15,637	17,260	19,042
2027		15,793	17,519	19,423
2028		15,951	17,782	19,812
2029		16,111	18,048	20,208
2030		**16,272**	**18,319**	**20,612**
2031		16,434	18,594	21,024
2032		16,599	18,873	21,445
2033		16,765	19,156	21,874
2034		16,932	19,443	22,311
2035		17,102	19,735	22,757
2036		17,273	20,031	23,213
2037		17,445	20,331	23,677
2038		17,620	20,636	24,150
2039		17,796	20,946	24,633
2040		17,974	21,260	25,126
2041		18,154	21,579	25,629
2042		18,335	21,903	26,141
2043		18,519	22,231	26,664
2044		18,704	22,565	27,197
2045		18,891	22,903	27,741
2046		19,080	23,247	28,296
2047		19,271	23,595	28,862
2048		19,463	23,949	29,439
2049		19,658	24,309	30,028
2050		**19,855**	**24,673**	**30,629**

NOTE: Actual population values are shown in yellow highlight and are not projected values.

APPENDIX B - WASTEWATER FLOWRATE CALCULATIONS

Appendix B - Wastewater Flow Rate Calculations
Subject: Values from Table 7-1 of March 2003 Report
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: February 10, 2010

Values in this table are from City of Prince Rupert - Table 7-1 - Average Dry and Wet Weather Flows, Final Report: Comprehensive Monitoring Program - Impacts of Wastewater Discharges on Prince Rupert Harbour, March 2003

			Average Dry Weather Flow[2]				*1:5 Year Predicted*	*Calculated*	*Average Wet Weather Flow*[3]					
Outfall	**System Type**	**Equivalent Population**[1]	**Sanitary (L/s)**	**Infiltration (L/s)**	**Total (L/s)**	**Total m3/s)**	***Q_{peak}*[4] *(m3/s)***	***Peaking Factor***	**Sanitary (L/s)**	**Storm / Inflow (L/s)**	**Infiltration (L/s)**	**Rain Derived Infiltration (L/s)**	**Total (L/s)**	**Total (m3/s)**
A	combined	704	2.8	10	12.8	0.013	1.4	109	2.8	30.6	40	11.6	85	0.085
B	sanitary	3387	9.8	0.1	9.9	0.010	0.26	26	9.8	5.5	10	12.1	37.4	0.037
C	combined	2204	8.9	97.8	106.7	0.107	2.33	22	8.9	76.4	154	23	262.3	0.262
F	sanitary	252	1	0.3	1.3	0.001	0.16	123	1	4.9	0.8	10.9	17.6	0.018
G	combined	257	1	3	4	0.004	0.17	43	1	7	5	1.1	14.1	0.014
H	combined	1558	6.3	9	15.3	0.015	2.11	138	6.3	57.8	19.1	11.8	95	0.095
I	sanitary	7470	30.3	3.7	34	0.034	0.34	10	30.3	8.6	15.7	24.9	79.5	0.080
J	combined	230	0.9	0.1	1	0.001	0.15	150	0.9	4.4	0.1	3.3	8.7	0.009
K	combined	170	0.7	0.1	0.8	0.001	0.1	125	0.7	2.6	0.1	2.1	5.5	0.006
L	sanitary	3118	12.6	5.5	18.1	0.018	0.2	11	12.6	4.4	13.5	8.9	39.4	0.039
	TOTAL	**19,350**	**74.3**	**129.6**	**203.9**	**0.20**			**74.3**	**202.2**	**258.3**	**109.7**	**644.5**	**0.64**

Note 1: Equivalent population includes residential, commercial, industrial and institutional (p. 5-2 of 2003 Report)

Note 2: The average two-week dry weather was used to reflect typical summertime condition during a period of no rainfall. This would reflect the strongest wastewater strength and the lowest flow condition (p. 7-2 of 2003 Report).

Note 3: The average two-week wet weather was used to reflect the late fall and wintertime condition. These values were calculated based on the wettest two weeks that were captured during the flow monitoring period (p. 7-2 of 2003 Report).

Note 4: The predicted 5-Year return period rainfall peak flow event for each of the sewer areas was used to calculate the peaking factor for each catchment by dividing it by the ADWF for each catchment. 5-year return period rainfall peak flow event values were calculated by Associated Engineering in 2000 and are provided in the City of Prince Rupert Comprehensive Monitoring Program - Impacts of Wastewater Discharges on Prince Rupert Harbour (Supplementary Data: Hydraulic Model Results For Pipe Network). Project Number: 002118.

Appendix B - Wastewater Flow Rate Calculations
Subject: Projected Flows for Design Years 2030 and 2050
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: March 8, 2010

Target Population		**18,500**	*(est. to be reached in year 2030 based on 1.5% growth)*				
Multiplier		**0.96**					
		Projected Values for Target Population of 18,500					
		Projected	***Average Dry Weather Flow (L/s)***				
Outfall	**System Type**	**Population**	**Sanitary**	**Base Infiltration[2]**	**Total**	**Peaking Factor[1]**	**Max Day Flow (L/s)**
A	combined	673	2.7	1.2	3.9	109.4	424.0
B	sanitary	3,238	9.4	0.1	9.5	26.3	248.6
C	combined	2,107	8.5	3.7	12.2	21.8	266.6
F	sanitary	241	1.0	0.3	1.2	123.1	153.0
G	combined	246	1.0	2.9	3.8	42.5	162.5
H	combined	1,490	6.0	2.6	8.6	137.9	1,189.2
I	sanitary	7,142	29.0	3.5	32.5	10.0	325.1
J	combined	220	0.9	0.1	1.0	150.0	143.4
K	combined	163	0.7	0.1	0.8	125.0	95.6
L	sanitary	2,981	12.0	5.3	17.3	11.0	191.2
	TOTAL	**18,500**	**71**	**20**	**91**		**3,199**
		Secondary Treatment (2 x ADWF)			***182***	***L/s***	
		Primary Treatment (4 x ADWF)			***363***	***L/s***	
Target Population		**25,000**	*(est. to be reached in year 2050 based on 1.5% growth)*				
Multiplier		**1.29**					
		Projected Values for Target Population of 25,000					
		Projected	***Average Dry Weather Flow (L/s)***				
Outfall	**System Type**	**Population**	**Sanitary**	**Base Infiltration[2]**	**Total**	**Peaking Factor[1]**	**Max Day Flow (L/s)**
A	combined	910	3.6	1.6	5.2	109.4	570.7
B	sanitary	4,376	12.7	0.1	12.8	26.3	335.9
C	combined	2,848	11.5	4.9	16.4	21.8	358.1
F	sanitary	326	1.3	0.4	1.7	123.1	206.7
G	combined	332	1.3	3.9	5.2	42.5	219.6
H	combined	2,013	8.1	3.5	11.6	137.9	1,605.2
I	sanitary	9,651	39.1	4.8	43.9	10.0	439.3
J	combined	297	1.2	0.1	1.3	150.0	193.8
K	combined	220	0.9	0.1	1.0	125.0	129.2
L	sanitary	4,028	16.3	7.1	23.4	11.0	258.4
	TOTAL	**25,000**	**96**	**27**	**123**		**4,317**
		Secondary Treatment (2 x ADWF)			***245***	***L/s***	
		Primary Treatment (4 x ADWF)			***490***	***L/s***	

Note 1: Peaking factors shown were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each of the sewer areas by the total ADWF for each catchment. For calculations, please see Table 7-1 March 03 Report worksheet in same Excel file.

Note 2: The base infiltration rates for Catchments A, C and H have been modified from those presented in Table 7-1 of the March 03 Report. New base infiltration rates are based on a total flow of 500 L/cap/day, using sanitary flows of 350 L/cap/day.

APPENDIX C - GRIT AND SLUDGE CALCULATIONS

Appendix C - Girt and Sludge Calculations
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: March 8, 2010

Grit Calculations							
Grit quantities are from Metcalf and Eddy, Third Ed., Table 9-4							
Range	0.5	to	27	ft^3/Mgal			
Range - Metric	0.0037	to	0.202	$m^3/10^3m^3$			
Typical	2	ft^3/Mgal					
Typical - Metric	0.015	$m^3/10^3m^3$					
NOTE: ft^3/Mgal * 0.00748 = $m^3/10^3m^3$							
Design Year	***ADWF (L/s)***		***ADWF (m3/day)***		***Volume of Grit - typical (m3/day)***		
2030	91	L/s	7862	m3/day	0.12		
2050	123	L/s	10627	m3/day	0.16		
Sludge Calculations							
Assumptions:							
BOD Load	0.07	kg/cap/day	where BOD is Biochemical Oxygen Demand				
TS generation	0.85	kg/kg BOD removed	where TS is Total Solids				
Percent VS in TS	76	%	where VS is Volatile Solids				
Maximum Month BOD loading =	1.2	x average					
(Assume 100% removal of BOD in Secondary Process)							
Assumed primary sludge % solids	4	%					
Specific Gravity of Sludges	1	(conservative wet volume calculations)					
Year	***Projected Population***	***Max Month BOD loading (kg/day)***	***Max Month TS Generation (kg/day)***	***Max Month VS Generation (kg/day)***	***Volume of Sludge (dry) (m3/day)***	***Sludge at 4% (Thickend) (m3/day)***	***Sludge at 25% (Dewatered) (m3/day)***
2030	18500	1554	1321	1004	1.32	33.0225	5.28
2050	25000	2100	1785	1357	1.79	44.625	7.14

B Appendix B – DP2-2- Wastewater Treatment Facility Options

DISCUSSION PAPER 2-2

City of Prince Rupert
Liquid Waste Management Plan - Stage 2

Wastewater Treatment Facility Options

Issued:	September 18, 2009
Previous Issue:	None

1 Introduction and Objectives

The City of Prince Rupert (City) is developing Stage 2 of its Liquid Waste Management Plan (LWMP). As part of this plan, various aspects concerning the overall treatment of the City's wastewater are being investigated and reported. Discussion Paper 2-1: Wastewater Volumes and Facility Sizing Criteria was prepared to confirm the future population of the City in planning years 2030 and 2050, estimate the volume of wastewater and biodegradable and non-biodegradable solids requiring treatment, and define the portions of wastewater that need to be treated according to the British Columbia Municipal Sewage Regulations requirements.

This discussion paper, Discussion Paper 2-2: Wastewater Treatment Facility Options, will continue to expand on the information needs for Stage 2 of the City's LWMP. The objectives of this discussion paper are to present feasible options for the number and location(s) of wastewater treatment facilities. The advantages and disadvantages of each option will be presented so that cost estimates for short listed options can be prepared in a future discussion paper, Discussion Paper 2-7 Cost Estimate for Short Listed Options.

2 Proposed Wastewater Treatment Facility Options

There are several potential options for the number and general location of wastewater treatment facilities that may be considered by the City. In the past, the standard approach was to convey collected wastewater to a single, large treatment facility, commonly referred to as "centralized" treatment. Presently, the concept of "decentralized" treatment is gaining acceptance. Decentralized treatment basically refers to the treatment of wastewater using several "local" wastewater treatment facilities. The use of decentralized treatment may be driven by a number of factors, including the inability to locate a centralized facility because a large enough suitable property is not available. In other cases, topography and wastewater conveyance requirements may dictate decentralized treatment as an easier and less expensive alternative.

In the City's case, it would not be economical or practical to build wastewater treatment facilities for each of the ten sewer catchments. The most cost effective approach will be to consolidate the wastewater collection system by constructing a major trunk sewer interceptor system along the City's waterfront to direct wastewater flows to between one and three wastewater treatment facilities. The treated effluent would then be discharged to the marine environment through outfalls at each facility. Selecting the preferred option regarding the number and location of the treatment facility(ies) needs to take into account both the economics of the on-shore wastewater treatment works and the off-shore environmental impacts of the effluent outfalls.

To assist the City in deciding its future wastewater management path, the wastewater treatment facility options available to the City have been broken down into three potential options. Option 1 involves having a single wastewater treatment facility (centralized treatment), located, for example, at either Hays Creek, Port Edward, or the Industrial Park. Option 2 involves having two wastewater treatment facilities (decentralized treatment), for example, at Hays Creek and Ritchie Point, or Hays Creek and Morse Creek. Option 3 involves having three separate wastewater treatment facilities (decentralized treatment), for example, one each at Hays Creek, Ritchie Point, and Morse Creek area.

Descriptions of the above mentioned options, including the advantages and disadvantages of each option will be presented in the following subsections of Section 2.

The reader should note that currently the City does not own any properties on the waterfront that are readily available for the required treatment facilities. The mentioning of specific potential locations is to allow the reader to understand the general area of interest for the wastewater treatment facility.

2.1 Option 1 - Single Wastewater Treatment Facility (Centralized Treatment)

Conventional urban planning has, in the past, used a centralized wastewater management system that collects all flows at a single, large treatment facility, followed by disposal of the effluent to a nearby surface water body, such as the ocean in the City’s case. If a central treatment facility is selected, the flows from the various pump stations, gravity sewers, and force mains could potentially be consolidated so that all wastewater is directed to one wastewater treatment facility. Consolidation of the collection system could occur by constructing a major sewer interceptor system, which will consist of gravity sewers and pump stations with force mains along the City’s waterfront that would direct the wastewater from all ten existing catchment areas to the centralized treatment facility.

Naturally any conveyance system design should attempt to take advantage of a gravity sewer system as much as possible and minimize the number of pump stations and the volume of pumped wastewater. Doing so, would help reduce both the capital and operational cost involved in building and operating the pumping stations and related infrastructure.

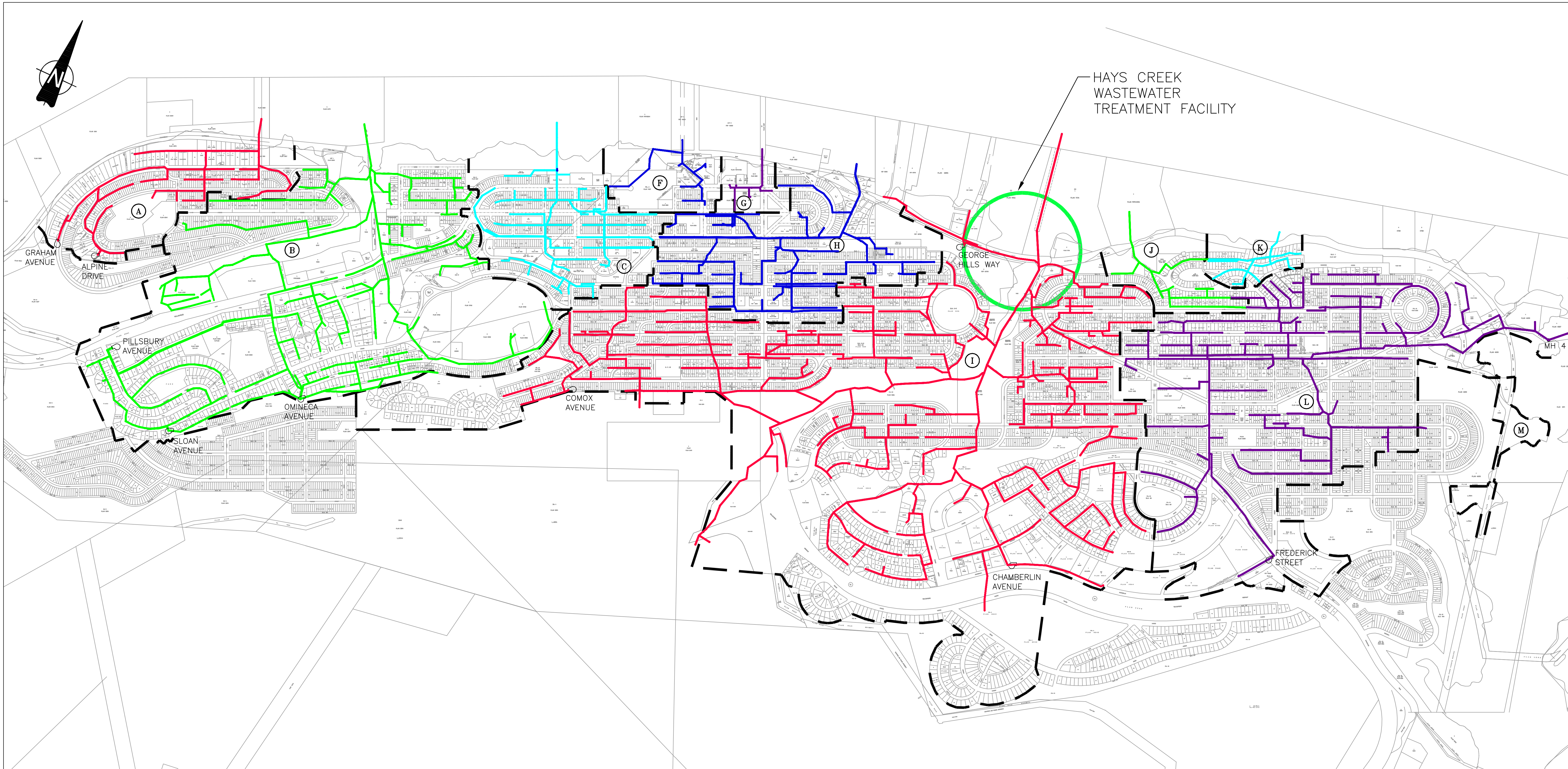
Having a centralized treatment facility would also be beneficial because any solids including biosolids, screenings, and solids resulting from mechanical separation treatment processes would likely be handled on site and not require solids having to be hauled off site for treatment. On site treatment would likely consist of some type of sludge stabilization method followed by some type of sludge dewatering method. The stabilized and dewatered sludge would require disposal in the form of composting, land application, landfill, or incineration. The screenings from the wastewater would need to be hauled off-site for disposal at a landfill or incineration. Another benefit of having a centralized facility is that some resource recovery technologies, such as energy recovery from organic solids, have advantages at a larger scale.

2.1.1 Option 1A - Hays Creek

As shown on **Figure 2-1**, a potential location for a single treatment facility could be near the harbour front, in the vicinity of Hays Creek area. Siting a treatment facility in the Hays Creek area makes a lot of sense because approximately 40 percent of the City's total wastewater flow is discharged through Outfall I (Hays Creek area), which is the City's deepest outfall. Assuming there is adequate outfall capacity available; the treated effluent would be discharged through the existing outfall. Alternatively, a larger outfall could be installed. If this option were selected, there would certainly be requirements for the installation of new pump stations and gravity sewers to convey the wastewater along the City's waterfront to the treatment facility. The pump stations would provide the required conveyance to the facility and also assist in flow equalization due to the holding capacity within their wet well and incoming sewers. This capacity, along with process regulations, would help maintain a more stable and constant flow to the facility, which in turn will assist in maintaining the treatment performance. Conveyance using gravity alone would not be possible due to the topography of the area.

2.1.2 Option 1B - Port Edward

The former pulp mill at Port Edward, located about 15 km outside the City is another potential location for a wastewater treatment facility (refer to **Figure 2-2**). The Port Edward site is a possible location considering that the existing tankage at the former pulp mill industrial wastewater treatment facility could potentially be converted to a secondary municipal wastewater treatment process. For this option to work, the entire City's wastewater would need to be conveyed initially to a central location (most likely the location proposed in Option 1A, i.e., the Hays Creek area). It would then be pumped to the Port Edward facility via a major pump station and force main. Economically, the cost to first convey all wastewater to a centralized site using both gravity flow and pumps, and then pump the combined flows to the Port Edward facility could be quite extensive, and may not off-set the economical benefits of using the existing treatment facility tankage. Additionally, the nature and configuration of the existing tanks may limit the selection of the type of wastewater treatment technology used to treat the wastewater. The type of treatment technology used at Port Edward may not necessarily be the best type of treatment technology for municipal wastewater. It may simply be that the type of treatment technology implemented is the type that works well using the existing tankage. It should be noted that the existing tankage is not sized for the City and, therefore, may present challenges in retrofitting. Additionally, the costs of acquiring the existing facilities and



LEGEND:

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-1

OPTION 1A - SINGLE TREATMENT FACILITY AT HAYS CREEK

N.T.S.

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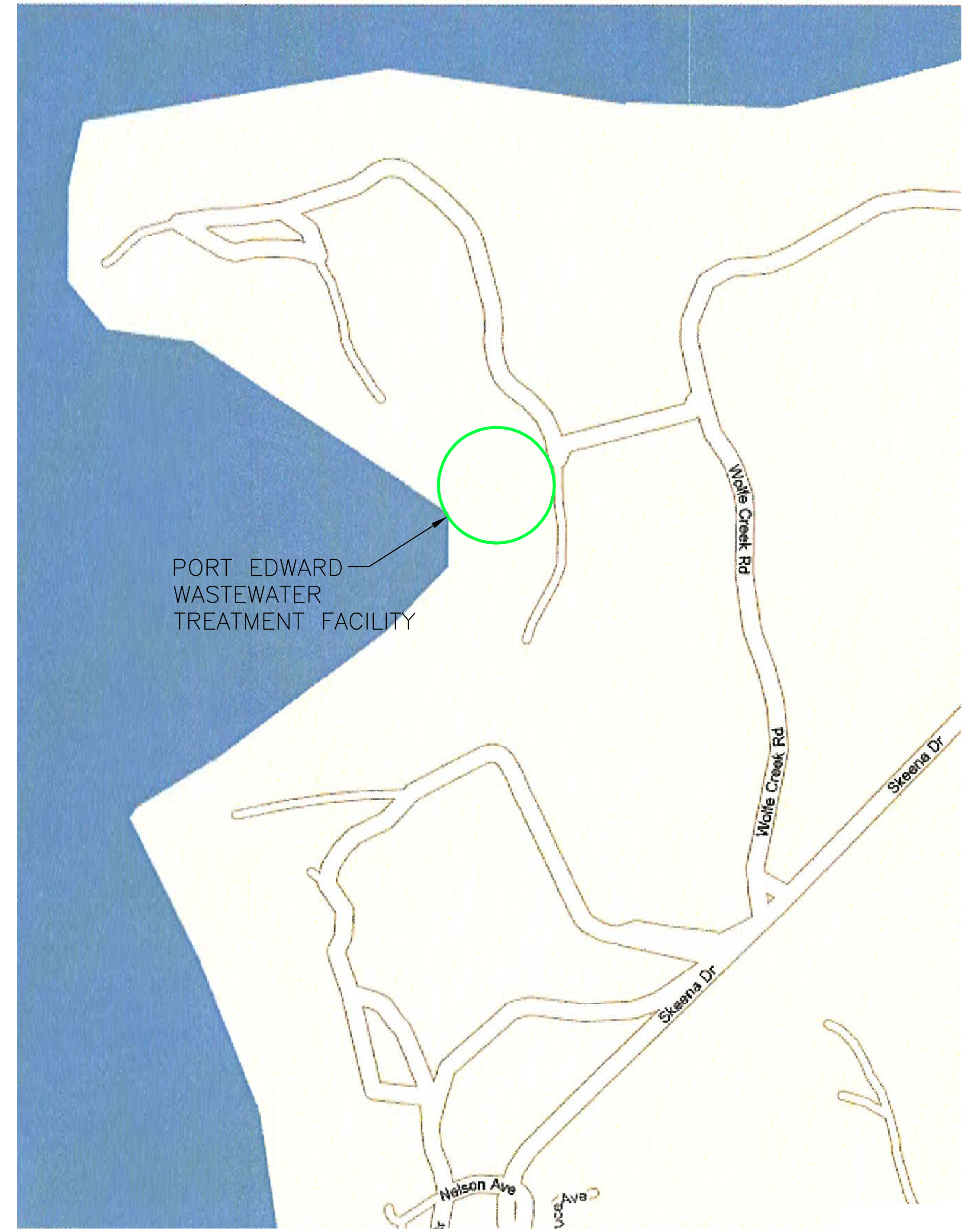

LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-2
OPTION 1B - SINGLE TREATMENT FACILITY AT PORT EDWARD

N.T.S.

Associated Engineering

P:\20062891\02_PURP_LWMPP_S2\Working_Dwgs\100_Civil\Figure 2-2.dwg
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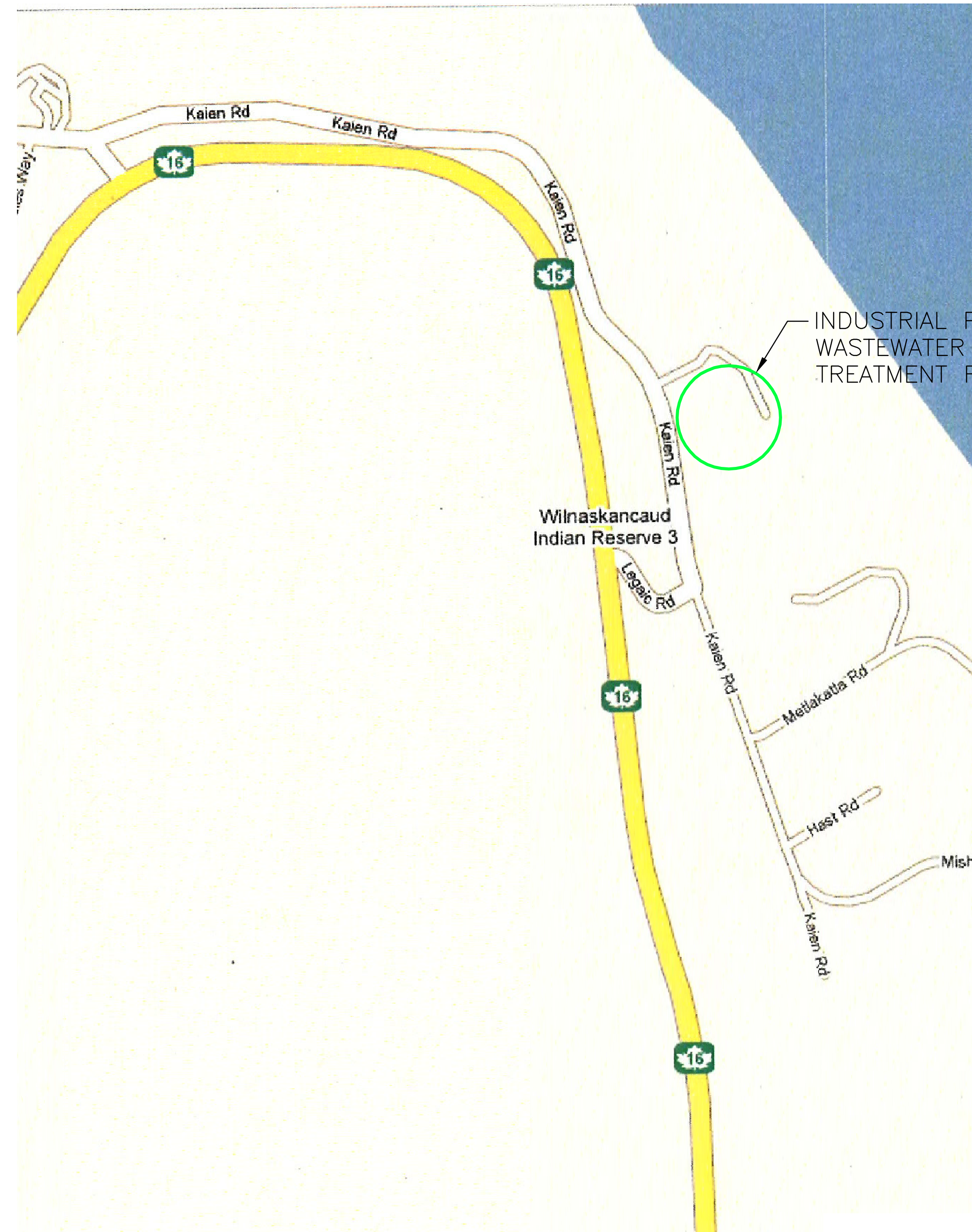
refurbishing the existing tanks and aeration system would need to be considered if this option is to be short-listed.

2.1.3 Option 1C - Industrial Park

The Prince Rupert Industrial Park, located approximately 5 km outside the City core area is another potential site for a municipal wastewater treatment facility (refer to **Figure 2-3**). Similar to Option 1B – Port Edward, this option would require the entire City's wastewater to be conveyed initially to a central location (most likely the location proposed in Option 1A, i.e., the Hays Creek area) and then pumped to the Industrial Park facility via a major pump station and force main. Economically, the cost to first convey all wastewater to a centralized site using both gravity flow and pumps, and then pump the combined flows to the Industrial Park facility could be quite extensive. However, if this option is selected, it may be easier and less expensive to acquire the land to build a treatment facility. Compared to Option 1B – Port Edward, this option does not have any existing tankage and therefore, does not have the same treatment process limitations that Option 1C may have. This option will most likely require an effluent pump station and force main back to the Harbour outfall.

2.2 Option 2 - Two Wastewater Treatment Facilities (Decentralized Treatment)

Decentralized treatment using two wastewater treatment facilities would split the flows from the various pump stations, gravity sewers, and force mains so that wastewater is directed to one of two wastewater treatment facilities. These facilities would be located near the harbour front, in the vicinity of either Hays Creek and Morse Creek or Hays Creek and Ritchie Point, for example. The Hays Creek facility is included for both Option 2 sub-options because approximately 40 percent of the City's total wastewater flow is discharged through Outfall I (Hays Creek area), which is also the City's deepest outfall. These potential treatment facility locations have been selected because they correspond with the areas generating the largest sanitary flows and therefore, it is more economical to pump wastewater from the smaller areas to the larger areas, rather than vice versa. Option 2 would potentially require pumping wastewater in interceptor sewers along the City's shore to convey the flows to the respective treatment facilities. It is likely that the resulting solids produced at each treatment facility may have to be dealt with off site, which may include trucking the solids from each of the wastewater treatment facilities to another location or to the largest treatment facility for solids treatment. Solids treatment would consist of some form of digestion and dewatering. The stabilized sludge would then be disposed of using composting, land application, landfilling, or incineration. The screenings would need to be hauled off site for landfill disposal or incineration. Some resource recovery technologies such as heat recovery may lend itself well to this option because the location of the treatment facilities could be closer to users of the recovered heat.



LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-3
OPTION 1B - SINGLE TREATMENT FACILITY AT INDUSTRIAL PARK

N.T.S.

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2.2.1 Option 2A - Hays Creek and Morse Creek

Decentralized wastewater treatment at Hays Creek and Morse Creek would require conveying wastewater from Areas A, B, C, and F to a Morse Creek Wastewater Treatment Facility and conveying wastewater from Areas G, H, I, J, K, L, and M to a Hays Creek Wastewater Treatment Facility (refer to **Figure 2-4**). In this option, Hays Creek would handle approximately 70 percent of the sewered area and Morse Creek would handle 30 percent of the sewered area. Treated effluent would be discharged from the respective treatment facilities to the harbour through long, deep outfalls. Option 2A would require pump stations to convey flows from areas K, L, and M to the Hays Creek Facility. Due to lower flows coming from Areas K, L, and M, these pumps, related equipment and associated conveyance operational costs would be less than those used to convey flows in Option 2B.

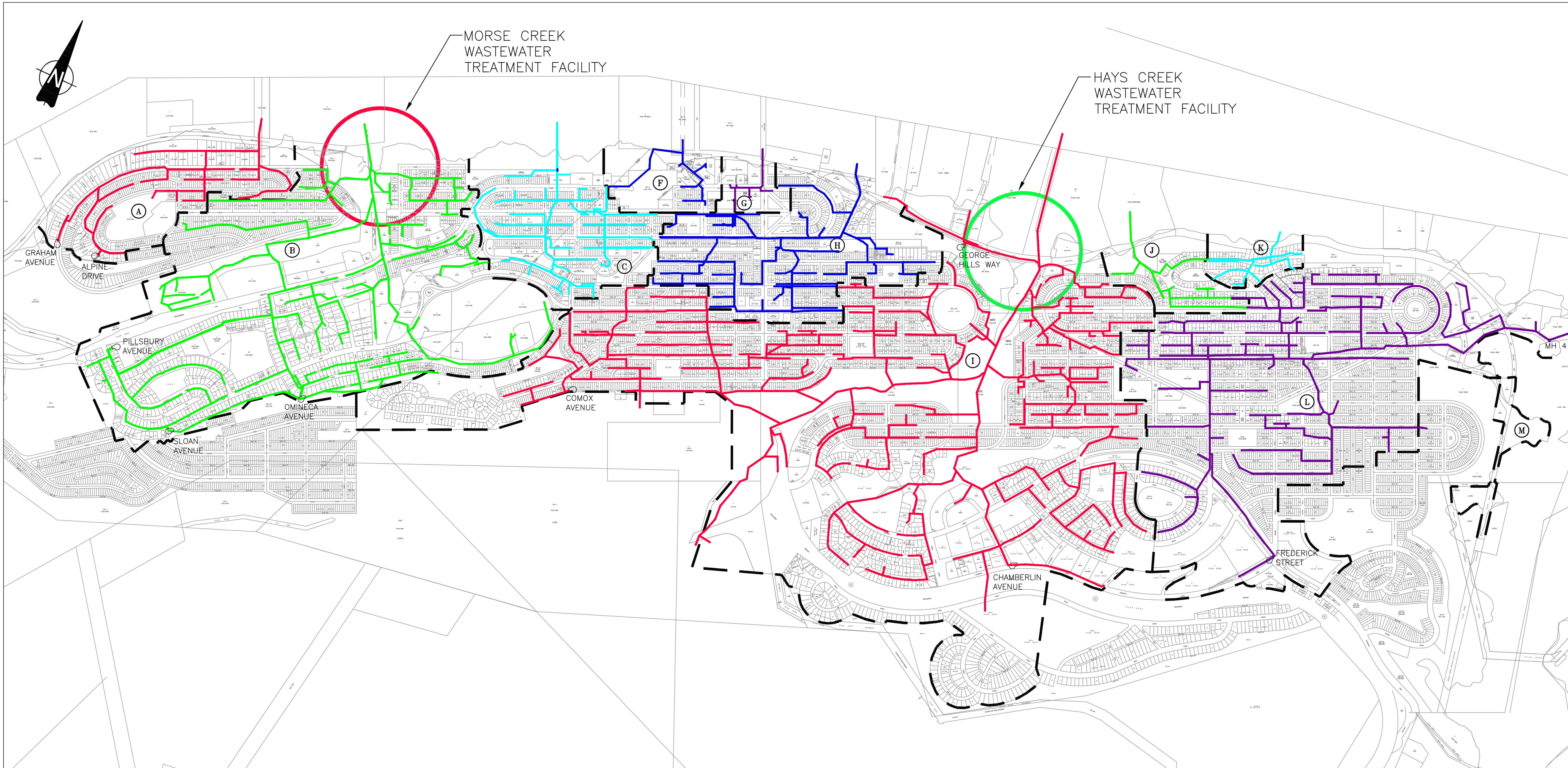
2.2.2 Option 2B - Hays Creek and Ritchie Point

Decentralized wastewater treatment at Hays Creek and Ritchie Point would require conveying wastewater from Areas A, B, C, F, G, H, I, and J to a Hays Creek Wastewater Treatment Facility and conveying wastewater from Areas K, L, and M to a Ritchie Point Wastewater Treatment Facility (refer to **Figure 2-5**). In this option, Hays Creek would handle approximately 80 percent of the sewered area and Ritchie Point would handle 20 percent of the sewered area. Treated effluent would be discharged from the respective treatment facilities to the harbour through long, deep outfalls. Similar to Option 2A, this option would still consist of two treatment facilities; however in order to handle the higher incoming flows, the Hays Creek Facility would be extensively larger than the Ritchie Point Facility. The catchment for the Hays Creek facility would require larger pumps and related pumping equipment, which would likely contribute to higher conveyance capital and operating costs than Option 2A.

2.3 Option 3 - Three Wastewater Treatment Facilities (Decentralized Treatment) at Hays Creek, Ritchie Point, and Morse Creek

In this option, the flows from the various pump stations, gravity sewers, and force mains could potentially be directed to one of three wastewater treatment facilities. These facilities would be located near the harbour front, likely in the vicinity of Morse Creek, Hays Creek, and Ritchie Point (refer to **Figure 2-6**). These treatment facility locations have been selected because they correspond with the areas generating the largest sanitary flows and therefore, it is more economical to pump wastewater from the smaller areas to the larger areas, rather than vice versa.

Wastewater from Areas A, B, C, and F would be conveyed to a Morse Creek Wastewater Treatment Facility. Wastewater from Areas G, H, I, and J would be conveyed to a Hays Creek Wastewater Treatment Facility. Wastewater from Areas K, L, and M would be conveyed to a Ritchie Point Wastewater Treatment Facility. In this option, Hays Creek, Morse Creek, and Ritchie Point would handle approximately 50, 30, and 20 percent of the sewered areas, respectively.



LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-4
OPTION 2A - A TWO TREATMENT FACILITIES OPTION:
HAYS CREEK & MORSE CREEK

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Associated Engineering

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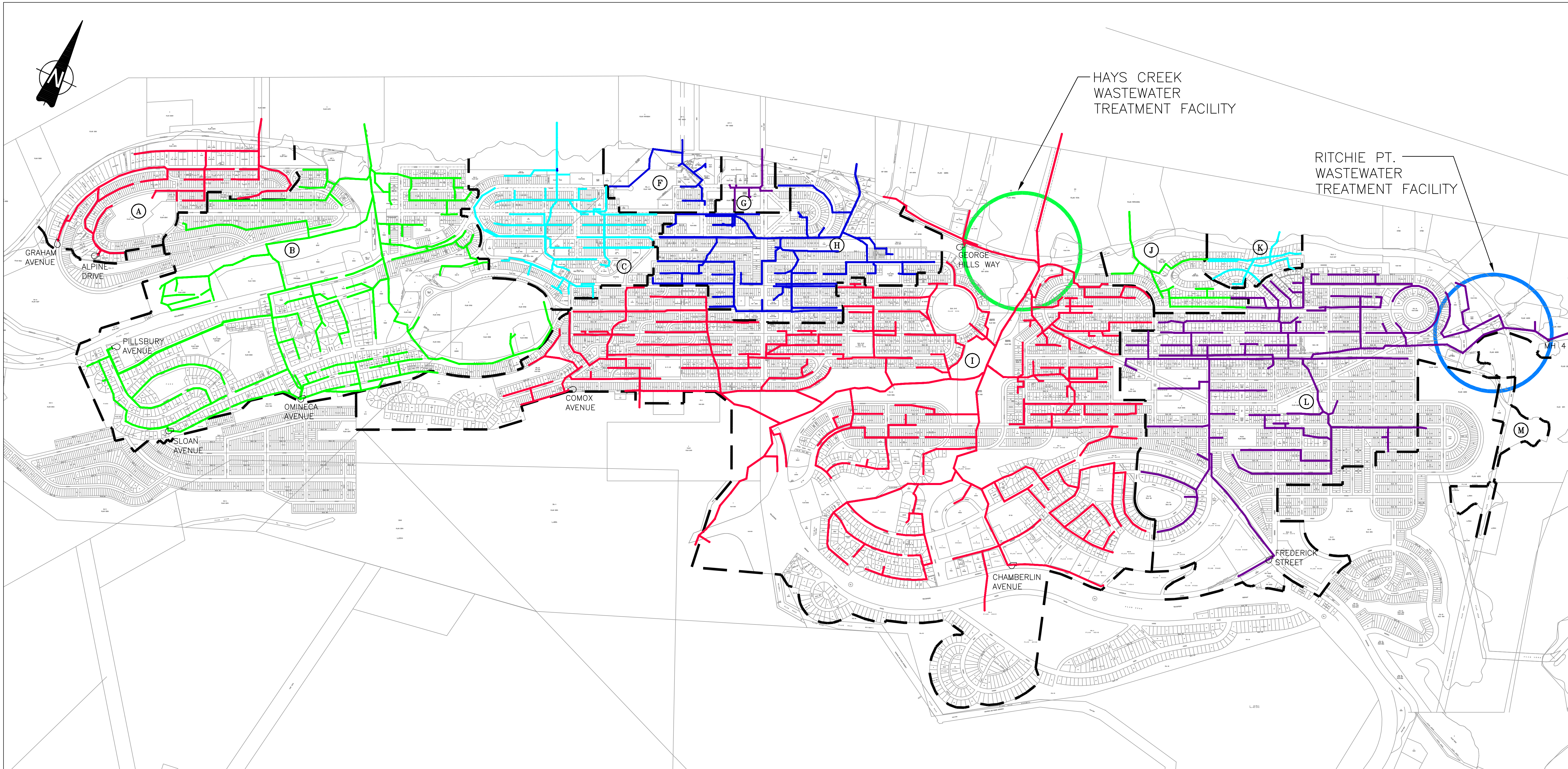

LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-5

OPTION 2B - A TWO TREATMENT FACILITIES OPTION: HAYS CREEK & RITCHIE POINT

N.T.S.

Associated Engineering

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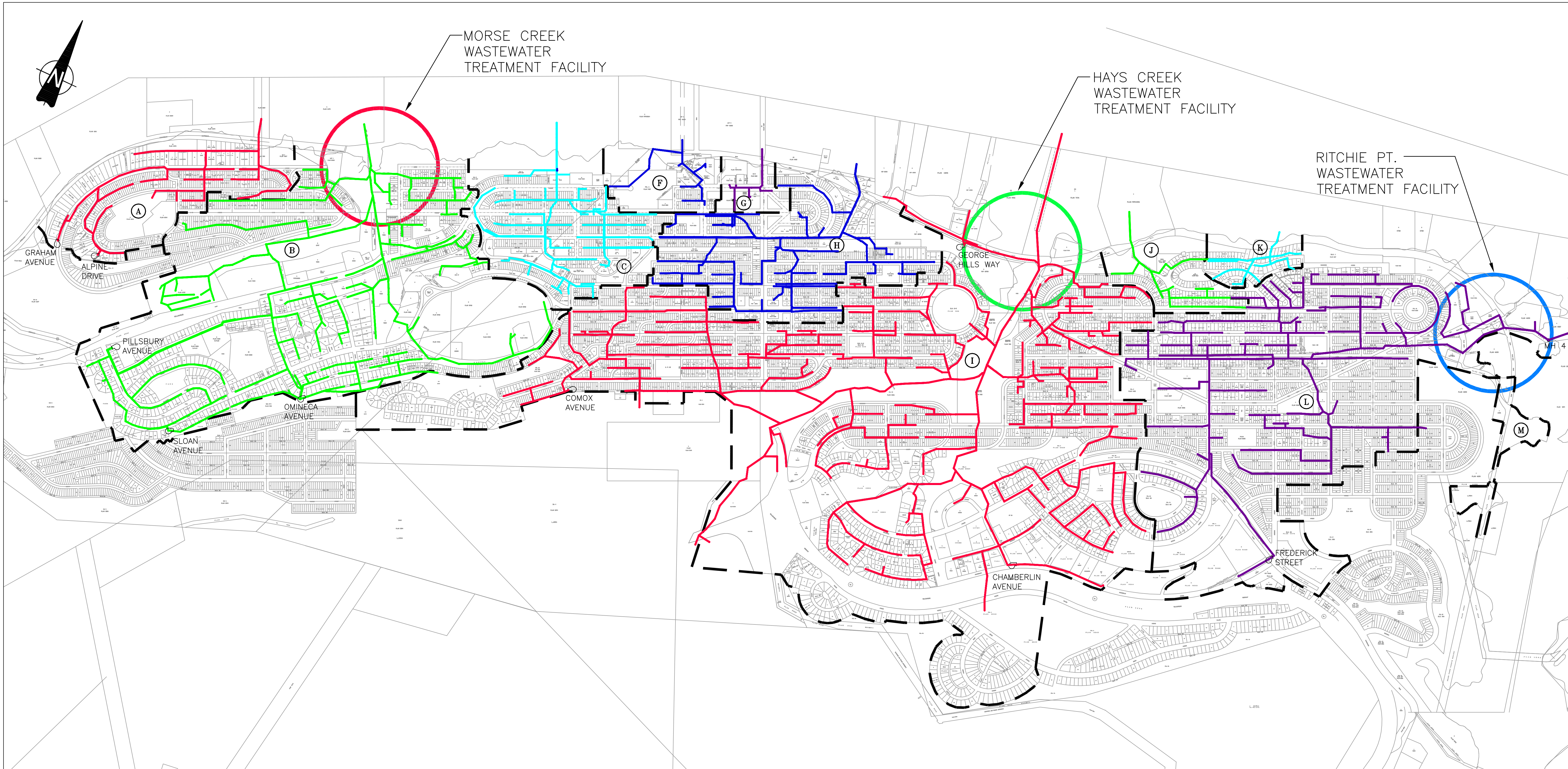

LEGEND

PROPOSED LOCATION FOR NEW WASTEWATER TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER TREATMENT FACILITY OPTIONS

FIGURE 2-6
OPTION 3 - A THREE TREATMENT FACILITIES OPTION:
HAYS CREEK, RITCHIE POINT & MORSE CREEK

N.T.S.

Associated Engineering

Treated effluent would be discharged from the respective treatment facilities to the harbour through long, deep outfalls.

This option would potentially require pumping wastewater in interceptor sewers along the City's shore to convey the flows to the respective treatment facilities. Similar to the two wastewater treatment facilities option, it is likely that the solids, produced at each individual treatment facility may have to be dealt with off site. Another option would be to haul solids produced at the smaller facilities to the largest treatment facility for solids treatment. Both options would require trucking the solids from the wastewater treatment facilities to another location for treatment and/or disposal.

Some resource recovery technologies, such as heat recovery are better achieved on a local, decentralized, basis. For example, the decentralized facilities could essentially provide local heat recovery in the sewerage area. Increasing opportunity for this type of distributed concept is made feasible by technological advances in wastewater treatment, such as membrane-based separation technology, which provide an increase in treatment performance and a smaller equipment footprint.

3 Comparison of Wastewater Treatment Facility Options

The advantages and disadvantages of each of the potential wastewater treatment facility options are provided in **Table 3-1**.

Table 3-1
Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
1A – Hays Creek	• 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • May be able to use existing outfall if capacity is available. • Conveyance costs are less than Options 1B and 1C. • Solids would likely be treated on site and not require hauling off site. • Resource recovery, such as energy recovery from organic solids is potentially viable.	• Requires new pump stations and sewers. • May require new, larger capacity outfall. • Located in the City core area. • Land may be difficult and more expensive to acquire.

Option	Advantages	Disadvantages
1B – Port Edward	• Existing tankage. • Away from highly populated area. • Land will be cheaper and easier to acquire than Option 1A. • Solids would likely be treated on site and not require hauling off site.	• Requires conveyance of wastewater to centralized site and then to Port Edward. • Higher conveyance costs than Option 1A and 1C. • Existing tankage may limit the wastewater treatment process selection. • Tanks will likely require refurbishment.
1C – Industrial Park	• Away from highly populated area. • Land will be cheaper and easier to acquire than Option 1A. • No existing tankage to limit the selection of the wastewater treatment process. • Solids would likely be treated on site and not require hauling off site.	• Requires conveyance of wastewater to centralized site and then to Industrial Park. • Higher conveyance costs than Option 1A. • Will likely require an effluent pump station and force main to the Harbour outfall.
2A – Hays Creek and Morse Creek	• 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Lower conveyance costs than Options 1A, 1B, 1C, 2B and 3. • Resource recovery, such as heat recovery is potentially viable.	• The Hays Creek Treatment Facility is located in the City's core area. • Land may be difficult and more expensive to acquire. • Solids would likely be treated at a central facility and will require hauling off-site.

Option	Advantages	Disadvantages
2B – Hays Creek and Ritchie Point	• 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Lower conveyance costs than Options 1A, 1B, and 1C. • Resource recovery, such as heat recovery is potentially viable.	• The Hays and Morse Creek Treatment Facilities are location in the City's core area. • Land may be difficult and more expensive to acquire. • Solids would likely be treated at a central facility and will require hauling off-site.
3 – Hays Creek, Ritchie Point, and Morse Creek	• 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Treatment facilities are located in areas with largest wastewater flows. • Lower conveyance costs than Options 1B, and 1C. • Resource recovery, such as heat recovery is potentially viable.	• Located in the City core area. • Land may be difficult and more expensive to acquire. • Solids would likely be treated at a central facility and will require hauling off-site.

Options 1B, a single treatment facility at Port Edward, and Option 1C, a single treatment facility at the Industrial Park, are located quite far from where the City's wastewater is generated and as such, these options will require pumping wastewater to one central location and then to the treatment facility at either Port Edward or the Industrial Park. Very rough conveyance cost estimates (Class D) were prepared for Options 1B and 1C (refer to Appendix A). The estimated conveyance costs for Options 1B and 1C are approximately $31 M and $14 M, respectively. Due to the high cost of conveyance alone, Options 1B and 1C are not as favourable as other potential options, and, as a result, they are not recommended for short listing.

Options 1A, 2A, 2B, and 3 all consist of having a treatment facility at Hays Creek, whether it involves centralized or decentralized treatment. The benefit of having a facility at Hays Creek is that 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). However, this does not mean that Options 1A, 2A, 2B, and 3 are all feasible. Option 2B, treatment facilities at Hays Creek and Ritchie Point, may not make sense considering the treatment facility at Ritchie Point may likely only handle approximately 20 percent of the City's sewered area, while the treatment facility at Hays Creek would handle 80 percent of the City's wastewater. With such a small fraction of the sewered area wastewater being treated at Ritchie Point, it may be better to eliminate the Ritchie Point Treatment Facility and have all wastewater flows directed to a single treatment facility at Hays Creek (Option 1A). Option 2A, treatment facilities at Hays Creek and Morse Creek, is similar to Option 2B; however, the treatment facility at Morse Creek would likely handle 30 percent of the City's sewered area and would likely have lower conveyance costs than Options 1A, 2B, and 3. Option 3, treatment facilities at Hays Creek, Ritchie Point, and Morse Creek, would likely have higher capital and conveyance costs than Options 1A, 2A, and 2B. Therefore, Option 3 is not as favourable. Of the options involving a treatment facility at Hays Creek, Options 1A and 2A are the most favourable, and, as a result, they are recommended for short listing.

Future discussion papers will provide more information regarding these potential wastewater treatment facility options. As more information becomes available, the City will be able to determine which options are the most feasible and offer the greatest benefits.

4 Summary and Conclusions

This Discussion Paper has explored potential options for managing the City's wastewater. Option 1 involves having a single wastewater treatment facility (centralized treatment); whether that is at Hays Creek, Port Edward, or the Industrial Park. Option 2 involves having two wastewater treatment facilities (decentralized treatment), whether they are at Hays Creek and Ritchie Point, or Hays Creek and Morse Creek. Option 3 involves having three separate wastewater treatment facilities (decentralized treatment), one each at Hays Creek, Ritchie Point, and Morse Creek.

The advantages and disadvantages of each of the options were provided in Table 3-1 so that some of the options could be short listed and further developed in future LWMP planning documents. Options 1A, a single treatment facility at Hays Creek, and Option 2A, treatment facilities at Hays Creek and Morse Creek, are options with the most benefits for the City and therefore, are recommended for short listing. Cost estimates for the most favourable treatment facility options will be prepared in a future discussion paper, Discussion Paper 2-7: Cost Estimate for Short Listed Options.

5 References

1. Associated Engineering. 2009. City of Prince Rupert Liquid Waste Management Plan – Stage 1, *Discussion Paper 1-5: Wastewater Management Options*.

2. Associated Engineering. 2004. City of Prince Rupert, Report: *Sewage System Upgrading Plan*.

APPENDIX A - Cost Estimates

Appendix A - Cost Estimates
City of Prince Rupert Stage 2 Liquid Waste Management Plan
DP 2-2 Wastewater Treatment Facility Options

Prepared by: Manjit Herar
Date of last revision: September 17, 2009

OPTION 1B - PUMP WASTEWATER TO PORT EDWARD

Assumptions:
Assume that two times ADWF from 25,000 persons is pumped along the railway right of way to the treatment facility
Use ADWF of 500 L/d/cap; Design Flow = 0.29 m3/s
At 1.0 m/s pipe velocity, this gives a 600 mm dia pipe

This estimate is based on a cost estimate prepared by Associated Engineering in January 2008. Engineering News-Record (ENR) Construction Cost indexes were used to escalate the costs from January 2008 to September 2009 dollars. This estimate is a Class D cost estimate.

Item	Units	Unit Price	Extension
Raw Wastewater Pump Station	1	$4,000,000	$4,000,000
Pipeline (m)	15000	$1,100	$16,500,000
subtotal			$20,500,000
add engineering and contingency (40%)			$8,200,000
Total Cost (2008$)			**$28,700,000**
Engineering News-Record Construction Cost Index - September 2009			8585.71
Engineering News-Record Construction Cost Index - January 2008			8090.06
Total Cost (2009$)			**$30,458,350**
		say	**$30.5M**

ENR September 21, 2009
ENR January 28, 2008

Appendix A - Cost Estimates
City of Prince Rupert Stage 2 Liquid Waste Management Plan
DP 2-2 Wastewater Treatment Facility Options

Prepared by: Manjit Herar
Date of last revision: September 17, 2009

OPTION 1C - PUMP WASTEWATER TO INDUSTRIAL PARK

Assumptions:

Assume that two times ADWF from 25,000 persons is pumped along the railway right of way to the treatment facility
Use ADWF of 500 L/d/cap; Design Flow = 0.29 m3/s
At 1.0 m/s pipe velocity, this gives a 600 mm dia pipe

This estimate is based on a cost estimate prepared by Associated Engineering in January 2008 for the former Pulp Mill Site at Port Edward. The only difference is that the pipeline distance has been adjusted for the Industrial Park option. Engineering News-Record (ENR) Construction Cost indexes were used to escalate the costs from January 2008 to September 2009 dollars. This estimate is a Class D cost estimate.

Item	Units	Unit Price	Extension
Raw Wastewater Pump Station	1	$4,000,000	$4,000,000
Pipeline (m)	5000	$1,100	$5,500,000
subtotal			$9,500,000
add engineering and contingency (40%)			$3,800,000
Total Cost (2008$)			**$13,300,000**
Engineering News-Record Construction Cost Index - September 2009			8585.71
Engineering News-Record Construction Cost Index - January 2008			8090.06
Total Cost (2009$)			**$14,114,845**
		say	**$14.2 M**

References:
ENR September 21, 2009
ENR January 28, 2008

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C Appendix C - DP2-3 - Treatment Technology Options

DISCUSSION PAPER 2-3

City of Prince Rupert
Liquid Waste Management Plan - Stage 2

Treatment Technology Options

Issued:	September 18, 2009
Previous Issue:	None

1 Introduction and Objectives

The City of Prince Rupert (City) is undertaking the development of a Stage 2 Liquid Waste Management Plan (LWMP) to address the long-term management of the City's wastewater. The LWMP planning process involves the development of discussion papers that cover a variety of topics pertaining to the City's current wastewater situation and future wastewater management outlook. As part of the LWMP, and considering the existing and future legislative requirements, the City needs to develop a wastewater treatment program to protect the environment and safeguard the public.

As part of the Stage 2 LWMP, the City has established an advisory committee to provide insight and direction regarding the issues at hand and potential solutions.

Previous discussion papers prepared for the Stage 2 LWMP have provided information pertaining to waste volumes and facility sizing criteria (Discussion Paper 2-1), and potential wastewater treatment facility options (Discussion Paper 2-2). This discussion paper, Discussion Paper 2-3, presents options for wet and dry weather flow treatment and lists the advantages and disadvantages of each option.

The objective of this discussion paper is to provide the City, the advisory committees, and the public with feasible treatment options that may be further short-listed down to two to three options for more extensive investigation, costing and reviews. The options presented are representative technologies, useful for planning purposes. Actual technology selection will be made at the preliminary design stage.

2 Requirements

2.1 Treatment Requirements

In British Columbia, wastewater treatment is governed by the Ministry of Environment's 1999 Municipal Sewage Regulation (MSR). The MSR sets out requirements for wastewater treatment for a variety of situations including wet weather flows and dry weather flows.

Based on the Average Dry Weather Flow (ADWF) for Design Year 2030 and Design Year 2050, estimated in Discussion Paper 2-1, the City will develop a wastewater treatment regime to meet self-imposed requirements as outlined below:

- Up to two times the ADWF will be treated to secondary treatment standards.
  - For design year 2030, the wastewater flow to be treated is estimated to be 390 L/s.
  - For design year 2050, the wastewater flow to be treated is estimated to be 530 L/s.

- Up to four times the ADWF will be treated to primary treatment standards.
  - For design year 2030, the wastewater flow to be treated is estimated to be 780 L/s.
  - For design year 2050, the wastewater flow to be treated is estimated to be 1060 L/s.

- All flows greater than four times the ADWF will be treated to preliminary treatment level.

The ADWF is the average non-storm flow over 24-hours during the dry months of the year (typically May through to the beginning of September and more specifically July to August). It is composed of both the average sanitary wastewater flow, and the average dry weather inflow/infiltration.

Treating only two times the ADWF to secondary treatment level is based on the principle of providing the City with a cost effective treatment scheme that would provide efficient use of capital investment, minimize expenditures on facility and related equipment that would be used infrequently, and provide the required level of environmental protection. In this approach any flows above four times the ADWF will be low strength and would normally be considered combined sewer overflows (CSOs). The CSOs will be discharged to the ocean through short outfalls after preliminary treatment such as screening.

The City's treated wastewater effluent will be discharged to the marine environment. The MSR's, required level of effluent quality for primary and secondary treated effluent is provided in **Table 2-1**.

Table 2-1
Summary of Regulatory Effluent Quality Requirements for Primary and Secondary Treatment

Parameter	Compliance Criteria[1] Primary Treatment	Compliance Criteria [1] Secondary Treatment
Biochemical Oxygen Demand (BOD_5)	130 mg/L Maximum	45 mg/L Maximum
Total Suspended Solids (TSS)	130 mg/L Maximum	45 mg/L Maximum
Fecal Coliforms	Not applicable	Not applicable
Turbidity	Not applicable (at this time)	Not applicable (at this time)
Nitrogen	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone

[1] Schedule 7, Municipal Sewage Regulations, 1999.

The MSR requirements in Table 2-1 are "never-to-exceed" values for single samples. In contrast, the up-coming compliance criteria for BOD_5 and TSS from the Canadian Council of Ministers of the Environment's Canada-Wide strategy process would likely be somewhat more stringent than the above numbers, but would be based on "average" values over a certain period of time, e.g., less than 30 mg/L BOD and less than 30 mg/L TSS on a 30-day running average. Regardless, the target values for secondary treatment design and operation are normally set on a lower level than the above numbers, e.g., less than 20 mg/L BOD and 20 mg/L TSS.

The need for disinfection is based on water contact recreation needs and shellfish harvesting. If any recreational activities or shellfish harvesting is to be considered in the future, treatment specifically targeting a reduction in pathogenic organisms would most likely be required by the City.

2.2 Redundancy Requirements

Redundancy of critical items is necessary to increase the reliability of the treatment system, usually in the case of failure or regular maintenance requirements. Redundancy requirements for wastewater treatment process equipment, i.e., tanks, pumps, etc. are outlined in Schedule 7 – Design Standards for Sewage Facilities of the British Columbia MSR. Schedule 7 will be used at a later time to determine the redundancy requirements of the selected treatment process equipment. This will impact capital and operating costs.

3 Preliminary Treatment Technologies

Preliminary treatment is the first level of treatment which involves the removal or reduction of coarse solids and easy to settle materials. For the City's wastewater, preliminary treatment would be applied to all flows and would be the only treatment for flows greater than four times the ADWF. Technologies that would provide preliminary treatment include four types of screening options and vortex separators. These technologies are discussed in Sections 3.1 and 3.2 respectively.

3.1 Screens

A screen consists of openings that are typically uniform in size, which retain material larger than the size of the screen openings. The purpose of screening is to remove coarse, non-degradable debris from raw wastewater, such as sticks, rags, plastics, rubber goods, food wastes, etc., which may clog pumps or pipes, reduce the effectiveness of downstream treatment process, and/or contaminate waterways. There is limited carry-over of solids into the effluent stream from screen panels. Screened material would be dewatered and disposed of at a licensed landfill on a regular basis.

Three different screening methods: mechanical screening, fine screening, and netting are presented.

3.1.1 Mechanical Screening

Screening typically uses a mesh, generally of uniform size, that retains solids and the liquid passes through. Typically the wastewater flow enters the screen and solids are captured by perforated panels. Perforated panels convey screened material and discharge solids on the downstream side of the screen. Screened material is removed from the panels by a high-speed rotating brush and water spray. Refer to **Figure 3-1** for an example of a mechanical screen installation. Other configurations include rotary drum screens.

Figure 3-1
Example of a Mechanical Screen Installation

Photo of Escalator Fine Screen courtesy of John Meunier, Inc.

3.1.2 Fine Screening

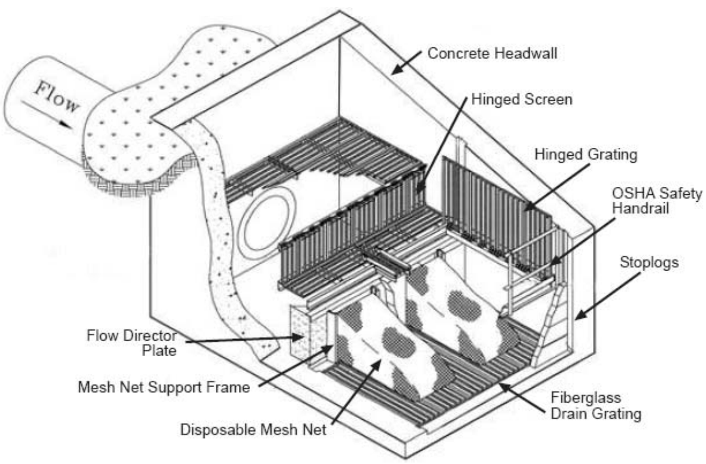
Fine screens may be used for preliminary wastewater treatment. Refer to **Figure 3-2** for a photo of a fine screen. Fine screening provides capture and treatment of storm water pollutants, as well as sanitary wastewater pollutants. Fine screens are normally effective at removing floatables and solids greater than 4 mm. Material removed from fine screening is typically bagged at the treatment facility and disposed of in a landfill. This technology has potentially high operation and maintenance costs.

Figure 3-2
Example of Fine Screens

3.1.3 Solid Collection Systems (e.g., Netting TrashTrap®)

This system is a prefabricated trash and floatables collection system that operates unattended with no external power. Refer to **Figure 3-3** for an end of pipe collection system. The energy of the flow itself is used to drive the trash/floatable materials into disposable mesh nets.

Figure 3-3
Typical End of Pipe Collection System



Netting TrashTrap® photo courtesy of Fresh Creek Technologies, Inc.

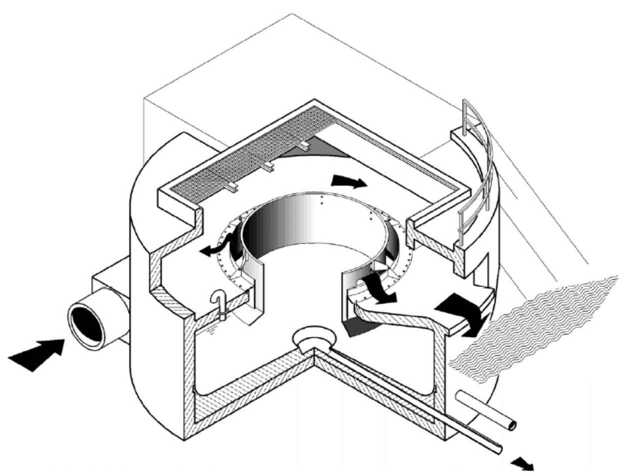
The end of pipe system is a modular structure configured for one or more nets based on the site-specific parameters.

The amount of TSS removal is dependent on the particle size. The net is provided with 5 mm openings in two dimensions to achieve considerable solids capture. The nets require servicing, which is done by replacing the disposable nets following a wet weather event or when they are full. The full nets would require disposal at a licensed landfill.

3.2 Vortex Separators

Vortex separation uses a swirling action to move particles to a centre drain and the liquid to the outside effluent channel. Centrifugal movement, together with higher specific gravity of the solids result in solids concentration and removal. Refer to **Figure 3-4** for an example of a vortex separation system.

Figure 3-4
Vortex Separation System



Picture FluidSep™ courtesy of John Meunier, Inc.

Captured solids can be collected and conveyed to a solids handling facility, and “underflow” can be conveyed back to a treatment facility.

Generally, vortex solids separators are effective at removing gritty materials, heavy particulates, and floatables from wastewater flow, but ineffective in removing materials with poor settleabilities. The vortex system is designed to operate even under extremely high flow conditions and provides sufficient treatment for downstream disinfection. Vortex systems have a relatively small foot print requirement and relatively low capital and operational costs.

4 Primary Treatment Technologies

Primary treatment consists of unit processes that can effectively remove floating, and settleable solids from wastewater. Primary treatment leaves a portion of the non-soluble organics and most of the soluble organics in the wastewater.

Up to four times the City's ADWF will be treated to primary treatment standards. Primary treatment technologies include primary clarification, chemically-enhanced primary treatment (CEPT), and micro screens. These technologies are discussed in Sections 4.1, 4.2, and 4.3 respectively.

4.1 Primary Clarification

Primary clarification is based on the principles that liquids containing solids in suspension, at a relatively quiescent state, will tend to allow solids with a higher specific gravity to settle and those with a lower specific gravity to rise. The primary clarifier is a rectangular or circular tank that is used to reduce the amount of suspended solids content in the wastewater by slowing the influent flow so that organic and inorganic suspended solids can settle to the bottom of the tank and floatable solids and grease can be skimmed off the top by a rotating arm and deposited in a scum trough. Refer to **Figure 4-1** for a photo of an existing primary clarifier.

Figure 4-1
Existing Primary Clarifier

Primary clarification is used to remove the following:

- Settleable solids capable of forming sludge deposits in the receiving waters
- Free oil and grease and other floating materials
- A portion of the organic load discharged to the receiving waters

Primary clarification tanks, if designed correctly, are capable of removing 50 to 70 percent of the suspended solids and 25 to 40 percent of the BOD. This treatment process generally has a large footprint and is quite expensive to build and operate. Primary clarification also requires infrastructure for sludge thickening, digestion and dewatering.

4.2 Chemically Enhanced Primary Treatment

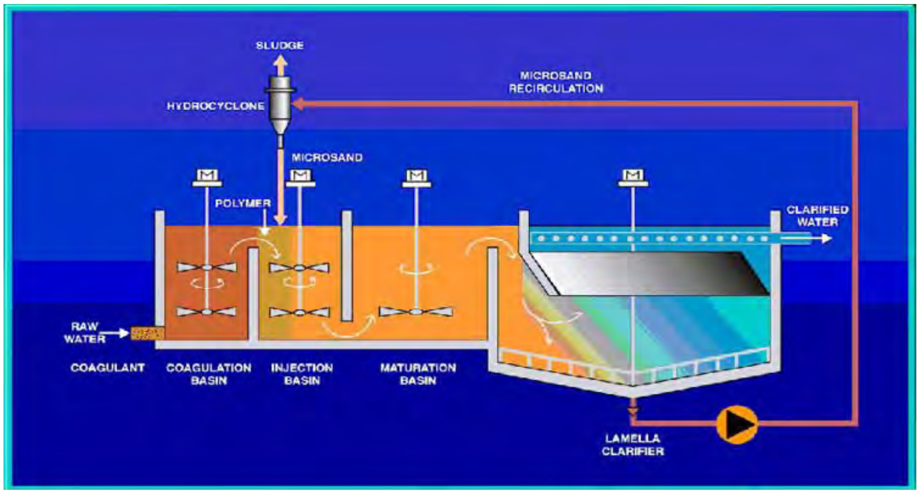
Primary clarification is sometimes unable to provide sufficient treatment to meet the permit requirements during the summer when there is lower infiltration and inflow into the sewer systems, which results in a more “concentrated” wastewater. In these cases, treatment is improved via the addition of coagulant chemicals, such as alum and ferric chloride, to the primary clarifiers. This treatment process is known as CEPT. CEPT requires infrastructure to deal with the settled solids (sludge) such as sludge digestion and dewatering.

In addition to conventional CEPT processes, there are CEPT systems that use fine sand and/or polymers (sticky long-chain chemicals), which further enhance the clarification process. Examples of this process, described in further detail below, include Actiflo™ and DensaDeg® clarifiers. The Actiflo™ and DensaDeg® processes require less space than conventional primary treatment systems and produce an effluent that is of better quality than primary clarification effluent. However, they do cost more to own and operate than straight primary treatment.

4.2.1 Actiflo™

Flocculation is a process of creating larger particles that can be removed through clarification. Ballasted flocculation is a proprietary process that uses a flocculation aid and a ballasting agent such as fine sand grains to form dense particles. The particles are “ballasted” and settle rapidly. An example is Actiflo™, which is a high-rate ballasted flocculation process. Refer to **Figure 4-2** for the process schematic. Coagulant is injected into the overflow stream at the rapid mix chamber. Sand and polymer are injected downstream of the rapid mix chamber. Flocs attach to the sand in the maturation basin. The resultant heavy flocs are settled out in a clarifier equipped with lamella settling plates. The floc is then pumped to a hydrocyclone where the sludge is separated from the sand. The sand is recycled in the process. During extended run times, the operator may have to add sand to the process. The sludge would be directed to the wastewater treatment plant or stored on-site.

Figure 4-2
Actiflo™ Process



The Actiflo ™ process (courtesy of John Meunier, Inc).

Based on manufacturer's pilot studies, the Actiflo™ process can achieve up to approximately 70% BOD removal and 90% TSS removal.

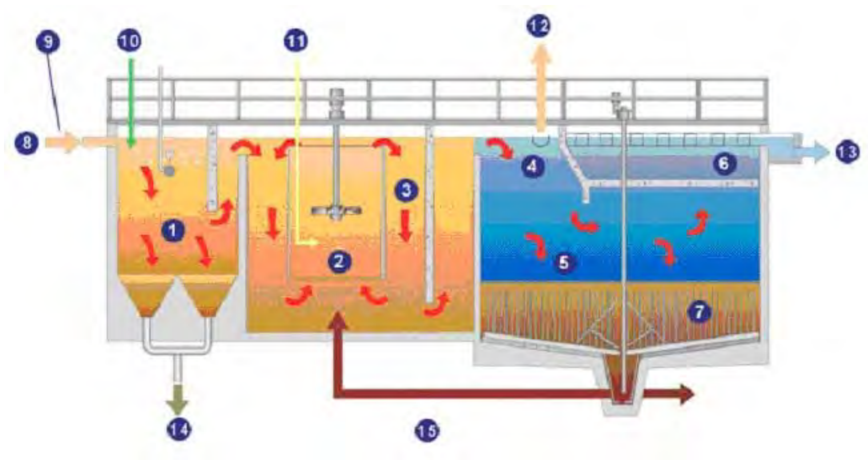
The process has the capacity to accept very high peak flows without affecting performance. The process can be started immediately when an overflow condition occurs and can withstand frequent start-up and shutdown cycles without loss of efficiency.

Due to the hydraulics of the process, the system would have to be below ground or would require the use of wastewater transfer pumps. For the in-ground option, excavation and construction would be required. For above-ground installation, wastewater transfer pumps will be required to feed the process.

4.2.2 Densadeg™

The Densadeg™ system is a high rate solids contact clarifier combined with grit removal, oil and grease removal, coagulation, flocculation and settling. Refer to **Figure 4-3** for a process schematic. The high-rate solids contact clarifier can accommodate a wide range of flow rates and BOD/TSS loading.

Figure 4-3
Densadeg Process



Legend

1-Grit removal/coagulation	9-Coagulating agent
2-Flocculation, first stage	10-Air
3-Flocculation, second stage	11-Flocculating agent
4-Grease and scum removal	12-Grease and scum draw-off
5-6-Pre-settling and lamellar settling	13-Treated water
7-Sludge densification and thickening	14-Grit draw-off
8-Raw wastewater	15-Sludge recirculation

A coagulant is added upstream of the grit removal/coagulation chamber. The water then flows into the flocculation basin, where a polymer is added.

Grease and scum are collected on the surface of the clarifier, upstream of a lamella settling zone. The water then flows through the lamella settling zone where residual floc is removed. The sludge from the clarifier is recycled from the settling tank to the flocculation chamber. Sonic sludge blanket sensors are used to control the sludge blanket level, however, operator attention may be required to monitor and maintain the sludge blanket depth and density. The sludge blanket level is adjusted through the sludge recirculation and draw-off rate.

Like the Actiflo™ system, due to the hydraulics of the Densadeg™ system the tanks would have to be below ground or would require the use of wastewater transfer pumps to feed the process.

The Densadeg™ process can start up within 15 to 30 minutes and will remove approximately 50 to 60% of BOD and 85 to 95% TSS based on manufacturer's pilot studies.

4.3 Micro Screens

Micro screens use a mesh filter with openings that range from 1 to 350 µm (microns). Micro screens offer a high degree of TSS and BOD removal. Soluble BOD is not removed with the micro screen. Direct and indirect solids removal is accomplished by the screen. Solids are either captured on the screen or are indirectly captured on a "mat" or thin film of solids that have been previously caught on the mesh surface. The fine mesh fabric is typically mounted in a continuously rotating mesh drum; refer to **Figure 4-4** for an example of the micro screen.

Figure 4-4
Micro Screen

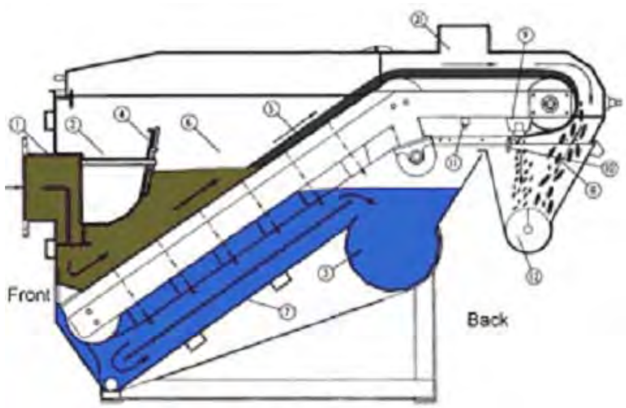


Figure courtesy of Salsnes Filter® North America

The wastewater enters the micro screen through the inlet tube and flows through the screen. The filter cloth rotates and moves the sludge to an air cleaning device. Compressed air blows the sludge into a sludge holding area. A screw pushes the sludge to a press cylinder where it is dewatered. The sludge would require storage treatment and disposal.

The level of the incoming water is monitored using a pressure transmitter. The speed the screen rotates is adjusted based on this level. If the level drops below a predetermined set point, the screen will stop rotating. The mesh is back-washed to maintain performance.

Refer to **Figure 4-5** for an existing micro screen installation.

Figure 4-5
Existing Micro Screen Installation

To prevent damage to the screen, upstream treatment using a bar or fine screen is recommended. A disadvantage of the micro screen is the potential high cost of operation and maintenance. The Town of Enderby in the North Okanagan has this type of screen.

5 Secondary Treatment Technologies

Secondary treatment removes soluble and insoluble organic matter that is left in primary effluent. Without secondary treatment, organic matter discharged to the receiving environment (rivers, lakes or the ocean) would use the dissolved oxygen in the water for degradation, leading to oxygen depletion and thus contributing to the loss of an habitable environment for fish.

Additionally, secondary treatment helps to remove contaminants of emerging concern such as some endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs). Secondary treatment also helps to manage the creation of nitrous oxide from proteins and ammonia, which is about 330 times more potent as a greenhouse gas than carbon dioxide.

All flows up to two times ADWF would receive secondary treatment.

5.1 Activated Sludge

The activated sludge process is a type of suspended growth process in which microorganisms (bacteria, fungi, rotifers, protozoa, and algae) responsible for wastewater treatment are maintained in suspension within the liquid. The activated sludge process involves the production of an activated mass of microorganisms capable of stabilizing wastewater in an aerobic (presence of oxygen) environment.

Wastewater is introduced into a tank where the microorganisms are maintained in suspension. The contents in the reactor are referred to as “mixed liquor”. An aerobic environment is maintained by adding oxygen into the tank using diffused air or mechanical aeration. The aeration also keeps the “mixed liquor” well mixed. After a set time period, the mixture is sent to a settling tank where the microbial cells are separated from the treated wastewater as secondary sludge. Some of this secondary sludge is wasted each day. The remainder is re-circulated back to the front of the aeration tank.

The activated sludge process provides good nitrification (oxidation of ammonium), is able to handle peak loads, and can be used for small wastewater treatment plants. This process does however require aeration, and as a result, has high operational costs. It also requires a settling tank which contributes to a large overall footprint. High flow rates, such as during storm events, will wash out solids.

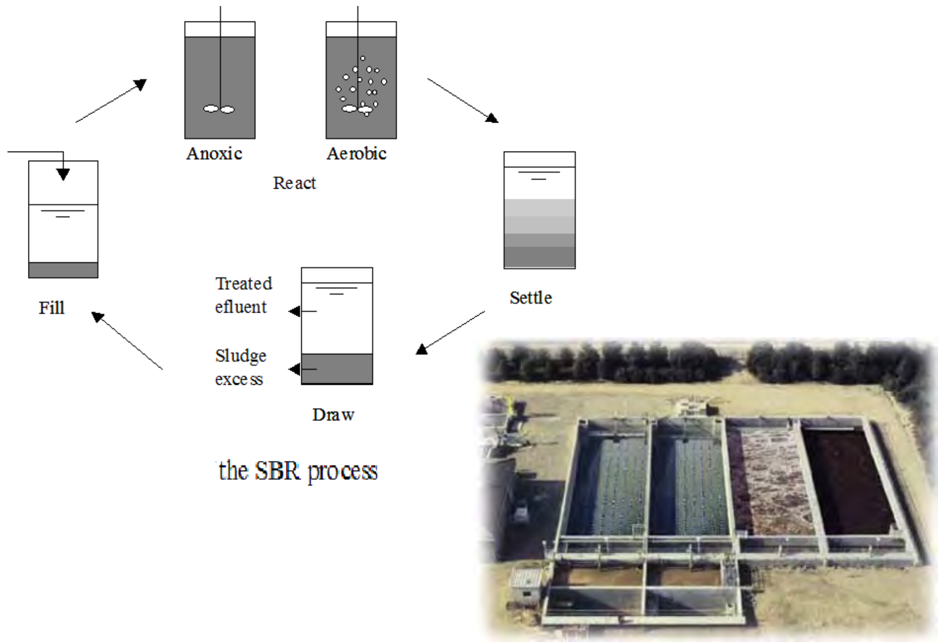
Some examples of activated sludge treatment facilities are located in Port Hardy and Comox on Vancouver Island.

5.2 Sequencing Batch Reactors

The sequencing batch reactor (SBR) process is a type of suspended growth treatment process similar to the activated sludge process, with some variations. SBRs can provide both high quality effluent and provide the possibility of biological nutrient (nitrogen and phosphorus) removal. The main difference between an SBR and a conventional activated sludge treatment process is that after preliminary treatment (screening and grit removal), all of the wastewater treatment processes occur in one tank in the SBR process. There is no separate secondary clarifier(s) as in the activated sludge process.

SBR tanks are equipped with both an aeration system and a means to settle the solids and decant off treated liquid. A schematic of the SBR process is shown in **Figure 5-1**.

Figure 5-1
The Sequencing Batch Reactor Treatment Process
(Schematic Showing an Operating Cycle and a Four-Tank System)



There are several variations of the SBR process. One of the more common ones is the intermittent cycle extended aeration system (ICEAS). The ICEAS has a small pre-react chamber at the influent end of the SBR tank and a baffle wall that forces the influent to the bottom of the tank. This feature and the addition of making the SBR tank somewhat longer allows for continuous loading of raw screened influent to all the SBR tanks (e.g., one or more tanks) in the process. This permits much simpler operation of the SBR.

SBRs have some capacity to biologically remove nutrients; however, such high quality effluent would not be required for the City. Like activated sludge systems, SBRs have some capacity to reduce EDCs and PPCPs, particularly at longer sludge ages (less biomass wasting per day).

SBRs are most often used to treat smaller flows, e.g., under 5000 m^3/day. However, there are larger SBR installations in the world, e.g., Dublin, Ireland. That said, at the larger flows, the SBR process may not be cost competitive with other processes, including conventional activated sludge systems.

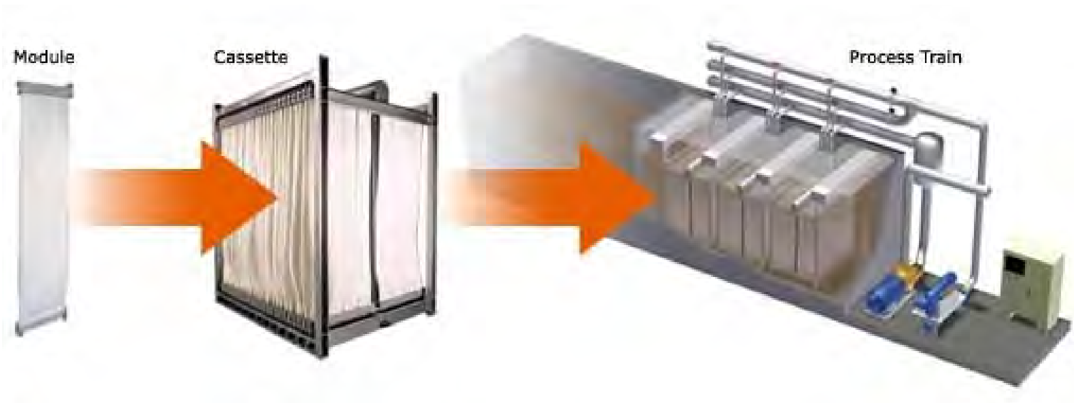
The advantages of the SBR process are that both reaction and settling occur in the same tank even though two or more tanks are required for continuous operation. SBRs generally have a small footprint and provide good settling, flexible operation, and automation. Typically, SBRs are used for smaller plants. In the City's case, construction of SBR tanks can be staged so that design year 2030 and design year 2050 flows can be met when they are needed, thus delaying the spending of capital until it is required. A disadvantage of the SBR process is that special decanting equipment is required and disinfection systems (if needed) need to be designed for the decanting flow rate (typically higher than the influent flow rate).

The closest example of SBR system is in Port McNeil on Vancouver Island. Others are located in Aga and Sooke.

5.3 Membrane Bioreactors

Membrane bioreactors (MBRs) also use a single tank system similar to the SBR process. However, they do not have a decanter and an intermittent cycle, since the membrane bioreactor process eliminates the need for either a clarifier or a decanter to separate the biological solids from the purified effluent. A membrane system is used to provide a physical barrier between the biomass and the effluent. A pressure gradient provided by either gravity on the aeration side of the membrane or a vacuum on the effluent side of the membrane is used to provide the driving force across the membrane. This helps to pull (or push) water through the membrane while leaving the solids in the MBR tank (subject to wasting). **Figure 5-2** presents a graphical representation of an MBR treatment plant.

Figure 5-2
The Membrane Bioreactor Process



MBRs have a compact footprint and can produce the highest quality effluent currently possible with "conventional" treatment, i.e., typically less than 10 mg/L BOD and TSS. The membrane pore sizes generally exclude both bacteria and viruses so the effluent quality is very good even prior to disinfection. MBRs have good capacity to biologically remove nutrients as in the activated sludge process, provided the required anaerobic and anoxic tanks are added to the system. MBRs are also likely to have long sludge ages and, as a result, are most likely to be capable of reducing EDCs and PPCPs.

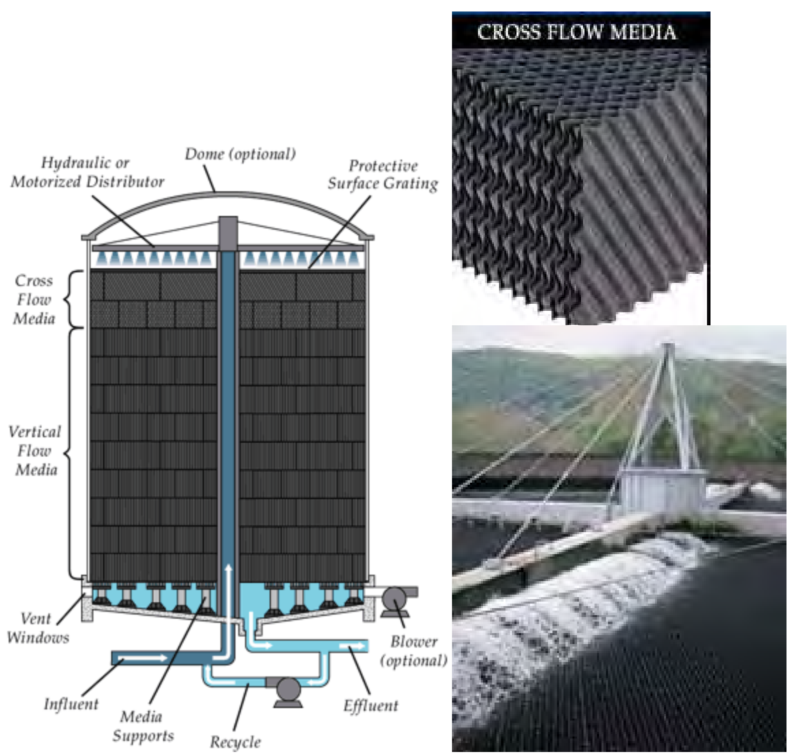
The downside to the MBR is the additional equipment and energy required to make the process work. MBRs have high capital costs for the membrane system and high operational costs for the aeration requirements and the vacuum on the microfilter. To some degree, the high costs are mitigated by the elimination of the need for secondary sedimentation that conventional activated sludge requires.

The closest examples of MBRs are at Mt. Washington near Comox and at Ganges on Saltspring Island.

5.4 Trickling Filter/Solids Contact

Trickling filters consist of a media bed of highly permeable material such as rock or plastic on to which microorganisms are attached. Wastewater is percolated or trickled down onto this media bed, as shown in Figure 5-3. Treatment occurs when the wastewater comes in contact with the rock or plastic media and microorganisms begin to degrade the organic material in the wastewater, converting the soluble and non-soluble organics to new cell mass that eventually sloughs off the media and is subsequently settled out.

Figure 5-3
Trickling Filter Basics



Trickling filters typically shed or slough small amounts of biological solids from the biofilm on the plastic media on a constant basis. In some situations, these biological solids are very difficult to settle because they are small in size and light in mass. As a result, on their own, trickling filters do not have high quality effluent because of the higher TSS. To aid the settling of these solids, in the trickling filter/solids contact (TF/SC) process, the trickling filter process is followed by a short retention time (e.g., one hour) activated sludge aeration tank. This additional step improves the settleability of the solids and therefore, improves the clarity of the effluent.

The solids contact tank used in the TF/SC process is followed by a clarifier. The sludge age is kept very short, e.g., one day, and as a result, most of the solids are wasted to the sludge digestion system.

Trickling filters do provide a robust form of secondary treatment in that they are not as easy to upset as suspended growth systems can be. Because this is an attached growth process it is able to retain biofilm better than an activated sludge system. This is a distinct advantage during high flow events. However, one problem that they do have is the sloughed trickling filter solids do not settle as well as activated sludge mixed liquor does. This results in a poorer quality effluent (higher BOD and TSS) than activated sludge effluent. This can also mean that effluent disinfection becomes more difficult, either because of increased chemical dosages for chlorination or lamp fouling and/or light penetration for ultraviolet irradiation. The TF/SC process helps with this problem but does not completely eliminate it.

TF/SC systems can be used for biological nutrient removal but this is not required for the City's wastewater. While the TF/SC process likely reduces EDC and PPCP concentrations more than a straight trickling filter system, the improvement is very small and does not approach even that of a short (four-day) conventional activated sludge system.

There can be potential odour issues with the TF/SC process, which may be mitigated by reversing the airflow through the trickling filter so that it moves downwards through the media bed.

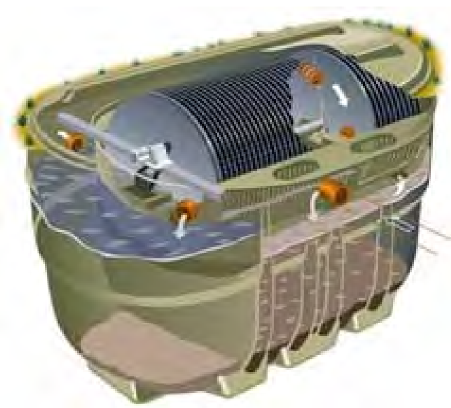
The closest example of a TF/SC plant is in Prince George serving the majority of the City.

5.5 Rotating Biological Contactors

Rotating biological contactors (RBCs) are a fixed-film secondary treatment process in which the biology is virtually identical to that of the trickling filter. The only difference is that instead of the media sitting passively and the primary effluent trickled over it as in the trickling filter process, with an RBC; the media rotates through the wastewater alternately picking up fresh wastewater and fresh air.

RBCs typically consist of a series of closely spaced circular disks, which are submerged in wastewater and rotated slowly through it. In the RBC process, microorganisms become attached to the disk surfaces and form a "slime" layer (much the same as a trickling filter). The rotation of the disks provides the microorganisms with food in the form of the organic material present in the wastewater and also oxygen present in the atmosphere. The rotation of the disks affects oxygen transfer and maintains the microorganisms in an aerobic environment. Figure 5-4 shows the general RBC process in a small scale packaged wastewater treatment system application.

Figure 5-4
Schematic View of a Small Scale RBC



Like trickling filters, RBCs provide a robust form of secondary treatment in that they are not as easy to upset as suspended growth systems can be. Because it is an attached growth process, it is able to retain biofilm better than an activated sludge system. However, as with trickling filters, the sloughed solids from the RBC media do not settle as well as activated sludge mixed liquor does. This typically results in a poorer quality effluent (higher BOD and TSS) than activated sludge effluent. This can also mean that effluent disinfection becomes more difficult, either because of increased chemical dosages for chlorination or lamp fouling and/or light penetration for UV irradiation. RBCs are potentially capable of being incorporated into some form of biological nutrient removal scheme, but rarely are because of their use in smaller treatment plants. RBCs are similar to trickling filters for EDC and PPCP removal, i.e., not as good as activated sludge and MBR systems.

RBCs are relatively easy to maintain since they typically do not require additional aeration and the only electric motors are relatively low horsepower used to rotate the shafts through the wastewater. Based on economics, RBCs are typically suitable for small treatment system installations. The closest example of an RBC system is at the Haisla First Nation's Kitamaat Village.

5.6 Integrated Fixed Film Activated Sludge/Moving Bed Biofilm Reactor

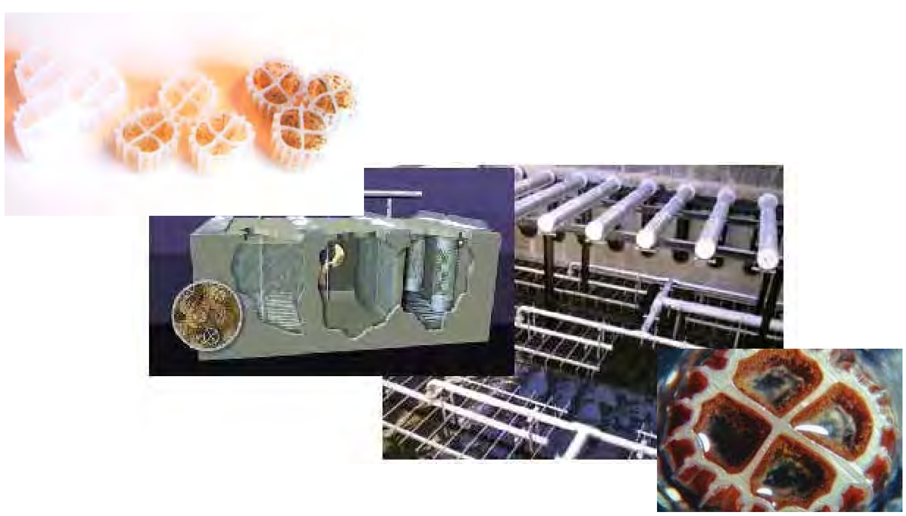
The integrated fixed-film activated sludge (IFAS) process is a variation of the conventional activated sludge process. In this process, synthetic materials, i.e., polyethylene, foam, or polyvinyl chloride are used within the activated sludge tank to provide additional surface area for the growth of microorganisms to treat the wastewater. These synthetic materials are often suspended within the activated sludge mixed liquor. In some cases, the additional fixed film media is fixed firmly in place within the aeration tank. In either case, this approach enhances the activated sludge process by increasing the concentration of microorganisms.

The IFAS process generally provides better EDC and PPCP removal capabilities than an activated sludge treatment process because of the greater biomass involved and also the longer overall sludge retention time.

The moving bed biofilm reactor (MBBR), such as that developed by Kaldnes®, is an example of an IFAS process. In the MBBR process, small polyethylene cylinders, i.e., approximately 10 mm in diameter and 7 mm in height are suspended within an aerated or non-aerated activated sludge basin. Air or mixing is applied to the tank to keep the cylinders in circulation. The use of these cylinders increases the surface area for growth of biological organisms. A screening system is used to keep the plastic media and its attached biological growth in the activated sludge aeration tank. Typically for this process, a clarifier follows the aeration tank to settle out biological solids. The MBBR process would have better EDC and PPCP removal capabilities than an activated sludge process because of the greater biomass involved and also the longer overall sludge retention time.

Figure 5-5 shows some of the characteristics of an MBBR process (including the media with biofilm, the aeration tank, and the separation screens.

Figure 5-5
Moving Bed Biofilm Reactor



Images courtesy of Veolia - Kaldnes

There are no known MBBR plants in BC.

6 Disinfection

Disinfection is a process used to kill most disease-causing organisms (Metcalf and Eddy, 1991). The disinfection of wastewater provides a degree of protection from contact with pathogenic organisms including those causing cholera, polio, typhoid, hepatitis and a number of other bacterial, viruses, and parasitic diseases. Since individual pathogenic organisms can be difficult to detect in a large volume of wastewater, disinfection efficiency is most often measured using "indicator organisms" that coexist in high quantities where pathogens are present. The most common indicator organisms for wastewater evaluation are fecal coliforms. Typical targets for fecal coliforms in wastewater effluents are less than 200 per 100 mL (the swimming contact standard) and 14 per 100 mL in shellfish areas (MSR, 1999).

Disinfection of wastewater has played a large part in the reduction of waterborne diseases. There are a number of chemicals and processes that will disinfect wastewater, but none are universally applicable. Chlorination/dechlorination and ultraviolet (UV) irradiation are the most widely used disinfection technologies, although UV is becoming the industry standard.

Disinfection of the City's wastewater effluent may not be required. If the City decides to re-open the harbour to shell fishing, and some other commercial and recreational activities, wastewater disinfection will be required

6.1 Chlorination/Dechlorination

Chlorination is one of the most widely used methods of disinfection. Chlorination disinfects by inactivating pathogenic organisms. Chlorine is available as chlorine gas, sodium hypochlorite, calcium hypochlorite, and chlorine dioxide. Sodium hypochlorite has been used more frequently due to safety concerns with chlorine gas. Sodium hypochlorite is available in either a dry or wet form and can be generated on-site or delivered as a solution. However, sodium hypochlorite solution decomposes over time. For example, a 16.7 percent solution stored at 26.7°C will loose 10 percent of its strength in 10 days. Many treatment facilities are generally moving away from gaseous chemical systems. As a result, use of gaseous chlorine systems will not be considered for the City's treatment systems.

Chlorination is typically dosed using breakpoint chlorination. Breakpoint chlorination occurs when there is enough chlorine added to the water that it has reacted with all substances including ammonia and remains in solution as free chlorine. Factors that influence disinfection with chlorine include proper mixing, contact time, and control system. Rapid mixing is required to disperse the chlorine. Contact time is important to reduce the bacteria count and for virus inactivation. The control system for chlorination can vary depending on the process. Flow and demand variations would require flow proportioning and residual control. Chlorine resistant microorganisms (e.g., *Giardia*, *Cryptosporidium*, *staphylococcus aureus*, viruses, etc.) should also be considered.

Chlorination is known to produce disinfection by-products. Disinfection by-products are produced when chlorine reacts with naturally occurring organic matter to form trihalomethanes and other compounds. Chlorine can potentially harm receiving water ecosystems. The BC MSR states that "A person must not use chlorine to disinfect an effluent which is to be discharged to surface water unless the effluent is dechlorinated before discharge".

Dechlorination can be achieved with the addition of sulphur dioxide, sodium thiosulphate, sodium bisulphite, or sodium sulphite. Factors influencing effective dechlorination include mixing, contact time, system size, and process control. Refer to **Table 6-1** for the advantages and disadvantages of each dechlorination chemical.

Table 6-1
Advantages and Disadvantages of Alternative Chemical Addition for Dechlorination

Chemical	Advantages	Disadvantages
Sulphur Dioxide	• Significant historical use • Inexpensive for large installations • Injection equipment similar to that for chlorine gas can be used	• Corrosive and hazardous to use • Initial capital costs are high • May increase hazard liability insurance • Requires special storage and handling equipment • Expensive for small installations
Sodium Thiosulphate	• Significant historical use • Non-toxic, non-corrosive, easy to use • Low initial capital costs • Easy to inject	• Subject to freezing in cold weather
Sodium Bisulphite	• Significant historical use • Easy to inject • Low use ratio	• Expensive chemical • Corrosive • Subject to freezing in cold weather
Sodium Sulphite	• Significant historical use • Non-toxic, non corrosive, easy to use	• High use ratio • Subject to freezing in cold weather

In general chlorine is a well established, reliable, easy to use, and relatively inexpensive disinfecting agent. It is effective against a wide spectrum of microorganisms, even in low concentrations. Chlorine disinfection offers flexible dosing which enables greater control over disinfection since wastewater characteristics vary from time to time.

However, chlorination/dechlorination contributes to the formation of trihalomethanes and disinfection-by-products. These compounds are a concern because they are carcinogenic. The use of chlorination/dechlorination for disinfection provides poor *Cryptosporidium* and *Giardia* control – organisms which have the potential to cause gastrointestinal problems. Additionally, chlorine residual, even at low concentrations, are toxic to aquatic life. All forms of chlorine are highly corrosive and toxic. Thus, storage, shipping, and handling pose safety risks to staff. Chlorination/dechlorination also has high operation and maintenance costs.

6.2 Ultraviolet Irradiation

Ultraviolet (UV) irradiation is a very common disinfection alternative to chlorination. UV irradiation does not require chemical addition for disinfection or dechlorination. UV irradiation is a physical disinfection process, which uses electromagnetic radiation at wavelengths ranging from 100 to 400 nanometers. The typical UV irradiation wavelength of 254 nm damages cellular DNA, which makes organisms unable to replicate.

The effectiveness of a UV irradiation system depends on the characteristics of the wastewater, the intensity of the UV irradiation, the amount of time the microorganisms are exposed to the radiation, and the reactor configuration (EPA, Wastewater Technology Fact Sheet Ultraviolet Disinfection). UV irradiation has been found to be a function of TSS concentration and light transmittance, as well as contact time and UV intensity. UV transmittance is the amount of light transmitted through the wastewater, typically reported as a percentage. Very clean water would have a high UV transmittance and dirty water would have a low transmittance. The transmittance of the wastewater must be taken into account when sizing a disinfection system. It is recommended that samples of the wastewater be analyzed for UV transmittance before the system is sized, as this can have a significant effect on capital and operational costs.

To make UV more effective, some level of physical treatment should precede the disinfection process. Wastewater should be pre-treated upstream of the UV reactor, as high TSS can reduce UV irradiation effectiveness. High suspended solids would require longer contact time, potentially increasing the size of the facility and operational costs. High TSS (>50 mg/L) could also limit the amount of disinfection by shielding the organisms from the UV light. Lamp fouling is a potential problem with wastewater disinfection. Fouling is reduced with a proper cleaning regime. An automated cleaning system is typically included in UV irradiation systems.

A UV system can be installed in an open or closed channel. **Figure 7-1** for a recent installation at a wastewater treatment facility and **Figure 7-2** for a typical UV lamp bank for an open channel disinfection system.

Figure 7-1
Waterton Lakes National Park, Wastewater Treatment Plant Upgrade
UV irradiation System

Figure 7-2
Typical UV Lamp Bank

Picture Courtesy of Trojan Technologies

The advantages of UV irradiation include the following:

- Effective at inactivating most bacteria, viruses, spores, and cysts.
- Eliminates the need to generate, handle, transport, or store toxic, hazardous, or corrosive chemicals.
- There is no residual effect that can be harmful to humans or aquatic life.
- Can be less labour intensive to operate.

- Uses shorter contact times than chlorine.
- Dechlorination is not required.
- Requires less space for equipment and process than chlorine.

The limitations of UV irradiation include the following:

- UV radiation is not suitable for water with high levels of suspended solids, turbidity, color, or soluble organic matter.
- No standardized mechanism measures, calibrates, or certifies how well equipment works before or after installation.
- Low dosage may not effectively inactivate some viruses, spores, and cysts.
- Organisms can sometimes repair and reverse the destructive effects of UV through a "repair mechanism," known as photo reactivation, or in the absence of light known as "dark repair" (Source: Crites and Tchobanoglous, 1998).
- A preventive maintenance program is necessary to control fouling of tubes.
- UV irradiation is not as cost-effective as chlorination, but costs are competitive when chlorination/dechlorination is used and fire codes are met.

7 Comparison of the Reviewed Treatment Processes

The treatment processes reviewed in this discussion paper are presented in **Table 7-1**. Table 7-1 compares the technologies for preliminary treatment, primary treatment, secondary treatment, and disinfection based on capital cost, operational cost, footprint, BOD removal, TSS removal, and EDC/PPCP removal. For each category, ratings of low, medium, and high were used to rank each technology so that an assessment could be made to short-list the options for Stage 2 of the City's LWMP.

Based on the abovementioned comparison categories, the short-listed options are as follows:

- Preliminary treatment - vortex separator
- Primary treatment - microscreen
- Secondary treatment - activated sludge and sequencing batch reactor
- Disinfection - UV irradiation (if required)

Even though much attention has been given to selecting appropriate technologies to meet the City's overall requirements, the short-listing of these technologies is for planning purposes only. This discussion paper is a planning document and, therefore, does not provide the level of detail that is required for actual treatment technology selection and implementation. A more in-depth evaluation and selection of treatment technologies will be done at the pre-design stage.

Table 7-1: Wastewater Treatment Options - Comparison Table

Discussion Paper 2-3: Treatment Technology Options
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: M. Herar
Reviewed by: D. Forgie
Date of last revision: September 14, 2009

LEGEND

1 = low
2 = medium
3 = high
N/A = Not Applicable
Technologies in Red are short-listed options based on the comparison categories shown.

Treatment Technology	Preliminary Treatment	Primary Treatment	Secondary Treatment	Disinfection	Capital Cost	Operational Cost	Footprint	BOD Removal	TSS Removal	EDC / PPCP Removal
Mechanical Screening	✔				1	1	1	1	1	N/A
Fine Screening	✔				1	1	1	1	2	N/A
Solids Collection System, e.g., Netting Trash Trap®	✔				1	1	1	1	2	N/A
Vortex Separator	✔				1	1	1	1	2	N/A
Primary Clarification		✔			2	2	2 / 3	1 / 2	3	N/A
Chemically Enhanced Primary Treatment		✔			2	2 / 3	2	2	3	N/A
Microscreens		✔			1	2	1	2	2	N/A
Activated Sludge			✔		2 / 3	2 / 3	3	2 / 3	2 / 3	2
Sequencing Batch Reactor			✔		2	2	1	2 / 3	2 / 3	1
Membrane Bioreactor			✔		3	3	1	3	3	2 / 3
Trickling Filter / Solids Contact			✔		2 / 3	2	3	2	2	1
Rotating Biological Contactor			✔		2 / 3	2	3	2	2	1
Integrated Fixed Film Activated Sludge / Moving Bed Biofilm Reactor			✔		2 / 3	2	3	2 / 3	2 / 3	2 / 3
Chlorination / Dechlorination				✔	2	2	2	N/A	N/A	N/A
Ultraviolet Irradiation				✔	2 / 3	2	1	N/A	N/A	N/A

8 Conclusions

This discussion paper provided information regarding feasible wastewater treatment options that may be further short-listed down to the vortex separator for preliminary treatment, the microscreen for primary treatment, activated sludge and sequencing batch reactor technologies for secondary treatment, and UV irradiation for disinfection. The treatment technologies selected are representative technologies useful for planning. Actual technology selection will be made at the preliminary design stage. Treatment and redundancy requirements were outlined and preliminary, primary, secondary, and disinfection technologies were presented.

Land availability and conditions will also play an important role in treatment technology selection. The preferred area or areas available will be investigated in Discussion Paper 2-4: Land Requirements and Availability.

9 References

1. Associated Engineering. 2009. City of Prince Rupert Liquid Waste Management Plan – Stage 2, *Discussion Paper 2-1: Waste Volumes and Facility Sizing Criteria.*

2. British Columbia – Ministry of Environment. 1999. *Municipal Sewage Regulations.* Available from: http://www.env.gov.bc.ca/epd/epdpa/mpp/msreg.html

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10. U.S. Environmental Protection Agency - Municipal Technology Branch U.S. EPA. 1999. *Wastewater Technology Fact Sheet – Chlorine Disinfection.*

11. White, Clifford. 1999. *Handbook of Chlorination and Alternative Disinfectants,* Fourth Edition.

D Appendix D - DP2-4 - Land Requirements and Availability

DISCUSSION PAPER

City of Prince Rupert
Liquid Waste Management Plan - Stage 2

Discussion Paper 2-4– Land Requirements and Availability

Prepared by: Manjit Herar, M.S., P.Eng., LEED® AP
Issued: March 10, 2010
Previous Issue: February 23, 2010

1 Introduction and Objectives

The City of Prince Rupert (City) has identified the need to improve the management of the City's wastewater through the development of a Liquid Waste Management Plan (LWMP). The City has successfully completed Stage 1 of the LWMP and is currently in the process of completing the requirements for Stage 2 of the LWMP.

Discussion Paper 2-1 confirmed the design population, estimated the wastewater volumes, and established the City's wastewater management approach. The estimated population for design year 2030 and 2050 is 18,500 and 25,000 respectively. The Average Dry Weather Flow (ADWF) for design year 2030 and 2050 was estimated to be 7,862 m^3/day (91 L/s) and 10,627 m^3/day (123 L/s), respectively. Based on the ADWF for design years 2030 and 2050, the City's wastewater management strategy includes treating up to two times the ADWF to secondary treatment standards, up to four times the ADWF to primary treatment standards. Considering very large peaking factors (i.e. over 100 times) and resulted dilution, all flows greater than four times the ADWF will be bypassed as part of an interim wet weather flow strategy.

Discussion Paper 2-2 presented wastewater treatment facility options. These included options to have between one and three wastewater treatment facilities. Based on discussions with the LWMP Technical and Local Advisory Committees, the treatment facility options were short-listed from six to the following three:

- Option 1A – Single Wastewater Treatment Facility at Hays Creek;
- Option 2A – Two Wastewater Treatment Facilities at Hays Creek and Morse Creek;
- Option 3 – Three Wastewater Treatment Facilities at Hays Creek, Ritchie Point, and Morse Creek.

Discussion Paper 2-3 presented wastewater treatment technology options. The treatment options were shortlisted down to vortex separators for potential preliminary treatment, microscreens for primary treatment, activated sludge or Sequencing Batch Reactors (SBR) for secondary treatment, and UV irradiation for disinfection. The shortlisted technologies are representative technologies for planning purposes only.

The objective of this discussion paper is to determine approximate footprint requirements based on Year 2030 and Year 2050 design criteria, wastewater management approach, and preferred technologies. This discussion paper will also present potential areas for siting these treatment facilities.

2 Wastewater Management Approach

Based on a review of Discussion Paper 2-1 and 2-2, the preferred approach for managing the City's wastewater would consist of either a centralized treatment facility or two to three decentralized facilities.

In general, the strategy for each of the wastewater treatment facility options would involve conveying all flows to one, two, or three treatment plants. Flows up to two times the ADWF will be treated to secondary treatment standards (activated sludge or SBR). Flows up to four times the ADWF will be treated to primary treatment standards (microscreen). All flows greater than four times the ADWF will be bypassed as part of an interim wet weather flow strategy while the City is implementing their long term sewer separation program.

The wastewater management approach also includes on-site solids treatment via aerobic digestion and dewatering. For the centralized treatment facility option, solids treatment would occur on-site. For all decentralized treatment facility options, solids generated at the smaller of the two or three treatment facilities would be trucked to the largest treatment facility. Should an alternative solids treatment approach such as off-site treatment of wastewater solids combined with fish processing wastes be used by the City, anaerobic digestion could also be considered. Off-site solids composting can also be considered as a measure. These options will be discussed further in Discussion Paper 2-6 – Sustainability and Resource Recovery Options.

3 Land Requirements

In order to calculate land requirements for the proposed City's treatment facility options, the approximate "liquid treatment" footprints (building and tankage footprint required for liquid wastewater treatment only - no solids processing) for the currently operating or currently designed treatment facilities were referenced. The following facilities were used for this purpose:

- Village of Pemberton Wastewater Treatment Plant, Village of Pemberton, BC
- Porteau Cove Wastewater Treatment Plant, Porteau Cove, BC
- Capital Regional District's West Shore Treatment Plant, Victoria, BC and
- Capital Regional District's Saanich East Wastewater Treatment Plant, Saanich, BC

For each reference facility, the approximate areas (m^2) for each of the following were calculated:

- Headworks, treatment tankage, and required rooms,
- Solids thickening, and
- UV disinfection.

The sums of these areas were divided by the respective reference treatment facility ADWF (m^3/day) to calculate a treatment area per volume of ADWF treated ratio (m^2/m^3). A diagram showing the reference treatment facilities ADWF versus required area per volume of ADWF treated was developed. Knowing the ADWF for each of the City's treatment facility options, the equation of the line generated by the points on the curve was used to determine the required area per volume of ADWF (m^2/m^3) for each option. To calculate the estimated "liquid treatment" footprint (m^2), the determined area per volume of ADWF ratio (m^2/m^3) for each respective treatment facility option was multiplied by the treatment facility's ADWF (m^3/day)

To determine the approximate land required for on-site solids processing, fifty percent additional area was added to the estimated "liquid treatment" footprint of the central treatment facility and to the largest treatment facility of the decentralized treatment facility options. Additional area for access roads and buffering were allocated by multiplying the estimated total footprint by 2.5 and 4, respectively for the large or small treatment facilities.

Table 3-1 and **Table 3-2** present the estimated footprints of the building and tankage area, as well as the estimated footprint of the building and tankage inclusive of access roads and buffer space for Year 2030 and 2050 design flows. Due to potential future changes in wastewater treatment regulations and treatment technology, the footprints provided in **Table 3-1** and **Table 3-2** may vary, depending on when the treatment facilities are built. These numbers provide a conservative estimate for the total area required. All background calculations are provided in **Appendix A**.

Table 3-1
Summary of Estimated Footprint Requirements for Proposed Wastewater Treatment Facility Options (Year 2030 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	7,600	19,000
2A – Two facilities	Hays Creek	5,400	13,500
	Morse Creek	1,600	6,400
3 – Three facilities	Hays Creek	3,900	9,800
	Morse Creek	1,600	6,400
	Ritchie Point	1,100	4,400

Table 3-2
Summary of Estimated Footprint Requirements for Proposed Wastewater Treatment Facility Options (Year 2050 Design Flows)

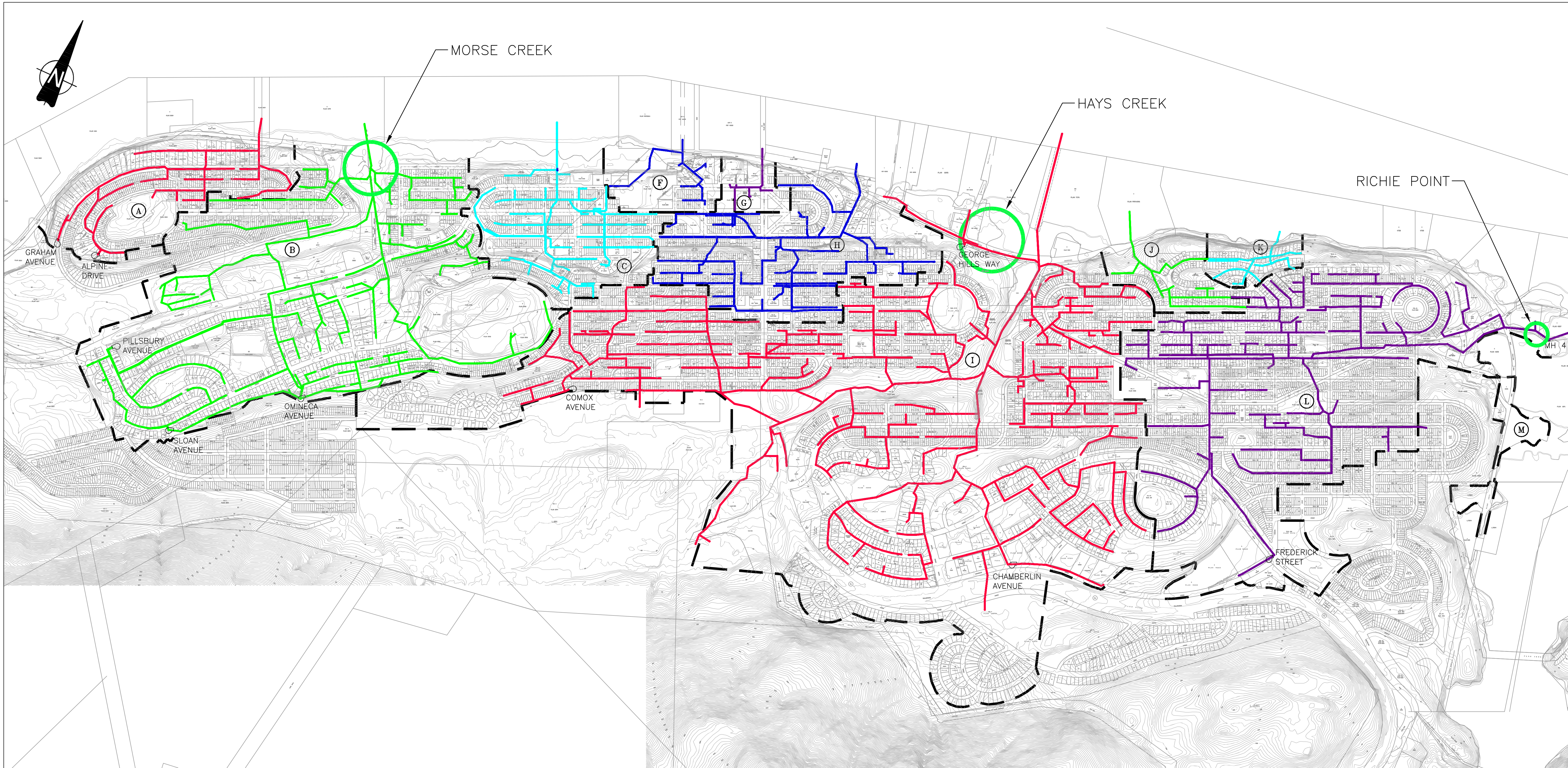
Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	10,000	25,000
2A – Two facilities	Hays Creek	7,200	18,000
	Morse Creek	2,100	8,400
3 – Three facilities	Hays Creek	5,300	13,300
	Morse Creek	2,100	8,400
	Ritchie Point	1,400	5,600

4 Available Land for Siting of Facilities

Available land for siting one, two or three wastewater treatment facilities in the City is sparse due to the current development of the City's waterfront properties. Historically, the City's wastewater management strategy consisted primarily of wastewater collection and disposal (Associated Engineering, 1977). In the past, wastewater treatment was not required and the implementation costs too extensive to justify the environmental benefit. Due to more recent changes in wastewater legislation, the City is now required to treat its wastewater. As such, the City needs to select and acquire properties to site one or more treatment facilities.

Generally, wastewater treatment facilities are preferred to be located away from or screened from residential areas. This helps to minimize nuisance effects in regards to the potential for noise, odour, and aesthetics. At the same time, the treatment facility should be located such that it is close to the gravity trunk sewers and the outfalls at the downstream ends in order to minimize pumping costs

Presently, the City does not own any parcels of land that are large enough to build all three of the smaller decentralized wastewater treatment facilities, or one large centralized treatment facility. The City will have to acquire one or more properties for this purpose. Potential locations for siting the treatment facilities include the areas of Hays Creek, Morse Creek, and Ritchie Point. These general locations are shown on **Figure 4-1**.



LEGEND:

POTENTIAL GENERAL LOCATION FOR TREATMENT FACILITY

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
POTENTIAL GENERAL LOCATIONS FOR SITING THE TREATMENT FACILITIES

FIGURE 4-1

Associated Engineering

5 Land Requirement Optimization Opportunities

If the required amount of land is not available or to provide more flexibility for siting in constrained settings, there is opportunity to further reduce treatment facility footprint demands. Brief description of optimization opportunities follows:

- *Optimization of secondary treatment process.* This option would include potential to reduce solids retention time (SRT) in the biological reactors, thereby reducing bioreactor volume requirements.
- *Construction of deeper basins.* Deeper basins, within the operational constrains, could be considered for the biological reactors. A slightly deeper basin could reduce footprint of the bioreactor structure.
- *Stacking of treatment units.* There is opportunity for reducing footprint by stacking units within the facilities. This approach could also be applicable to the treatment facility building. However, local height restrictions, as well as visual impacts need to be considered. Low profile structures, with the process works either below grade or at grade with covered tankage, and surface level structures and buildings architecturally styled to fit with the site theme can be used.
- *Solids processing off-site.* The processing of solids at an off-site location from the treatment facilities would reduce the required footprint of the treatment facility. Solids processing at an off-site location would require the City to acquire property for this purpose.

The land requirement optimization opportunities presented above were not applied to the estimated treatment facility footprints provided in Section 3. The values provided in Section 3 are estimates useful for planning purposes only and are based on representative treatment technologies used by currently operating or currently designed treatment facilities.

Optimization opportunities are site specific and require a higher level of effort and detail than is available for LWMP planning work. Land requirement optimization opportunities do not need to be investigated until the City has selected a treatment facility option (centralized or decentralized), which will likely be during the preliminary design stage and will be based on the availability of suitably sized and located property.

6 Summary

Approximate footprint requirements for centralized and decentralized treatment facility options, based on Year 2030 and Year 2050 design criteria, wastewater management approach, and preferred technologies, were determined and presented in this discussion paper. General locations to place one or more treatment facilities are in the Hays Creek, Morse Creek, and Ritchie Point areas. Currently, the City does not own any property large enough to site one, two or three treatment facilities in any of these areas. The City will continue to explore potential properties within the City. The availability of adequately sized property to meet treatment facility footprint requirements will impact the City's decision to build one centralized treatment facility or two or three decentralized treatment facilities in the future.

7 References

Associated Engineering. City of Prince Rupert Report on Long Range Plan for Sewage Disposal. December 1977.

Associated Engineering. Concord Pacific Group Inc. Porteau Cove Development Wastewater Treatment Facility 75% Design Submission. 2007.

Associated Engineering. Discussion Paper 2-1, Liquid Waste Management Plan - Stage 2, Waste Volumes and Facility Sizing Criteria. September 2009.

Associated Engineering. Discussion Paper 2-2, Liquid Waste Management Plan - Stage 2, Wastewater Treatment Facility Options. September 2009.

Associated Engineering. Discussion Paper 2-3, Liquid Waste Management Plan - Stage 2, Treatment Technology Options. September 2009.

Associated Engineering, CH2MHill, and KWL. Capital Regional District Core Area Wastewater Treatment Program – West Shore C and Saanich East Wastewater Treatment Facilities. 2009.

Earth Tech and Maple Reinders. Village of Pemberton Wastewater Treatment Plant 100% Design Submission. 2004.

Appendix A - Calculations

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-4 - Land Requirements and Availability
Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**
NOTE: This worksheet is a copy of calculations from: P:\20062891\02_PURP_LWMPP_S2\Engineering\03.00_Conceptual_Feasibility_Design\Task 210_Waste_Vol_Facility_Sizing_Criteria

Appendix B - Wastewater Flow Rate Calculations
Subject: Projected Flows for Design Years 2030 and 2050
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: February 10, 2010
The following projected flows are based on the flows provided in the 2003 Report.

Target Population 18,500 (est. to be reached in year 2030 based on 1.5% growth)
Multiplier 0.96

Projected Values for Target Population of 18,500

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s) Sanitary	Base Infiltration[2]	Total
A	combined	673	2.7	1.2	3.9
B	sanitary	3,238	9.4	0.1	9.5
C	combined	2,107	8.5	3.7	12.2
F	sanitary	241	1.0	0.3	1.2
G	combined	246	1.0	2.9	3.8
H	combined	1,490	6.0	2.6	8.6
I	sanitary	7,142	29.0	3.5	32.5
J	combined	220	0.9	0.1	1.0
K	combined	163	0.7	0.1	0.8
L	sanitary	2,981	12.0	5.3	17.3
	TOTAL	**18,500**	**71**	**20**	**91**
	Secondary Treatment (2 x ADWF)				**182**
	Primary Treatment (4 x ADWF)				**363**

Target Population 25,000 (est. to be reached in year 2050 based on 1.5% growth)
Multiplier 1.29

Projected Values for Target Population of 25,000

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s) Sanitary	Base Infiltration[2]	Total
A	combined	910	3.6	1.6	5.3
B	sanitary	4,376	12.7	0.1	12.8
C	combined	2,848	11.5	4.9	16.5
F	sanitary	326	1.3	0.4	1.7
G	combined	332	1.3	3.9	5.2
H	combined	2,013	8.1	3.5	11.6
I	sanitary	9,651	39.1	4.8	43.9
J	combined	297	1.2	0.1	1.3
K	combined	220	0.9	0.1	1.0
L	sanitary	4,028	16.3	7.1	23.4
	TOTAL	**25,000**	**96**	**27**	**123**
	Secondary Treatment (2 x ADWF)				**245**
	Primary Treatment (4 x ADWF)				**491**

Note 1: Peaking factors shown were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each of the sewer areas (Comprehensive Monitoring Program - Impacts of Prince Rupert Harbour, Associated Engineering 2003) by the total ADWF for each catchment. For calculations, please see Table 7-1 March 03 Report worksheet in same Excel file.

Note 2: The base infiltration rates for Catchments A, C and H have been modified from those presented in Table 7-1 of the March 03 Report. New base infiltration rates are based on a total flow of 500 L/cap/day, using sanitary flows of 350 L/cap/day.

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-4 - Land Requirements and Availability
Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**

Design Notes: The "flows" worksheet is a copy of calculations from:
P:\20062891\02_PURP_LWMPP_S2\Engineering\03.00_Conceptual_Feasibility_Design\Task 210_Waste_Vol_Facility_Sizing_Criteria
The "flows" calculations are used to determine the wastewater flow (ADWF) to 1, 2 or 3 treatment plants. The wastewater flows to each potential wastewater treatment plant are based on the total ADWF values calculated for each outfall (A, B, C, F, G, H, I, J, K, and L) for Design Years 2030 and 2050. The flow to each treatment facility will depend on whether one, two, or three treatment facilities are built. The values below, calculate the treatment facility flow requirements for each option for secondary treatment (2 X ADWF) and primary treatment (4 X ADWF).

Design Year 2030

Option	***Average Dry Weather Flow per WWTP***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek	91	**7,843**								
2A	Hays Creek	64	**5,528**	&	Morse Creek	27	**2,315**				
3	Hays Creek	46	**3,967**	&	Morse Creek	27	**2,315**	&	Ritchie Pt.	18	**1,561**

Design Year 2050

Option	***Average Dry Weather Flow per WWTP***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek	123	**10,599**								
2A	Hays Creek	86	**7,465**	&	Morse Creek	36	**3,134**				
3	Hays Creek	62	**5,356**	&	Morse Creek	36	**3,134**	&	Ritchie Pt.	24	**2,110**

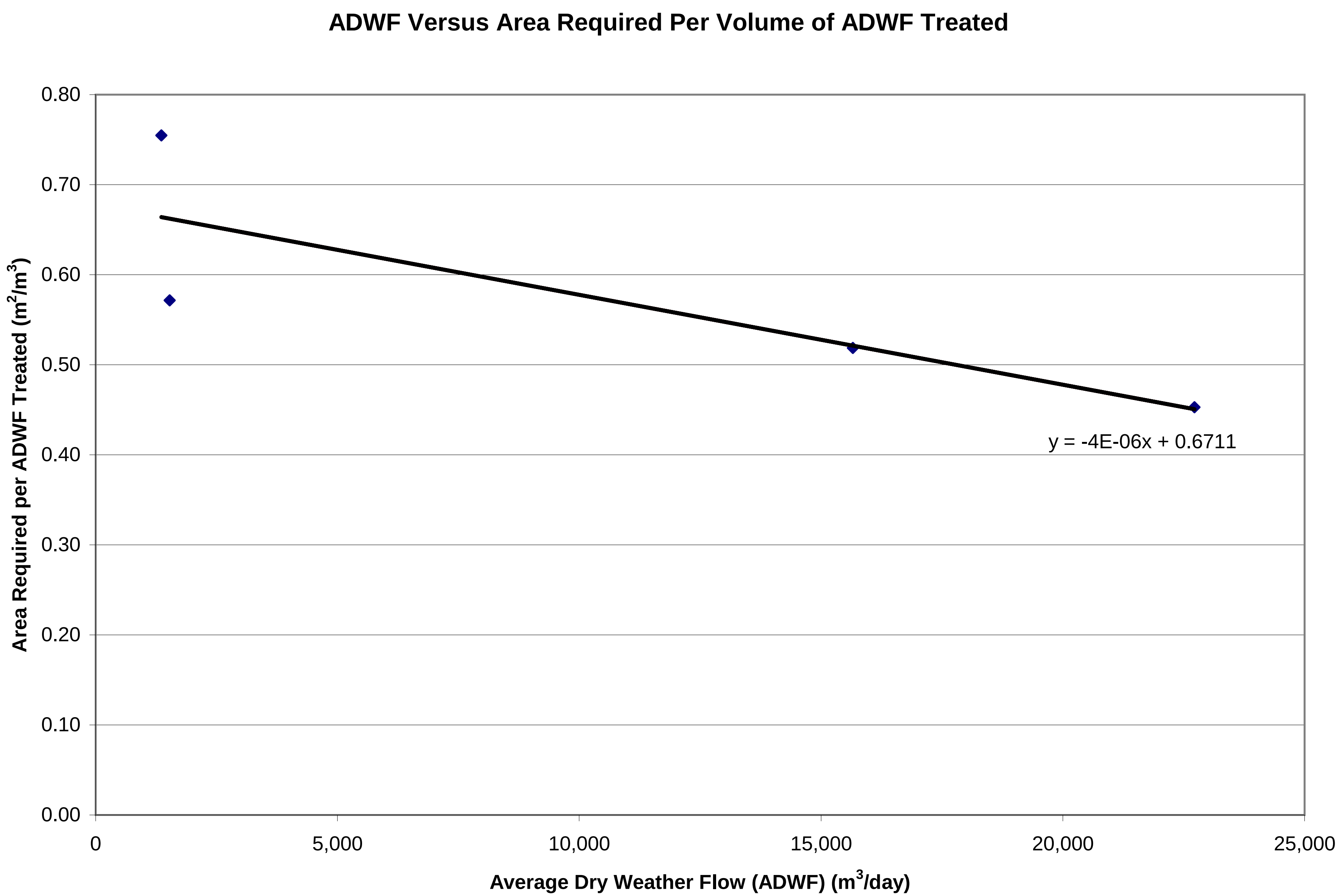
City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-4 - Land Requirements and Availability
Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**

Background:
As part of the City of Prince Rupert's Stage 2 Liquid Waste Management Plan (LWMP) work, potential wastewater treatment plants (WWTP) are to be sized.
For conceptual planning purposes, the estimated size of one to three treatment facilities will be based the Porteau Cove, Village of Pemberton, and Capital Regional District's Saanich and West Shore treatment facilities.

Notes:
1. Concord Pacific Group Inc., Porteau Cove Development Wastewater Treatment Facility Preliminary Design Report, Associated Engineering, March 2007.
2. Village of Pemberton, Wastewater Treatment Plant Operation & Maintenance Manual, Vol. 1, Section 2, Maple Reinders, March 2005.
3. Use adjustment factor to modify the required calculated treatment plant area. The factor adjusts required land area based on the premise that the m2/m3 does not increase to the same extent as flow increases. The operational areas of the plant (office
3. Capital Regional District, Core Area Wastewater Management Plan, Conceptual Plan for a new treatment facility at West Shore C. Associated Engineering project number 20062935.
4. Capital Regional District, Core Area Wastewater Management Plan, Conceptual Plan for a new treatment facility at Saanich East - Option 3. Associated Engineering project number 20062935.
5. Used the reference facilities ADWF (m3) and the reference facilities treatment area required per ADWF treated (m2/m3) to generate an ADWF versus treatment area required per ADWF curve. From the curve, the equation of the line was generated by Excel and used to determine the approximate liquid stream area required for the City of Prince Rupert liquid stream treatment facilities. The equation of the line is: Y = -0.000004X + 0.6711
6. Fifty percent additional area was added to the Liquid Stream area to provide sufficient area for full sludge processing. For decentratlized treatment facilities, sludge will be processed at the largest treatment facility.
7. To determine the overall site area required, including area for access roads and buffering, a factor of 2.5 was used for the large treatment facilities and a factor of 4 was used for the small treatment facilities.

Reference Treatment Facilities and Primary and Preliminary Treatment Technologies	**Porteau Cove[1.]**		**Pemberton[2.]**		**CRD West Shore C[3.]**		**CRD Saanich East Option 3[4.]**	
		m^2/m^3 of ADWF		m^2/m^3 of ADWF		m^2/m^3 of ADWF		m^2/m^3 of ADWF
Average Dry Weather Flow (m3/day):	1,359		1,530		15,658		22,721	
Average Dry Weather Flow (L/s):	15.73		17.71		181.23		262.97	
Treatment Technology Used:	Batch Decant Reactor		Sequencing Batch Reactor		Membranes		Membranes	
Approx. total tankage/building area (m2)	959	0.71	828	0.54	3,272	0.21	4,321	0.19
Appox. area solids thickening (m2)	19	0.01	29	0.02	4,470	0.29	5,472	0.24
Appox. area UV disinfection (m2)	48	0.03	18	0.01	381	0.02	496	0.02
Total approximate area (m2):	1,026	0.75	874	0.57	8,123	0.52	10,289	0.45

Potential Wastewater Treatment Facility Approximate Land Requirements	**Design Year**	**Facility Location**	**Wastewater Treatment Facility** ADWF (m3/day)	m^2/m^3 of ADWF[5.]	Area Required for Liquid Stream (m^2)	Area for Sludge Processing (m^2)[6.]	Total Building and Tankage Area (m^2)	**Multiplier for Access Roads, Landscaping, Buffer**	**Total Appoximate Area Required (m^2)[7.]**	**Total Appoximate Area Required (ha)[7.]**
Option 1A - 1 facility	**2030**	**Hays Creek**	**7,843**	**0.640**	**5,017**	**2,509**	**7,600**	**2.5**	**19,000**	**1.90**
	2050	Hays Creek	10,599	0.629	6,664	3,332	10,000	2.5	25,000	2.50
Option 2A - 2 facilities	**2030**	**Hays Creek**	**5,528**	**0.649**	**3,588**	**1,794**	**5,400**	**2.5**	**13,500**	**1.35**
	2050	Hays Creek	7,465	0.641	4,787	2,394	7,200	2.5	18,000	1.80
	2030	**Morse Creek**	**2,315**	**0.662**	**1,532**		**1,600**	**4**	**6,400**	**0.64**
	2050	Morse Creek	3,134	0.659	2,064		2,100	4	8,400	0.84
Option 3 - 3 facilities	**2030**	**Hays Creek**	**3,967**	**0.655**	**2,599**	**1,300**	**3,900**	**2.5**	**9,800**	**0.98**
	2050	Hays Creek	5,356	0.650	3,479	1,740	5,300	2.5	13,300	1.33
	2030	**Morse Creek**	**2,315**	**0.662**	**1,532**		**1,600**	**4**	**6,400**	**0.64**
	2050	Morse Creek	3,134	0.659	2,064		2,100	4	8,400	0.84
	2030	**Ritchie Point**	**1,561**	**0.665**	**1,038**		**1,100**	**4**	**4,400**	**0.44**
	2050	Ritchie Point	2,110	0.663	1,398		1,400	4	5,600	0.56


ADWF Versus Area Required Per Volume of ADWF Treated
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Area Required per ADWF Treated (m2/m3)
y = -4E-06x + 0.6711
0
5,000
10,000
15,000
20,000
25,000
Average Dry Weather Flow (ADWF) (m3/day)

E Appendix E - DP2-5 - Wastewater Conveyance and Disposal Methods

DISCUSSION PAPER

City of Prince Rupert
Stage 2 Liquid Waste Management Plan

Discussion Paper 2-5– Wastewater Conveyance and Disposal Methods

Prepared by: Manjit Herar, M.S., P.Eng., LEED® AP
Issued: March 10, 2010
Previous Issue: March 1, 2010

1 Introduction and Objectives

The City of Prince Rupert (City) is developing Stage 2 of its Liquid Waste Management Plan (LWMP). As part of this plan, three options for the number and location(s) of wastewater treatment facilities have been short-listed by the LWMP Advisory Committees. Option 1A consists of having one treatment facility located in the Hays Creek area. Option 2A consists of having two treatment facilities, one in the Hays Creek area and one in the Morse Creek area. Option 3 consists of having three treatment facilities, one in the Hays Creek area, one in the Morse Creek area, and one in the Ritchie Point area.

Currently, the City's sewer system consists of both sanitary and combined sewers that discharge wastewater to the ocean via outfalls. In the near future, the collected wastewater will be conveyed to one, two, or three wastewater treatment facilities for treatment. Only four times the average dry weather flow (ADWF) will be conveyed to the treatment facility(ies) via newly installed gravity trunk sewers and pump stations and force mains along the City's waterfront. Diversion chambers with flow controls will need to be installed near the waterfront, upstream of the existing outfalls to divert only four times the ADWF to the treatment facility. As an interim wet weather flow strategy and considering extremely high peaking factors, the diversion chambers will direct the remaining flows to the existing outfalls which will act as combined sewer overflows (CSO).

The basis for this wastewater management approach of only treating four times the ADWF is due to the fact that the City's sewer system consists of combined and old, separated sewers which permit high amounts of rainfall and groundwater to enter the system, thus contributing to higher than average peak wet weather flows. During wet weather events, the sewage flows become highly diluted due to the amount of rainfall entering the system. To design a treatment facility to handle the extreme wet weather flows would not be practical. The money required to build and operate a treatment facility to manage extreme wet weather flow conditions would be better invested in the design and implementation of wet weather flow management solutions such as replacing the combined sewers with separate sanitary and storm sewers.

This discussion paper will investigate wastewater conveyance and disposal methods for the proposed treatment options. For each treatment option, pumping and gravity sewers will be investigated. In regards to disposal methods, the capacity of the existing outfalls will be evaluated to determine if sufficient capacity is available to discharge consolidated flows from the various catchments.

2 Conveyance and Disposal Options

Basically, wastewater needs to be collected at manholes upstream of the existing outfalls and conveyed to the treatment facility(ies) by means of trunk sewers and pump stations. Naturally, any conveyance system design should attempt to take advantage of gravity sewer system as much as possible and minimize the number of pump stations and the volume of pumped wastewater. Doing so, would help reduce both the capital and operational cost involved in building and operating the pump stations and related infrastructure.

In regards to disposal, the use of existing outfalls, if required capacity is available, would be the best disposal option. Similar to gravity sewers, the preferred method of disposal would not require effluent pumping. However, in some instances, the only alternative to achieve the required static head would be to build a larger diameter outfall. Both pumping and building a larger diameter outfall have associated costs, which need to be evaluated in the preliminary design stage of the City's wastewater management program. Conceptual level cost estimates provided in Discussion Paper 2-7 will assume larger diameter outfalls, where necessary, will be designed and built.

2.1 Gravity Sewers

Conventional wastewater collection systems consist of gravity sewers to transport sewage from homes or other sources of wastewater via gravity flow through buried piping systems to a wastewater treatment facility. Gravity sewers have no power requirements because they rely on the slope of the land and gravity force to carry wastewater through the network of sewer pipes.

The cost of implementing gravity sewers increases substantially when deep excavations in hilly, flat, or rocky terrain are required. Costs are proportionally related to pipe diameter sizes and pipe depths. As the diameter of the pipe increases, the implementation cost also increases. Additionally, the installation and/or operation and maintenance of manholes and other appurtenances also add to the cost of the gravity sewer system. The installation of gravity trunk sewers will require excavation, trenching, installation, backfilling, and pavement resurfacing.

Wherever feasible, gravity trunk sewers will be the preferred conveyance method. The gravity trunk sewers will be sized to convey four times the Year 2050 ADWF. The diameter of the sewers will depend quantity of flow to be conveyed which is based on the selected wastewater treatment facility option.

2.2 Pump Stations and Force Mains

In catchments where gravity conveyance is not feasible due to the slope of the land, excavations, and installation being too deep and costly, pump stations and force mains are an alternative. Pump stations are structures that contain one or more pumps, piping, valves and other related auxiliary equipment. The force main is the pipe that the pump discharges into. The piping is filled with liquid, in the City's case, wastewater that is under pressure.

In addition to their primary purpose, which is conveyance, pump stations that are located immediately upstream of the treatment facility can assist with flow equalization at the respective treatment facility. Each pump station will have a certain holding capacity within their wet well and incoming sewers. This capacity, along with process regulations, would help maintain a more stable and constant flow to the facility, which in turn will assist in maintaining the treatment performance. The quantity of flow which is pumped to the wastewater facility(ies) will depend on the selected option for wastewater treatment.

The pump stations will need to be sited and built strategically along the City's waterfront. Similar to gravity sewers, force mains will require excavation, trenching, installation, backfilling, and pavement resurfacing. However, since the force mains do not rely on gravity, their depth is defined by minimum front protection cover requirements which will be relatively constant throughout.

The pump stations will be designed for four times the Year 2030 ADWF. The stations can be upgraded in the future to meet four times the Year 2050 ADWF. The force mains will be sized to convey four times the Year 2050 ADWF.

2.3 Outfalls

Currently, the City's wastewater is discharged to the ocean via a designated outfall from each catchment. The City's future wastewater management program would require consolidation and treatment of the wastewater at one, two, or three treatment facilities and the treated effluent would be discharged to the ocean via an outfall corresponding to the catchment in which the treatment facility is located.

The outfalls corresponding to Options 1A (Hays Creek – Outfall I), 2A (Hays Creek - Outfall I and Morse Creek – Outfall B), and 3 (Hays Creek - Outfall I, Morse Creek – Outfall B, and Ritchie Point – Outfall L) would be potential discharge points for the consolidated treated flows, and also the flows captured in that particular catchment that are diverted away from the treatment facility because they are greater than four times ADWF.

3 Proposed Wastewater Treatment Facility Conveyance Options

Conveyance options for the three wastewater treatment facility options were investigated using the City's existing sewer system and contour maps. The ground elevation of an existing manhole near the waterfront, but upstream of the individual catchment's outfall was used as the reference wastewater flow start point. The ground elevation of an existing manhole near the waterfront, but downstream of the first catchment, was used as the reference wastewater flow end point. The wastewater is to be conveyed sequentially along the waterfront, from one catchment to the next, until it reaches the treatment facility(ies).

Only four times the ADWF from each catchment (A, B, C, F, G, H, I, J, K, and L) would be conveyed to the treatment facility(ies). The wastewater in Catchment M is currently treated using on-site septic tank and disposal field technology. In the future, should the City decide to connect Catchment M residents to the City's sewer system, the wastewater would be conveyed to a wastewater treatment facility (Option 1A - Hays Creek, Option 2A – Hays Creek and Morse Creek, or Option 3 – Hays Creek, Morse Creek, and Ritchie Point), depending on the wastewater treatment facility option selected. All additional flows would be bypassed as CSOs, using a newly installed diversion chamber to the existing outfall in each catchment. The bypassed flows would be diluted due to the influence of the wet weather event and as a result would be significantly higher than four times ADWF (determined by the high 5-year storm peaking factors established in Discussion Paper 2-1 Waste Volumes and Facility Sizing Criteria). Limiting the wastewater flows to four times the ADWF will reduce the amount of wastewater requiring conveyance, and as a result, will reduce the size and capital, operational, and maintenance costs of the gravity sewers, pump stations, and force mains required.

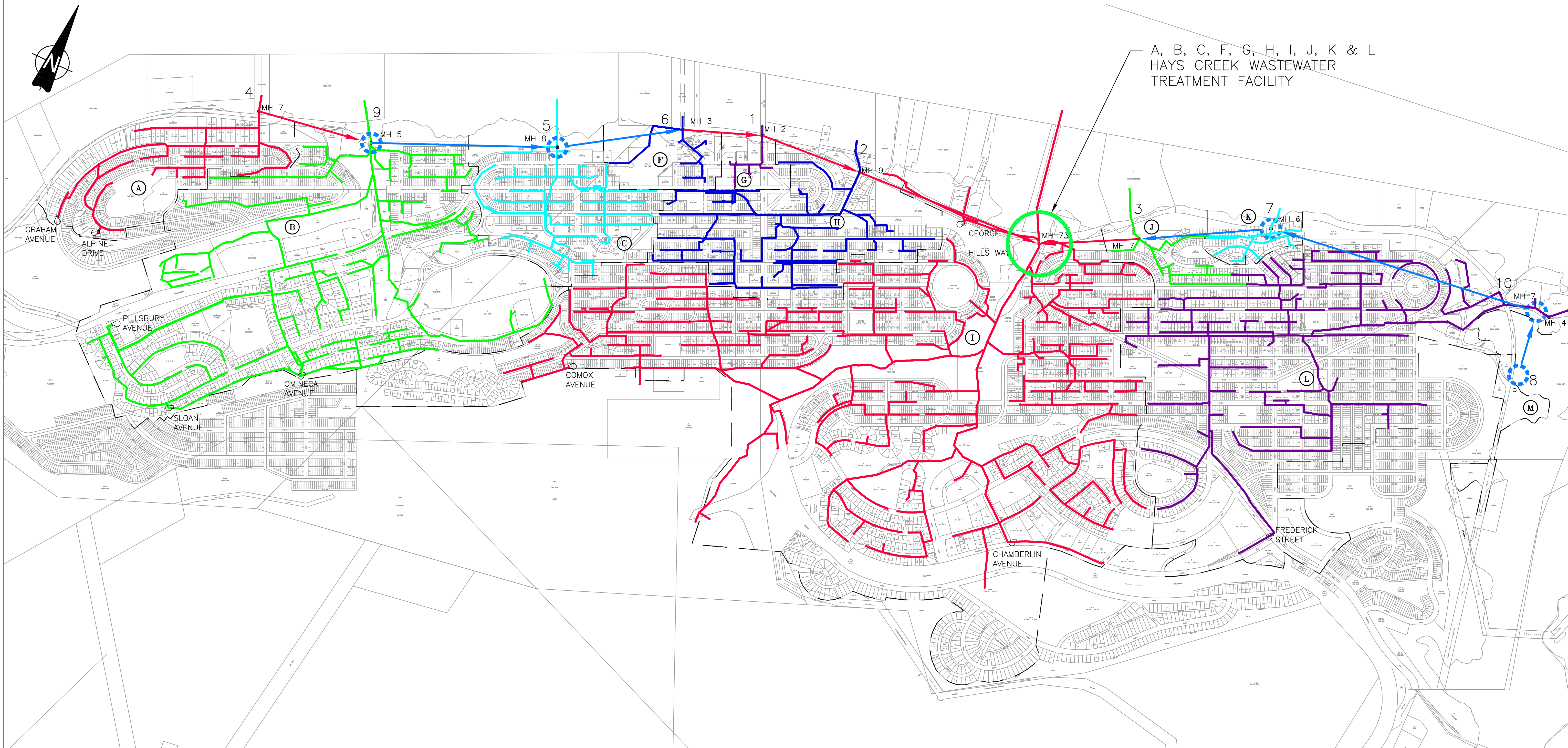
3.1 Option 1A - Single Wastewater Treatment Facility – Hays Creek

Option 1A, having a central treatment facility in the Hays Creek area will require flows from the various catchment areas to be consolidated. Consolidation of the collection system could occur by constructing a major sewer interceptor system, which will consist of gravity sewers and pump stations with force mains along the City's waterfront that would direct the wastewater from all ten existing catchment areas to the centralized treatment facility.

Conveyance requirements for this option are provided in **Table 3-1** and shown in **Figure 3-1**. Detailed calculations are provided in **Appendix A**. Conveyance using gravity alone would not be possible due to the topography of the City's entire wastewater treatment area. Pump stations would also be required.

Table 3-1
Conveyance for Option 1A – Hays Creek Wastewater Treatment Facility

From	To	Conveyance Method
Catchment A (MH7)	Catchment B (MH5)	Gravity
Catchment B (and A) (MH5)	Catchment C (MH8)	Pump and force main
Catchment C (and A and B) (MH8)	Catchment F (MH3)	Pump and force main



LEGEND

POTENTIAL PUMP STATION

FORCE MAIN

GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 1A CONVEYANCE
AND DISPOSAL OPTIONS

FIGURE 3-1

N.T.S.

Associated Engineering

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From	To	Conveyance Method
Catchment F (and A, B and C) (MH3)	Catchment G (MH2)	Gravity
Catchment G (and A, B, C and F) (MH2)	Catchment H (MH9)	Gravity
Catchment H (and A, B, C, F, and G) (MH9)	Catchment **I** (MH73)	Gravity
Catchment L (MH7)	Catchment K (MH6)	Pump and force main
Catchment K (and L) (MH6)	Catchment J (MH7)	Pump and force main
Catchment J (and K and L) (MH7)	Catchment **I** (MH73)	Gravity

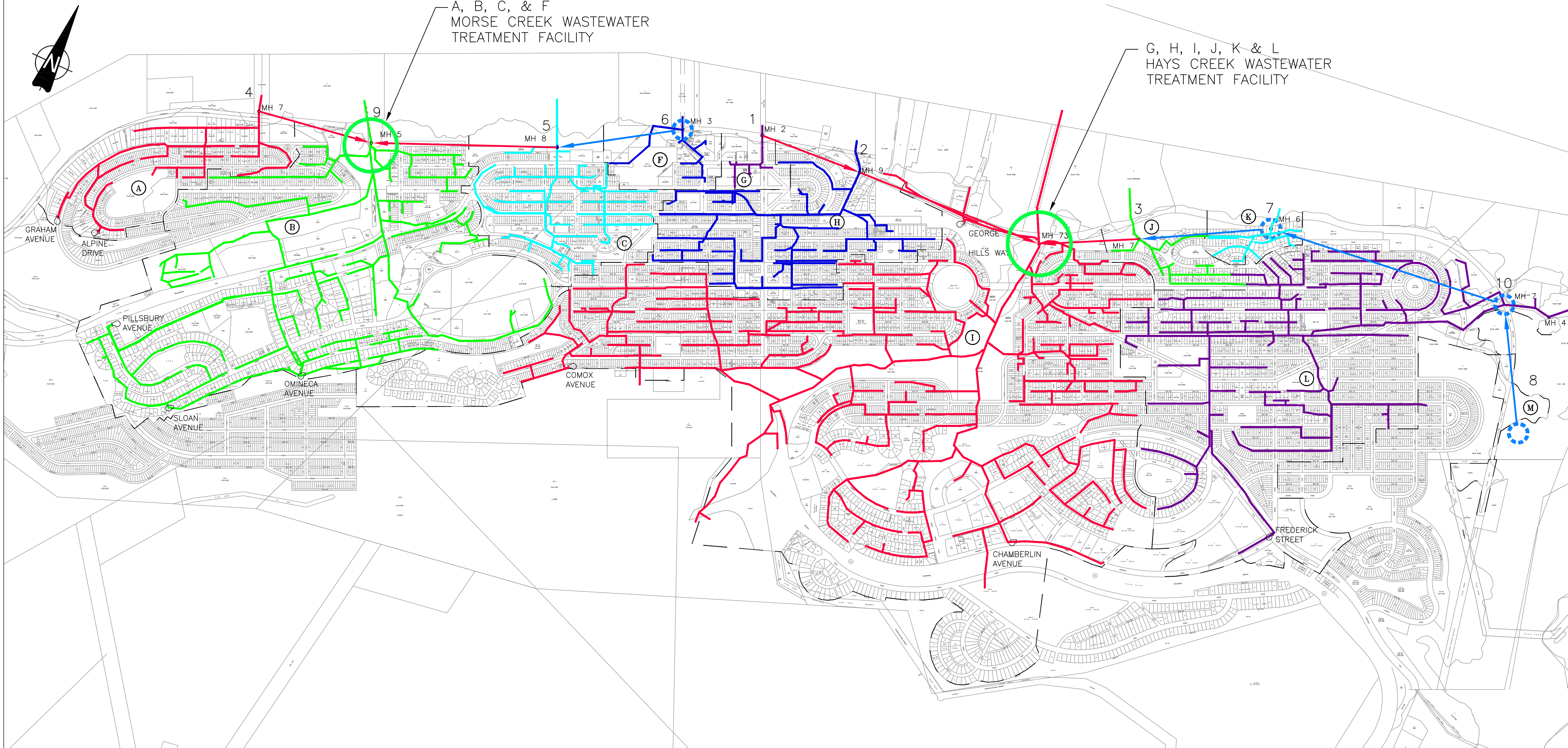
3.2 Option 2A - Two Wastewater Treatment Facilities – Hays Creek and Morse Creek

Decentralized treatment using two wastewater treatment facilities would split the flows from the various gravity sewers and pump stations and force mains so that wastewater is directed to one of two wastewater treatment facilities. Both treatment facilities would be located near the harbour front, in the vicinity of either Hays Creek or Morse Creek. Decentralized wastewater treatment at Hays Creek and Morse Creek would require conveying wastewater from Areas A, B, C, and F to a Morse Creek Wastewater Treatment Facility and conveying wastewater from Areas G, H, **I**, J, K, and L to a Hays Creek Wastewater Treatment Facility.

Conveyance requirements for the Hays Creek Wastewater Treatment Facility and the Morse Creek Wastewater Treatment Facility are provided in **Table 3-2** and **3-3** respectively, and shown in **Figure 3-2**. Detailed background calculations are provided in **Appendix A**.

Table 3-2
Conveyance for Option 2A – Hays Creek Wastewater Treatment Facility

From	To	Conveyance Method
Catchment G (MH2)	Catchment H (MH9)	Gravity
Catchment H (and G) (MH9)	Catchment **I** (MH73)	Gravity
Catchment L (MH7)	Catchment K (MH6)	Pump and force main
Catchment K (and L) (MH6)	Catchment J (MH7)	Pump and force main
Catchment J (and K and L) (MH7)	Catchment **I** (MH73)	Gravity



LEGEND

- POTENTIAL PUMP STATION
- FORCE MAIN
- GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 2A CONVEYANCE AND DISPOSAL OPTIONS

FIGURE 3-2

N.T.S.

Associated Engineering

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Table 3-3
Conveyance for Option 2A – Morse Creek Wastewater Treatment Facility

From	To	Conveyance Method
Catchment A (MH7)	Catchment B (MH5)	Gravity
Catchment F (MH3)	Catchment C (MH8)	Pump and force main
Catchment C (and F) (MH8)	Catchment B (MH5)	Gravity

3.3 Option 3 - Three Wastewater Treatment Facilities - Hays Creek, Morse Creek and Ritchie Point

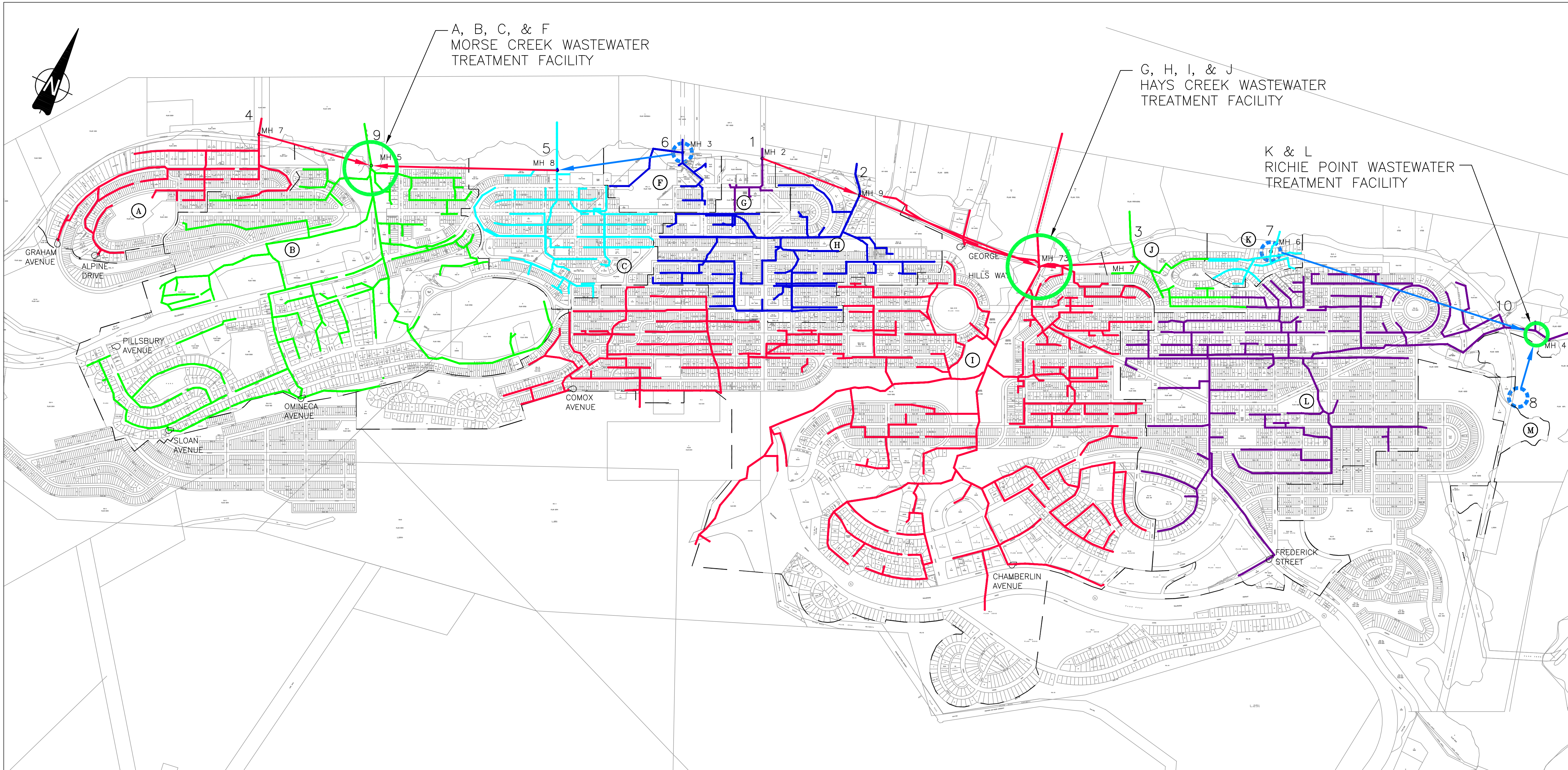
In this option, the flows from the various pump stations, gravity sewers, and force mains could potentially be directed to one of three wastewater treatment facilities at Morse Creek, Hays Creek, and Ritchie Point.

Wastewater from Areas A, B, C, and F would be conveyed to a Morse Creek Wastewater Treatment Facility. Wastewater from Areas G, H, I, and J would be conveyed to a Hays Creek Wastewater Treatment Facility. Wastewater from Areas K, and L would be conveyed to a Ritchie Point Wastewater Treatment Facility. Treated effluent would be discharged from the respective treatment facilities to the harbour through long, deep outfalls.

Conveyance requirements for the Hays Creek, Morse Creek, and Ritchie Point Wastewater Treatment Facilities are provided in **Tables 3-4**, **3-5**, and **3-6** respectively, and shown in **Figure 3-3**. Detailed calculations are provided in **Appendix A**.

Table 3-4
Conveyance for Option 3 – Hays Creek Wastewater Treatment Facility

From	To	Conveyance Method
Catchment G (MH2)	Catchment H (MH9)	Gravity
Catchment H (and G) (MH9)	Catchment I (MH73)	Gravity
Catchment J (MH7)	Catchment I (MH73)	Gravity



LEGEND

- POTENTIAL PUMP STATION
- FORCE MAIN
- GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
WASTEWATER FOR OPTION 3 CONVEYANCE
AND DISPOSAL OPTIONS

FIGURE 3-3

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Associated Engineering

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Table 3-5
Conveyance for Option 3 – Morse Creek Wastewater Treatment Facility

From	To	Conveyance Method
Catchment A (MH7)	Catchment B (MH5)	Gravity
Catchment F (MH3)	Catchment C (MH8)	Pump and force main
Catchment C (and F) (MH8)	Catchment B (MH5)	Gravity

Table 3-6
Conveyance for Option 3 – Ritchie Point Wastewater Treatment Facility

From	To	Conveyance Method
Catchment K (MH6)	Catchment L (MH7)	Pump and force main

4 Proposed Wastewater Treatment Facility Disposal Options

Disposal options for the three wastewater treatment facility options were investigated. A capacity analysis of Outfalls B, I, and L was conducted to determine if the existing outfalls have sufficient capacity to discharge the estimated potential Year 2050 design flows - both treated wastewater effluent and bypassed wet weather flows. The outfall capacity analysis referenced the following:

- Existing outfall details, sewer system map, and contour map
- Fisheries and Oceans Canada Higher High Water Level for the City of Prince Rupert
- Estimated Year 2050 wastewater treatment and wet weather design flows

For conceptual level planning purposes the following assumptions were made:

- Only four times the ADWF from each catchment (A, B, C, F, G, H, I, J, K, and L) would be conveyed to a wastewater treatment facility.
- Option 1A - Hays Creek would treat flows from catchments A, B, C, F, G, H, I, J, K, and L and discharged via Outfall I.
- Option 2A – Hays Creek would treat flows from catchments G, H, I, J, K, and L and discharge via Outfall I and Morse Creek would treat flows from catchments A, B, C, and F and discharge via Outfall B.
- Option 3 – Hays Creek would treat flows from G, H, I and J, and discharge via Outfall I, Morse Creek would treat flows from A, B, C, and F and discharge via Outfall B, and Ritchie Point would treat flows from K and L and discharge via Outfall L.
- Outfalls B, I, and L would continue to also discharge the bypassed, untreated, wet weather flows from catchments B, I, and L.

- Existing outfall diameter and lengths were used. The details for existing Outfalls B, I, and L are provided in **Table 4-1**.
- Considering the age of the outfalls, a Hazen-Williams C factor of 100 was used as a conservative measure of the pipe friction losses.
- The water level of the treatment facility was assumed to be 7 m based on an average of the inverts into downstream manholes of catchments B, I, and L.
- With 1:200 year flood elevation data unavailable, the wastewater treatment facility will be sited 1 m above the Higher High Water Level. Based on Fisheries and Oceans Canada Map of Tuck Inlet, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.
- The static head is 3.3 m, assuming the water level of the treatment facility is 7 and the Higher High Water Level of Prince Rupert Harbour is 3.7.

Table 4-1
Existing Outfall Details

Outfall	Diameter (mm)	Length (m)	Depth of Discharge Below Lower Low Water Level (m)
B	450	71	6
I	750	316	64
L	450	103	8

4.1 Option 1A - Hays Creek (Outfall I)

Option 1A, having a central treatment facility in the Hays Creek area will require flows from all the catchment areas to be consolidated. The proposed method of disposal would be using Outfall I.

Based on the assumptions stated above, Outfall I has sufficient capacity to discharge the required Year 2050 design flow (treated). Approximately another 1.3 m of static head is required to overcome the dynamic losses (minor and friction) if the wet weather flow component is also to be discharged via Outfall I. This can be achieved by increasing the water level at the treatment facility by another 1.3 m via pumping, thus increasing the available static head. Alternatively, the wet weather flow component can be diverted to the combined sewer overflow weir in Catchment I.

An outfall capacity summary for Outfall I is provided in **Table 4-2**. Detailed calculations are provided in **Appendix B**.

Table 4-2
Outfall Capacity for Option 1A – Hays Creek via Outfall I

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.49	-0.25
4 x ADWF and wet weather component	0.75	-1.28

4.2 Option 2A - Two Wastewater Treatment Facilities – Hays Creek (Outfall I) and Morse Creek (Outfall B)

Option 2A involves having two wastewater treatment facilities, one at Hays Creek and one at Morse Creek. The proposed method of disposal from the Hays Creek Wastewater Treatment Facility would be using Outfall I. The proposed method of disposal from the Morse Creek Facility would be using Outfall B.

Based on the assumptions stated above, Outfall I and Outfall B have sufficient capacity to discharge the required Year 2050 design flow (treated only). If the wet weather flow component is also to be included, approximately another 1 m of head would be required for each outfall. For Outfall I, the wet weather flow component can be diverted to the existing combined sewer overflow. For Outfall B, because it is a short outfall discharging effluent to shallow water, a new larger diameter and longer outfall is recommended. Outfall capacity summaries for Outfall I and B are provided in **Tables 4-3** and **4-4**, respectively. Detailed calculations for both outfalls are provided in **Appendix B**.

Table 4-3
Outfall Capacity for Option 2A – Hays Creek via Outfall I

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.35	0.15
4 x ADWF and wet weather component	0.61	-0.67

Table 4-4
Outfall Capacity for Option 2A – Morse Creek via Outfall B

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.15	1.06
4 x ADWF and wet weather component	0.43	-0.83

4.3 Option 3 - Three Wastewater Treatment Facilities - Hays Creek (Outfall I, Morse Creek (Outfall B), and Ritchie Point (Outfall L)

Option 3 consists of having three decentralized wastewater treatment facilities in the general locations of Hays Creek, Morse Creek, and Ritchie Point. The outfalls corresponding to these treatment facilities are Outfalls I, B, and L, respectively.

Based on the assumptions stated above, Outfall I has sufficient capacity to discharge the required Year 2050 design flow (treated and mostly all of the wet weather). If required, the wet weather flow component can be diverted and discharged via the existing combined sewer overflow.

Based on the assumptions stated above, Outfall B has sufficient capacity to discharge the Year 2050 design flow (treated only). However, because Outfall B is a short outfall, discharging effluent to shallow water, a new larger diameter and longer Outfall B is recommended.

Based on the assumptions stated above, Outfall L has sufficient capacity to discharge the required Year 2050 design flow (treated and wet weather). To promote better mixing of the discharged effluent and wet weather flows, Outfall L would have to be realigned to discharge out to Prince Rupert Harbour and not into the confines of Seal Cove, as it currently does.

Outfall capacity summaries for Outfall I, B, and L are provided in **Tables 4-5**, **4-6**, and **4-7**, respectively. Detailed calculations for both outfalls are provided in **Appendix B**.

Table 4-5
Outfall Capacity for Option 3 – Hays Creek via Outfall I

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.25	0.36
4 x ADWF and wet weather component	0.51	-0.32

Table 4-6
Outfall Capacity for Option 3 – Morse Creek via Outfall B

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.15	1.06
4 x ADWF and wet weather component	0.43	-0.83

Table 4-7
Outfall Capacity for Option 3 – Ritchie Point via Outfall L

Description of Flow	Flow (m^3/s)	Total Dynamic Head (m)
4 x ADWF	0.10	0.96
4 x ADWF and wet weather component	0.26	0.01

5 Comparison of Wastewater Conveyance and Disposal Requirements for the Wastewater Treatment Facility Options

The advantages and disadvantages of the potential wastewater conveyance and disposal requirements for each of the wastewater treatment facility options are provided in Table 5-1.

Table 5-1
Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
1A – Hays Creek	• Gravity flow can be used to consolidate flows from five catchment areas. • 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Outfall I has sufficient capacity to discharge Year 2050 treated flows.	• Requires four pump stations. • Located in the City core area. • Land may be difficult and expensive to acquire.

Option	Advantages	Disadvantages
2A – Hays Creek and Morse Creek	• Gravity flow can be used to consolidate flows from five catchments. • Number of pump stations required is less than Option 1A. • 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Sufficient capacity in Outfall I for discharging Year 2050 treated flows.	• Requires three pump stations. • Land may be difficult and expensive to acquire. • Larger diameter, longer, Outfall B is recommended.
3 – Hays Creek, Ritchie Point, and Morse Creek	• Gravity flow can be used to consolidate flows from five catchments. • Number of pump stations required is less than Options 1A and 2A. • 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area). • Treatment facilities are located in areas with largest wastewater flows. • Sufficient capacity in Outfalls I and L.	• Requires two pump stations. • Located in the City core area. • Land may be difficult and expensive to acquire. • Larger diameter, longer, Outfall B is recommended. • Outfall L requires a new alignment to discharge to Prince Rupert Harbour. Realignment will also require pumping.

6 Summary and Conclusions

This Discussion Paper has explored potential conveyance and discharge options for the three wastewater treatment facility options being reviewed by the City and the LWMP Advisory Committee.

Option 1A involves having a single wastewater treatment facility at Hays Creek. Conveyance requirements for this option include four pump stations to convey flows from four catchment areas, with the remaining five catchments using gravity flow. Conveyance for Option 1A, conveying all the City's wastewater to one central treatment facility at Hays Creek, requires the maximum number of pump stations of all three wastewater treatment options. As the number of pump stations increase, so does the cost of acquiring suitable land to site the stations and the capital and operational costs of the station itself. Outfall I has sufficient capacity to discharge Year 2050 treated flows. If Outfall

I is also to handle the wet weather flow component, an additional 1 m of static head is required. This can be achieved by pumping. Alternatively, the wet weather flow component can be diverted and discharged via the overflow weir in Catchment I.

Option 2A involves having two wastewater treatment facilities, one at Hays Creek one at Morse Creek. Conveyance requirements for this option include three pump stations - two pump stations to convey flows to the Hays Creek Wastewater Treatment Facility and one pump station to convey flows to the Morse Creek Wastewater Treatment Facility. The remaining catchments would use gravity flow. Due to one less pump station required, Option 2A, treatment facilities at Hays Creek and Morse Creek, would have lower conveyance costs than Options 1A. Based on the assumptions stated in Section 4, Outfall I would have the necessary capacity to meet the Year 2050 design flow requirements (treated flow only). Similar to Option 1A, the wet weather flow component can be diverted and discharged via the overflow weir in Catchment I. For Outfall B, a longer and larger diameter outfall is recommended. For conceptual level planning purposes, cost estimates provided in Discussion Paper 2-7 will assume a new Outfall B is designed and installed.

Option 3 involves having three separate wastewater treatment facilities, one each at Hays Creek, Morse Creek, and Ritchie Point. Conveyance requirements for this option include two pump stations - one pump station to convey flows to the Morse Creek Wastewater Treatment Facility and one pump station to convey flows to the Ritchie Point Wastewater Treatment Facility. The remaining catchments would use gravity flow. Even though Option 3, treatment facilities at Hays Creek, Morse Creek and Ritchie Point, requires one less pump station than Option 2A and two less than Option 1A, it is not as favourable. The small fraction of wastewater generated by the Ritchie Point area may be more cost effectively conveyed and treated at the Hays Creek Wastewater Treatment Facility, than build and operate a separate treatment facility at Ritchie Point. Initial evaluation of Outfall I indicates that it has sufficient capacity to handle the Year 2050 Design Flows (treated and wet weather). Outfalls B and L are short outfalls, discharging effluent to shallow water. Therefore, new larger diameter and longer Outfalls B and L are recommended.

7 References

1. Associated Engineering. 2009. City of Prince Rupert Liquid Waste Management Plan – Stage 2, Discussion Paper 2-1: Waste Volumes and Facility Sizing Criteria.

2. Associated Engineering. 2009. City of Prince Rupert Liquid Waste Management Plan – Stage 1, Discussion Paper 1-5: Wastewater Management Options.

3. Associated Engineering. 1977. City of Prince Rupert, Report on: Long Range Plan for Sewage Disposal.

4. Fisheries and Oceans Canada. Map of Tuck Inlet, British Columbia. 1999.

5. Master Municipal Construction Document Association. Municipal Infrastructure Design Guideline Manual. January 2005.

6. Sanks, Robert. Pumping Station Design. 2nd Edition. 1998.

Appendix A - Gravity Sewers, Pump Stations, and Force Mains Calculations

Appendix B - Wastewater Flow Rate Calculations
Subject: Projected Flows for Design Years 2030 and 2050
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: March 8, 2010

Target Population **18,500** *(est. to be reached in year 2030 based on 1.5% growth)*
Multiplier **0.96**

Projected Values for Target Population of 18,500

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s)		
			Sanitary	Base Infiltration[2]	Total
A	combined	673	2.7	1.2	3.9
B	sanitary	3,238	9.4	0.1	9.5
C	combined	2,107	8.5	3.7	12.2
F	sanitary	241	1.0	0.3	1.2
G	combined	246	1.0	2.9	3.8
H	combined	1,490	6.0	2.6	8.6
I	sanitary	7,142	29.0	3.5	32.5
J	combined	220	0.9	0.1	1.0
K	combined	163	0.7	0.1	0.8
L	sanitary	2,981	12.0	5.3	17.3
	TOTAL	**18,500**	**71**	**20**	**91**
		Secondary Treatment (2 x ADWF)			***182***
		Primary Treatment (4 x ADWF)			***363***

Target Population **25,000** *(est. to be reached in year 2050 based on 1.5% growth)*
Multiplier **1.29**

Projected Values for Target Population of 25,000

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s)		
			Sanitary	Base Infiltration[2]	Total
A	combined	910	3.6	1.6	5.2
B	sanitary	4,376	12.7	0.1	12.8
C	combined	2,848	11.5	4.9	16.4
F	sanitary	326	1.3	0.4	1.7
G	combined	332	1.3	3.9	5.2
H	combined	2,013	8.1	3.5	11.6
I	sanitary	9,651	39.1	4.8	43.9
J	combined	297	1.2	0.1	1.3
K	combined	220	0.9	0.1	1.0
L	sanitary	4,028	16.3	7.1	23.4
	TOTAL	**25,000**	**96**	**27**	**123**
		Secondary Treatment (2 x ADWF)			***245***
		Primary Treatment (4 x ADWF)			***490***

Note 1: Peaking factors shown were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each of the sewer areas by the total ADWF for each catchment. For calculations, please see Table 7-1 March 03 Report worksheet in same Excel file.

Note 2: The base infiltration rates for Catchments A, C and H have been modified from those presented in Table 7-1 of the March 03 Report. New base infiltration rates are based on a total flow of 500 L/cap/day, using sanitary flows of 350 L/cap/day.

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-5

Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**

Design Notes: The "flows" worksheet is a copy of calculations from:
P:\20062891\02_PURP_LWMPP_S2\Engineering\03.00_Conceptual_Feasibility_Design\Task 210_Waste_Vol_Facility_Sizing_Criteria
The "flows" calculations are used to determine the wastewater flow (ADWF) to 1, 2 or 3 treatment plants. The wastewater flows to each potential wastewater treatment plant are based on the total ADWF values calculated for each outfall (A, B, C, F, G, H, I, J, K, and L) for Design Years 2030 and 2050. The flow to each treatment facility will depend on whether one, two, or three treatment facilities are built. The values below, calculate the treatment facility flow requirements for each option for secondary treatment (2 X ADWF) and primary treatment (4 X ADWF).

Design Year 2030											
Option	***Average Dry Weather Flow per WWTP***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek	91	**7,843**								
2A	Hays Creek	64	**5,528**	&	Morse Creek	27	**2,315**				
3	Hays Creek	46	**3,967**	&	Morse Creek	27	**2,315**	&	Ritchie Pt.	18	**1,561**
Design Year 2050											
Option	***Average Dry Weather Flow per WWTP***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek	123	**10,599**								
2A	Hays Creek	86	**7,465**	&	Morse Creek	36	**3,134**				
3	Hays Creek	62	**5,356**	&	Morse Creek	36	**3,134**	&	Ritchie Pt.	24	**2,110**

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-5 - Wastewater Conveyance and Disposal Methods
Gravity Sewer Assessment

Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**

Notes:

Enter Data into Yellow Cells only

Design Parameter:	Value:		Source:
Max. cover depth	4.5	m	MMCDA 2004 Design Guideline Manual
Min. cover depth	1	m	MMCDA 2004 Design Guideline Manual
Max. design velocity (gravity sewer)	6	m/s	MMCDA 2004 Design Guideline Manual
Min. design velocity (gravity sewer)	0.75	m/s	MMCDA 2004 Design Guideline Manual
Roughness Coefficient, n	0.013		MMCDA 2004 Design Guideline Manual

R^ 0.667
S^ 0.5

*The calculations on this worksheet are an initial conveyance evaluation to determine if gravity sewers are feasible. For some locations, gravity sewers were not feasible because a) the depth to the pipe invert being too great, b) some or all of the pipe route having to go uphill, even though the start and end elevation of the gravity sewer pipe are within reasonable depth, and/or c) right-of-way issues. Such circumstances are indicated. For these pipe routes, pumping is

Wastewater Treatment Facility Options		LOCATION From	To	Length (m)	ADWF (L/s)	ADWF (m3/d)	ADWF (m3/s)	4 X ADWF m3/s	Minimum Slope	PIPE DATA Diameter mm	A m2	R m	n	slope m/m	Qf m3/s	Vf m/s	q(max)/Qf	Length m	DROP slope	other	Total
OPTION 3 - 3 treatment facilities (Morse Creek, Hays Creek, Ritchie Pt.)	Morse Creek	Catchment A (MH7)	Catchment B (MH5)	620	5.2	451	0.0052	0.0209	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.901	620	3.1	0.055	3.155
		Catchment F (MH3)	Catchment C (MH8)	650	1.7	145	0.0017	0.0067	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.290	650	3.25	0.055	3.305
		Catchment C(&F) (MH8)	Catchment B (MH5)	800	18.1	1,562	0.0181	0.0723	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	3.121	800	4	0.055	4.055
	Hays Creek	Catchment G (MH2)	Catchment H (MH9)	430	5.2	447	0.0052	0.0207	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.892	430	2.15	0.055	2.205
		Catchment H(&G) (MH9)	Catchment I (MH73)	850	16.8	1,452	0.0168	0.0672	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	2.902	850	4.25	0.055	4.305
		Catchment J (MH7)	Catchment I (MH73)	450	1.3	112	0.0013	0.0052	0.0050	200	0.031	0.050	0.013	0.0352	0.0615	1.957	0.084	450	15.85	0.055	15.904
	Ritchie Pt.	Catchment K (MH6)	Catchment L (MH7)	1300	1.0	89	0.0010	0.0041	0.0050	200	0.031	0.050	0.013	0.0208	0.0473	1.505	0.087	1300	27.08	0.055	27.138
OPTION 2A - 2 treatment facilities (Morse Creek & Hays Creek)	Morse Creek	Catchment A (MH7)	Catchment B (MH5)	620	5.2	451	0.0052	0.0209	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.901	620	3.1	0.055	3.155
		Catchment F (MH3)	Catchment C (MH8)	650	1.7	145	0.0017	0.0067	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.290	650	3.25	0.055	3.305
		Catchment C(&F) (MH8)	Catchment B (MH5)	800	18.1	1,562	0.0181	0.0723	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	3.121	800	4	0.055	4.055
	Hays Creek	Catchment G (MH2)	Catchment H (MH9)	430	5.2	447	0.0052	0.0207	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.892	430	2.15	0.055	2.205
		Catchment H(&G) (MH9)	Catchment I (MH73)	850	16.8	1,452	0.0168	0.0672	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	2.902	850	4.25	0.055	4.305
		Catchment L (MH7)	Catchment K (MH6)	1300	23.4	2,020	0.0234	0.0935	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	4.037	1300	6.5	0.055	6.555
		Catchment K(&L) (MH6)	Catchment J (MH7)	560	24.4	2,110	0.0244	0.0977	0.0050	200	0.031	0.050	0.013	0.0218	0.0484	1.540	2.019	560	12.21	0.055	12.264
		Catchment J(&K&L) (MH7)	Catchment I (MH73)	450	25.7	2,221	0.0257	0.1028	0.0050	200	0.031	0.050	0.013	0.0352	0.0615	1.957	1.672	450	15.85	0.055	15.904
OPTION 1A - 1 treatment facility (Hays Creek)	Hays Creek	Catchment A (MH7)	Catchment B (MH5)	620	5.2	451	0.0052	0.0209	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	0.901	620	3.1	0.055	3.155
		Catchment B(&A) (MH5)	Catchment C (MH8)	800	18.0	1,556	0.0180	0.0720	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	3.109	800	4	0.055	4.055
		Catchment C(&A&B) (MH8)	Catchment F (MH3)	650	34.4	2,973	0.0344	0.1376	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	5.940	650	3.25	0.055	3.305
		Catchment F(&A&B&C) (MH3)	Catchment G (MH2)	330	36.1	3,118	0.0361	0.1443	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	6.230	330	1.65	0.055	1.705
		Catchment G(&A&B&C&F) (MH2)	Catchment H (MH9)	430	41.3	3,564	0.0413	0.1650	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	7.122	430	2.15	0.055	2.205
		Catchment H (&A&B&C&F&G) (MH9)	Catchment I (MH73)	850	52.9	4,570	0.0529	0.2116	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	9.132	850	4.25	0.055	4.305
		Catchment L (MH7)	Catchment K (MH6)	1300	23.4	2,020	0.0234	0.0935	0.0050	200	0.031	0.050	0.013	0.0050	0.0232	0.737	4.037	1300	6.5	0.055	6.555
		Catchment K(&L) (MH6)	Catchment J (MH7)	560	24.4	2,110	0.0244	0.0977	0.0050	200	0.031	0.050	0.013	0.0218	0.0484	1.540	2.019	560	12.21	0.055	12.264
		Catchment J (&K&L) (MH7)	Catchment I (MH73)	450	25.7	2,221	0.0257	0.1028	0.0050	200	0.031	0.050	0.013	0.0352	0.0615	1.957	1.672	450	15.85	0.055	15.904

Option	LOCATION From	ELEVATIONS Upstream ground	invert	Depth	Dc	Ground Slope	Downstream ground	invert	Depth	Dc	Ave Depth	SUMMARY From	To	dia mm	length m	Ave Depth m	Conveyance Method*	Reason
OPTION 3	Catchment A (MH7)	10.789	9.59	1.20	1.00	0.0008	10.298	6.43	3.86	3.66	2.53	Catchment A (MH7)	Catchment B (MH5)	200	620	2.53	gravity	
	Catchment F (MH3)	9.558	8.36	1.20	1.00	-0.0017	10.649	5.05	5.60	5.40	3.40	Catchment F (MH3)	Catchment C (MH8)	200	650	3.40	pump	contours
	Catchment C(&F) (MH8)	10.649	9.45	1.20	1.00	0.0004	10.298	5.39	4.90	4.70	3.05	Catchment C(&F) (MH8)	Catchment B (MH5)	200	800	3.05	gravity	
	Catchment G (MH2)	10.649	9.45	1.20	1.00	0.0017	9.936	7.24	2.69	2.49	1.95	Catchment G (MH2)	Catchment H (MH9)	200	430	1.95	gravity	
	Catchment H(&G) (MH9)	9.936	8.74	1.20	1.00	0.0016	8.595	4.43	4.16	3.96	2.68	Catchment H(&G) (MH9)	Catchment I (MH73)	200	850	2.68	gravity	
	Catchment J (MH7)	24.444	23.24	1.20	1.00	0.0352	8.595	7.34	1.26	1.06	1.23	Catchment J (MH7)	Catchment I (MH73)	200	450	1.23	gravity	
	Catchment K (MH6)	36.653	35.45	1.20	1.00	0.0208	9.570	8.32	1.26	1.06	1.23	Catchment K (MH6)	Catchment L (MH7)	200	1300	1.23	pump	contours and ROW
OPTION 2A	Catchment A (MH7)	10.789	9.59	1.20	1.00	0.0008	10.298	6.43	3.86	3.66	2.53	Catchment A (MH7)	Catchment B (MH5)	200	620	2.53	gravity	
	Catchment F (MH3)	9.558	8.36	1.20	1.00	-0.0017	10.649	5.05	5.60	5.40	3.40	Catchment F (MH3)	Catchment C (MH8)	200	650	3.40	pump	contours and ROW
	Catchment C(&F) (MH8)	10.649	9.45	1.20	1.00	0.0004	10.298	5.39	4.90	4.70	3.05	Catchment C(&F) (MH8)	Catchment B (MH5)	200	800	3.05	gravity	
	Catchment G (MH2)	10.649	9.45	1.20	1.00	0.0017	9.936	7.24	2.69	2.49	1.95	Catchment G (MH2)	Catchment H (MH9)	200	430	1.95	gravity	
	Catchment H(&G) (MH9)	9.936	8.74	1.20	1.00	0.0016	8.595	4.43	4.16	3.96	2.68	Catchment H(&G) (MH9)	Catchment I (MH73)	200	850	2.68	gravity	
	Catchment L (MH7)	9.570	8.37	1.20	1.00	-0.0208	36.653	1.82	34.84	34.64	18.02	Catchment L (MH7)	Catchment K (MH6)	200	1300	18.02	pump	deep excavation
	Catchment K(&L) (MH6)	36.653	35.45	1.20	1.00	0.0218	24.444	23.19	1.26	1.06	1.23	Catchment K(&L) (MH6)	Catchment J (MH7)	200	560	1.23	pump	contours and ROW
	Catchment J(&K&L) (MH7)	24.444	23.24	1.20	1.00	0.0352	8.595	7.34	1.26	1.06	1.23	Catchment J(&K&L) (MH7)	Catchment I (MH73)	200	450	1.23	gravity	
OPTION 1A	Catchment A (MH7)	10.789	9.59	1.20	1.00	0.0008	10.298	6.43	3.86	3.66	2.53	Catchment A (MH7)	Catchment B (MH5)	200	620	2.53	gravity	
	Catchment B(&A) (MH5)	10.298	9.10	1.20	1.00	-0.0004	10.649	5.04	5.61	5.41	3.40	Catchment B(&A) (MH5)	Catchment C (MH8)	200	800	3.40	pump	contours and ROW
	Catchment C(&A&B) (MH8)	10.649	9.45	1.20	1.00	0.0017	9.558	6.14	3.41	3.21	2.31	Catchment C(&A&B) (MH8)	Catchment F (MH3)	200	650	2.31	pump	contours and ROW
	Catchment F(&A&B&C) (MH3)	9.558	8.36	1.20	1.00	-0.0033	10.649	6.65	4.00	3.80	2.60	Catchment F(&A&B&C) (MH3)	Catchment G (MH2)	200	330	2.60	gravity	
	Catchment G(&A&B&C&F) (MH2)	10.649	9.45	1.20	1.00	0.0017	9.936	7.24	2.69	2.49	1.95	Catchment G(&A&B&C&F) (MH2)	Catchment H (MH9)	200	430	1.95	gravity	
	Catchment H (&A&B&C&F&G) (MH9)	9.936	8.74	1.20	1.00	0.0016	8.595	4.43	4.16	3.96	2.68	Catchment H (&A&B&C&F&G) (MH9	Catchment I (MH73)	200	850	2.68	gravity	
	Catchment L (MH7)	9.570	8.37	1.20	1.00	-0.0208	36.653	1.82	34.84	34.64	18.02	Catchment L (MH7)	Catchment K (MH6)	200	1300	18.02	pump	deep excavation
	Catchment K(&L) (MH6)	36.653	35.45	1.20	1.00	0.0218	24.444	23.19	1.26	1.06	1.23	Catchment K(&L) (MH6)	Catchment J (MH7)	200	560	1.23	pump	contours and ROW
	Catchment J (&K&L) (MH7)	24.444	23.24	1.20	1.00	0.0352	8.595	7.34	1.26	1.06	1.23	Catchment J (&K&L) (MH7)	Catchment I (MH73)	200	450	1.23	gravity	

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-5 - Wastewater Conveyance and Disposal Methods
Pump and Force Main Assessment

Prepared by: Manjit Herar **Date of Last Revision: 8-Mar-10**
Reviewed by: **Date:**

Notes:

Enter Data into Yellow Cells only

Design Parameter:	Value:		Source:
Min. cover depth	1	m	MMCDA 2004 Design Guideline Manual
Min. design velocity in Force Main for raw sewage	0.6	m/s	Pump Station Design, Editor: Sanks, 1998
Max. design velocity in Force Main for raw sewage	2.4	m/s	Pump Station Design, Editor: Sanks, 1999

Wastewater Treatment Facility Options		LOCATION From	To	Length (m)	Yr. 2050 ADWF (L/s)	ADWF (m3/d)	ADWF (m3/s)	4 X ADWF m3/s	Diameter mm	A m2	C	Velocity m/s	ELEVATIONS Upstream ground	Downstream ground	Conveyance Method
OPTION 3 - 3 treatment facilities (Morse Creek, Hays Creek, Ritchie Pt.)	Morse Creek	Catchment F (MH3)	Catchment C (MH8)	650	1.7	145	0.0017	0.0067	100	0.008	120	0.855	9.558	10.649	pump
	Ritchie Pt.	Catchment K (MH6)	Catchment L (MH7)	1300	1.0	89	0.0010	0.0041	100	0.008	120	0.526	36.653	9.570	pump
OPTION 2A - 2 treatment facilities (Morse Creek & Hays Creek)	Morse Creek	Catchment F (MH3)	Catchment C (MH8)	650	1.7	145	0.0017	0.0067	100	0.008	120	0.855	9.558	10.649	pump
	Hays Creek	Catchment L (MH7)	Catchment K (MH6)	1300	23.4	2,020	0.0234	0.0935	250	0.049	120	1.906	9.570	36.653	pump
		Catchment K(&L) (MH6)	Catchment J (MH7)	560	24.4	2,110	0.0244	0.0977	250	0.049	120	1.990	36.653	24.444	pump
OPTION 1A - 1 treatment facility (Hays Creek)	Hays Creek	Catchment B(&A) (MH5)	Catchment C (MH8)	800	18.0	1,556	0.0180	0.0720	250	0.049	120	1.467	10.298	10.649	pump
		Catchment C(&A&B) (MH8)	Catchment F (MH3)	650	34.4	2,973	0.0344	0.1376	300	0.071	120	1.947	10.649	9.558	pump
		Catchment L (MH7)	Catchment K (MH6)	1300	23.4	2,020	0.0234	0.0935	250	0.049	120	1.906	9.570	36.653	pump
		Catchment K(&L) (MH6)	Catchment J (MH7)	560	24.4	2,110	0.0244	0.0977	250	0.049	120	1.990	36.653	24.444	pump

Appendix B - Outfall Capacity Calculations

Discussion Paper 2-5
Subject: Projected Flows for Design Years 2030 and 2050
City of Prince Rupert Stage 2 Liquid Waste Management Plan
Prepared by: Manjit Herar
Date of last revision: March 8, 2010

Target Population **18,500** *(est. to be reached in year 2030 based on 1.5% growth)*
Multiplier **0.96**

Projected Values for Target Population of 18,500

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s) Sanitary	Base Infiltration[2]	Total	Peaking Factor[1]	Max Day Flow (L/s)
A	combined	673	2.7	1.2	3.9	109.4	424.0
B	sanitary	3,238	9.4	0.1	9.5	26.3	248.6
C	combined	2,107	8.5	3.7	12.2	21.8	266.6
F	sanitary	241	1.0	0.3	1.2	123.1	153.0
G	combined	246	1.0	2.9	3.8	42.5	162.5
H	combined	1,490	6.0	2.6	8.6	137.9	1,189.2
I	sanitary	7,142	29.0	3.5	32.5	10.0	325.1
J	combined	220	0.9	0.1	1.0	150.0	143.4
K	combined	163	0.7	0.1	0.8	125.0	95.6
L	sanitary	2,981	12.0	5.3	17.3	11.0	191.2
	TOTAL	**18,500**	**71**	**20**	**91**		**3,199**
		Secondary Treatment (2 x ADWF)			***182 L/s***		
		Primary Treatment (4 x ADWF)			***363 L/s***		

Target Population **25,000** *(est. to be reached in year 2050 based on 1.5% growth)*
Multiplier **1.29**

Projected Values for Target Population of 25,000

Outfall	System Type	Projected Population	Average Dry Weather Flow (L/s) Sanitary	Base Infiltration[2]	Total	Peaking Factor[1]	Max Day Flow (L/s)
A	combined	910	3.6	1.6	5.2	109.4	570.7
B	sanitary	4,376	12.7	0.1	12.8	26.3	335.9
C	combined	2,848	11.5	4.9	16.4	21.8	358.1
F	sanitary	326	1.3	0.4	1.7	123.1	206.7
G	combined	332	1.3	3.9	5.2	42.5	219.6
H	combined	2,013	8.1	3.5	11.6	137.9	1,605.2
I	sanitary	9,651	39.1	4.8	43.9	10.0	439.3
J	combined	297	1.2	0.1	1.3	150.0	193.8
K	combined	220	0.9	0.1	1.0	125.0	129.2
L	sanitary	4,028	16.3	7.1	23.4	11.0	258.4
	TOTAL	**25,000**	**96**	**27**	**123**		**4,317**
		Secondary Treatment (2 x ADWF)			***245 L/s***		
		Primary Treatment (4 x ADWF)			***490 L/s***		

Note 1: Peaking factors shown were calculated by dividing the predicted 5-Year return period rainfall peak flow event for each of the sewer areas by the total ADWF for each catchment. For calculations, please see Table 7-1 March 03 Report worksheet in same Excel file.

Note 2: The base infiltration rates for Catchments A, C and H have been modified from those presented in Table 7-1 of the March 03 Report. New base infiltration rates are based on a total flow of 500 L/cap/day, using sanitary flows of 350 L/cap/day.

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation - Treatment Facility Flows
Project: 20062891
Prepared by: Manjit Herar **Date** **8-Mar-10**
Reviewed by:

Design Notes: The Design Year 2050 Average Dry Weather Flow per Wastewater Treatment Facility originates from:
P:\20062891\02_PURP_LWMPP_S2\Engineering\03.00_Conceptual_Feasibility_Design\Task 210_Waste_Vol_Facility_Sizing_Criteria

The "flows" calculations are used to determine the wastewater flow (ADWF) to 1, 2 or 3 treatment plants. The wastewater flows to each potential wastewater treatment plant are based on the total ADWF values calculated for each outfall (A, B, C, F, G, H, I, J, K, and L) for Design Years 2050. The flow to each treatment facility will depend on whether one, two, or three treatment facilities are built. The values below, calculate the treatment facility flow requirements for each option for secondary treatment (2 X ADWF) and primary treatment (4 X ADWF).

The wet weather flows for Design Year 2050 are provided below. The wet weather flows are based on peaking factors calculated by dividing the predicted 5-Year return period rainfall peak flow event for each of the sewer areas by the total ADWF for each catchment (calculations are provided in Discussion Paper 2-1) . These flows are in addition to the flows that would be treated at the treatment facility.

The existing capacity of Outfalls B, I, and L is evaluated using Year 2050 Design Flows, both treated and wet weather, that may be discharged. As a check of ultimate outfall capacity, Year 2050 Design Flows were used instead of Year 2030.

Design Year 2050

Option	***Average Dry Weather Flow per Wastewater Treatment Facility***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek	123	**10,599**								
2A	Hays Creek	86	**7,465**	&	Morse Creek	36	**3,134**				
3	Hays Creek	62	**5,356**	&	Morse Creek	36	**3,134**	&	Ritchie Pt.	24	**2,110**

Design Year 2050

Option	***Wet Weather Flow to Outfall (flow that was diverted away from treatment facility, but still has to be discharged via the outfall)***										
		L/s	m^3/day			L/s	m^3/day			L/s	m^3/day
1A	Hays Creek Outfall I	264	**22,772**								
2A	Hays Creek Outfall I	264	**22,772**	&	Morse Creek - Outfall B	285	**24,603**				
3	Hays Creek Outfall I	264	**22,772**	&	Morse Creek - Outfall B	285	**24,603**	&	Ritchie Pt. - Outfall L	165	**14,244**

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation - Loss Coefficient
Project: 20062891

Prepared by: Manjit Herar	**Date**	**24-Feb-10**	
Reviewed by:	**Date**		

Minor Losses	***Quantity***	K_L	***Total***
Entrance	1.00	0.25	0.25
Exit	1.00	1.00	1
say 45 deg. Bend	2.00	0.20	0.4
Total			1.65

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revision: 8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Hays Creek Facility - Outfall I

Minor Losses	sum K =	1.65
Diameter outfall (m) =		0.75
Length of outfall (m) =		316.00
C =		100
Effluent discharge depth (m) =		61
Effluent density @ 20 deg. C (kg/m3)) =		998
Ocean water density @ 10 deg. C (kg/m3)) =		1026

Assumed water level at treatment facility (m) =	7
Higher high water level (m) =	3.7
Static Head (m) =	**3.30**

Year 2050	Flow (L/s)	Flow (m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffusser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	122.68	0.12	0.28	0.006	0.06	1.71	1.0	2.77	0.53
2xADWF	245.35	0.25	0.56	0.026	0.20	1.71	1.0	2.94	0.36
3xADWF	368.03	0.37	0.83	0.058	0.43	1.71	1.0	3.20	0.10
4xADWF	490.71	0.49	1.11	0.104	0.74	1.71	1.0	3.55	-0.25
4xADWF & wet weather	754.27	0.75	1.71	0.245	1.63	1.71	1.0	4.58	-1.28

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Hays Creek Facility - Outfall I

Minor Losses	sum K =	1.65
Diameter outfall (m) =		0.75
Length of outfall (m) =		316.00
C =		100
Effluent discharge depth (m) =		61
Effluent density @ 20 deg. C (kg/m3)) =		998
Ocean water density @ 10 deg. C (kg/m3)) =		1026

Assumed water level at treatment facility (m) =	7
Higher high water level (m) =	3.7
Static Head (m) =	**3.30**

Year 2050	Flow (L/s)	(m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffusser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	86.41	0.09	0.20	0.003	0.03	1.71	1.0	2.74	0.56
2xADWF	172.81	0.17	0.39	0.013	0.11	1.71	1.0	2.83	0.47
3xADWF	259.22	0.26	0.59	0.029	0.23	1.71	1.0	2.96	0.34
4xADWF	345.62	0.35	0.78	0.051	0.38	1.71	1.0	3.15	0.15
4xADWF & wet weather	609.19	0.61	1.38	0.160	1.10	1.71	1.0	3.97	-0.67

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revision 8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Morse Creek Facility - Outfall B

Minor Losses	sum K =	1.65
Diameter outfall (m) =		0.45
Length of outfall (m) =		71.00
C =		100
Effluent discharge depth (m) =		34
Effluent density @ 20 deg. C (kg/m3)) =		998
Ocean water density @ 10 deg. C (kg/m3)) =		1026

Assumed water level at treatment facility (m) =	7
Higher high water level (m) =	3.7
Static Head (m) =	**3.30**

Year 2050	Flow (L/s)	(m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffusser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	36.27	0.04	0.23	0.004	0.02	0.96	1.0	1.98	1.32
2xADWF	72.54	0.07	0.46	0.017	0.06	0.96	1.0	2.03	1.27
3xADWF	108.81	0.11	0.68	0.039	0.12	0.96	1.0	2.12	1.18
4xADWF	145.08	0.15	0.91	0.070	0.21	0.96	1.0	2.24	1.06
4xADWF & wet weather	429.84	0.43	2.70	0.614	1.55	0.96	1.0	4.13	-0.83

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Hays Creek Facility - Outfall I

Minor Losses	sum K =	1.65
Diameter outfall (m) =		0.75
Length of outfall (m) =		316.00
C =		100
Effluent discharge depth (m) =		61
Effluent density @ 20 deg. C (kg/m3)) =		998
Ocean water density @ 10 deg. C (kg/m3)) =		1026

Assumed water level at treatment facility (m) =	7
Higher high water level (m) =	3.7
Static Head (m) =	**3.30**

Year 2050	Flow (L/s)	Flow (m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffuser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	61.99	0.06	0.14	0.002	0.02	1.71	1.0	2.73	0.57
2xADWF	123.98	0.12	0.28	0.007	0.06	1.71	1.0	2.77	0.53
3xADWF	185.96	0.19	0.42	0.015	0.12	1.71	1.0	2.85	0.45
4xADWF	247.95	0.25	0.56	0.026	0.21	1.71	1.0	2.94	0.36
4xADWF & wet weather	511.52	0.51	1.16	0.113	0.79	1.71	1.0	3.62	-0.32

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revision** **8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Morse Creek Facility - Outfall B

Minor Losses sum K =	1.65
Diameter outfall (m) =	0.45
Length of outfall (m) =	71.00
C =	100
Effluent discharge depth (m) =	34
Effluent density @ 20 deg. C (kg/m3)) =	998
Ocean water density @ 10 deg. C (kg/m3)) =	1026

Assumed water level at treatment facility (m) =	7
Higher high water level (m) =	3.7
Static Head (m) =	**3.30**

Year 2050	Flow (L/s)	Flow (m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffusser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	36.27	0.04	0.23	0.004	0.02	0.96	1.0	1.98	1.32
2xADWF	72.54	0.07	0.46	0.017	0.06	0.96	1.0	2.03	1.27
3xADWF	108.81	0.11	0.68	0.039	0.12	0.96	1.0	2.12	1.18
4xADWF	145.08	0.15	0.91	0.070	0.21	0.96	1.0	2.24	1.06
4xADWF & wet weather	429.84	0.43	2.70	0.614	1.55	0.96	1.0	4.13	-0.83

City of Prince Rupert - Stage 2 LWMP - Discussion Paper 2-5
Outfall Evaluation
Project: 20062891
Prepared by: Manjit Herar **Date of Last Revisior 8-Mar-10**
Reviewed by: **Date**

Due to the City of Prince Rupert not having 1:200 year flood elevation data, the City's Wastewater Treatment Facility will be sited 1 m above the Higher High Water Level for conceptual level planning purposes. Based on Fisheries and Oceans Canada Map of Tuck Inlet, published by the Canadian Hydrographic Service in 1999, the Higher High Water Level in Prince Rupert is 7.5 m (not reduced to chart datum (Lowest Normal Tide)), which at Prince Rupert is 3.8 m below Mean Water Level. Therefore, the Higher High Water Level in Prince Rupert is 7.5 m - 3.8 m = 3.7 m. The wastewater treatment facility will be sited at a minimum of 1 m above this elevation to avoid flood damage from a 1:200 year storm event. Actual siting of the wastewater treatment facility needs to take treatment facility hydraulics into consideration, as well as effects from storm surge or possible tsunami impacts.

Ritchie Point Facility - Outfall L

Minor Losses sum K =	1.65	Assumed water level at treatment facility (m) =	7
		Higher high water level (m) =	3.7
Diameter outfall (m) =	0.45		
Length of outfall (m) =	103.00	**Static Head (m) =**	**3.30**
C =	100		
Effluent discharge depth (m) =	41		
Effluent density @ 20 deg. C (kg/m3)) =	998		
Ocean water density @ 10 deg. C (kg/m3)) =	1026		

Year 2050	Flow (L/s)	Flow (m3/s)	Velocity (m/s)	Minor Loss (m)	Friction Loss (m)	Density Head Loss (m)	Diffusser Loss (m)	Sum of Dynamic Losses (m)	TDH (m)
1xADWF	24.42	0.02	0.15	0.002	0.01	1.16	1.0	2.17	1.13
2xADWF	48.84	0.05	0.31	0.008	0.04	1.16	1.0	2.21	1.09
3xADWF	73.26	0.07	0.46	0.018	0.09	1.16	1.0	2.26	1.04
4xADWF	97.67	0.10	0.61	0.032	0.15	1.16	1.0	2.34	0.96
4xADWF & wet weather	262.53	0.26	1.65	0.229	0.91	1.16	1.0	3.29	0.01

F Appendix F - DP2-6 - Sustainability and Resource Recovery Considerations

DISCUSSION PAPER

City of Prince Rupert
Liquid Waste Management Plan - Stage 2

Discussion Paper 2-6 – Sustainability and Resource Recovery Considerations

Prepared by: Arash Masbough, M.A.Sc., PMP, P.Eng.
Issued: March 3, 2010
Previous Issue: None

1 Objective

This Discussion Paper, DP 2-6, provides an overview of possibilities for integrated resource recovery and added value sustainability options within the wastewater collection, treatment and disposal system. It also deals with wastewater related solids collection and disposal processes for the City of Prince Rupert (the City). The following are discussed in this DP:

- An overview of the flow management strategies that aim to reduce the pumping energy in conveying wastewater throughout the City.
- An overview of the technology that can potentially be applied to recover the pressure energy in flowing wastewater / effluent within the City.
- An overview of technology that can be potentially used to recover heat from wastewater and effluent within the City.
- An overview of technology and applications in the context of organic residuals energy and resource management.

Because of abundant supply, relatively inexpensive municipal water, and the low rate of non-potable water consumption in both domestic and industrial areas, water reclamation and reuse has been ruled out in the Stage 1 LWMP. If, in the future, water reclamation proves to be beneficial, related infrastructure can be added to the treatment facility(ies).

2 Flow Energy Management and Energy Recovery

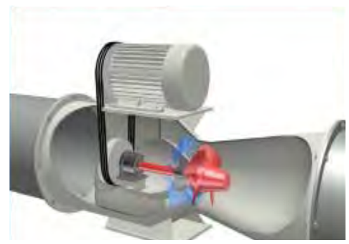
2.1 Wastewater Flow Management

Flow energy management focuses on conveying wastewater in a manner that practically minimizes external energy inputs (i.e. pumping) required in its transport. Some design strategies are fairly obvious in this context, for example, siting wastewater treatment facilities at lower elevations in order to reduce the volume of wastewater that needs to be pumped or lifted up to the treatment site. Other strategies are more subtle, but can contribute notably to decreasing pumping and thus energy reduction. One such example is to maintain high water levels in pump and lift station wet-wells during dry-weather, low wastewater flow periods. This operational strategy utilizes the excess capacity of the upstream sewers and wet-wells during such conditions, in turn minimizing the height that wastewater is lifted and the energy needed by the pumps. Further strategies are less direct and policy centred – implementing low-flow plumbing devices that ultimately contribute to reduced wastewater volumes and flow rates that, in turn, reduce energy associated with wastewater conveyance.

The City has considerable wastewater collection infrastructure already in the ground. However, considering the need for conveying wastewater to the proposed treatment facility locations, there are several significant opportunities for the City to optimize flow energy management as it develops new facilities and infrastructure. These opportunities will be considered in siting the new wastewater treatment / resource recovery facilities, both in the near-term and in the future. Other opportunities related to operations and policy can also be pursued.

2.2 Pressure Energy Recovery Technology

Pressure energy recovery in hydraulic systems involves using a turbine or other mechanical device to capture the energy contained in water flow. A variety of technologies currently exist. Their suitability depends on the application. None of the technologies are currently being marketed specifically for municipal wastewater (either raw or treated effluent). However, in micro hydro power production, they provide reliable results. Some examples of different technologies and brief explanations for each technology are listed below:



Internal construction of an in-line turbine.
Source: New Energy Foundation, Japan

In-Pipe Turbines: In-pipe turbines are a relatively new technology that is intended for installation in piping systems. The turbine runner is provided inside the pipe and the generator is installed on the outside. The runner is connected to the generator by a drive belt housed in a dry space in the turbine mounting.

A typical small-scale PAT installation.
Source: Associated Engineering

Pumps as Turbines: Pumps as turbines (PATs) are a recognized technology for providing inexpensive pressure energy recovery. In a PAT the pump is operated in reverse to drive a generator. Pumps are less expensive than turbines and are readily available. The efficiency of a PAT is generally less than a turbine but this is often a minor consideration when considering energy recovery. The other consideration is that the flow rate must be relatively constant for pumps versus turbines.

2.3 Raw Wastewater versus Effluent Application

Pressure energy recovery from piped wastewater is an attractive option provided there are sufficiently high flow rates and/or differences in elevation to sustain a turbine. However, applications involving raw wastewater must address such issues as the need for self-cleaning screens, and maintenance and service of the turbines in light of the solids and other constituents present in untreated wastewater.

The application where pressure energy recovery is more promising is for effluent, especially at outfalls to the harbour if there is some significant drop in elevation between the treatment facility and receiving water body. Given its characteristics, effluent does not present the same issues as were discussed with raw wastewater.

Flow energy recovery from wastewater should be further considered in the context of the overall implications of the City's LWMP. At this stage, flow energy recovery remains as a possible potential which needs to be considered further at the preliminary design stage. Energy recovery options will not affect the key decisions within the Stage 2 LWMP.

3 Heat Recovery

3.1 Heat Recovery Technology

Heat recovery from wastewater can be achieved using raw wastewater and effluent. The heat available in raw wastewater and effluent is described as "low-grade" heat. The low-grade heat extracted from wastewater can potentially be used for space heating and water heating through the application of heat pump technology. Heat pump technology uses a reverse refrigeration cycle to increase low temperatures up to useable heating levels.

Heat recovery from raw wastewater and effluent occurs via heat exchangers. Heat exchangers are devices designed to transfer heat between two liquids without crossover. Heat transfer occurs between two fluids of different starting temperatures, such as the wastewater and the refrigerant. Heat exchanger technologies that are typically used include pumped heat exchangers, in-tank heat exchangers, and in-pipe or in-trench heat exchangers. The following summarizes the relative heat transfer rates for in-tank heat exchangers and in-pipe and in-trench heat exchangers, based on a comparison with typical pumped tubular heat exchangers.

Pumped Heat Exchangers: Common pumped heat exchangers that may be used for wastewater heat recovery applications are the shell and tube heat exchanger and the plate and frame heat exchanger.

A plate and frame heat exchanger consists of a series of thin metal plates fastened into a rigid frame. The use of multiple thin plates results in a large surface area and facilitates more efficient to heat transfer between two fluids. Heat transfer coefficients for plate and frame heat exchangers are relatively high compared to tubular heat exchangers. An example of a plate and frame heat exchanger installed in a potable water treatment facility, which uses lake water for heating and cooling, is presented in **Figure 3-1**

Figure 3-1
Example of Pumped Plate and Frame Heat Exchanger Installed in a Water Treatment Facility that Uses Lake Water for Heating and Cooling
(Source: Associated Engineering)

A shell and tube heat exchanger consists of a shell or pressure vessel with bundles of tubes inside. Example of heat pumps equipped with shell and tube heat exchangers for raw wastewater heat recovery applications is presented in **Figure 3-2**.

Figure 3-2
Installation of Heat Pump (18.4 MW) Equipped With Shell and Tube Heat Exchangers for Heat Recovery from Raw Wastewater
(Source: Friotherm)

Pumped heat exchangers may be used for raw wastewater or effluent. However, for use of pumped heat exchangers with raw wastewater, the likelihood of fouling of the heat exchanger is more significant compared to effluent. Fouling of the heat exchanger will reduce the effectiveness of heat transfer between the two liquids. In order to minimize fouling and clogging of pumped heat exchangers when using raw wastewater, the wastewater must be screened or settled prior to use.

In-Tank Heat Exchangers: In-tank heat exchangers are typically used for in-pond and in-lake heat recovery applications. Such heat exchangers can be put into a tank of raw wastewater (e.g. sequencing batch reactors) or effluent for heat recovery applications.

Heat exchanger technology suitable for this application is plate heat exchangers typically used for lake and pond geo-exchange applications. This technology could potentially be applied for both raw wastewater and effluent. An example of submersible plate heat exchangers is presented in Figure 3-3.

Figure 3-3
Example of Plate Heat Exchangers Typically Used for Lake and Pond Geo-exchange Application
(Source: AWEB Supply)

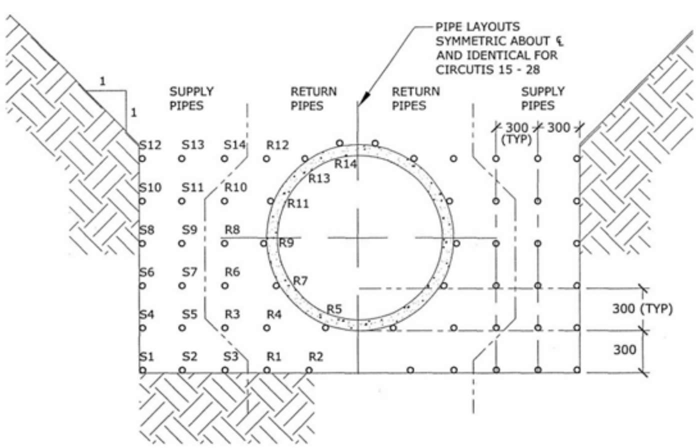
In-Pipe or In-Trench Heat Exchangers: In-pipe or in-trench heat recoveries are two alternate approaches that may be used for heat recovery from raw wastewater or effluent. In-pipe heat recovery involves the use of heat exchangers installed directly within the sewer pipe, whereas in-trench heat recovery involves the use of heat exchangers installed parallel to the exterior of the sewer pipe (Cobalt Engineering, 2005), i.e., directly in the trench of the sewer pipe.

In-pipe heat exchangers for raw wastewater are constructed of stainless steel plates that transfer heat to supply and return lines, which transport heat to a heat pump. An in-pipe heat exchanger in a concrete sewer pipe is presented in **Figure 3-4**.

Figure 3-4
Example of Concrete Pipe with a Built-in Pipe Heat Exchanger
(Source: BauLinks)

In-trench heat recovery technology involves the use of heat recovery pipes installed parallel to the sewer pipe within the trench itself. This approach uses the surrounding soil and groundwater to assist with heat transfer between the sewer pipe and the heat recovery pipes. Sewer pipes are typically constructed of concrete or PVC piping, while geo-exchange ground- and lake-loop systems use high-density polyethylene (HDPE) piping for heat exchangers. A schematic layout for in-trench heat recovery from sewer pipes is presented in **Figure 3-5**.

Figure 3-5
Example Layout of In-trench Sewer Heat Recovery Application
(Source: Cobalt Engineering)



3.2 Raw Wastewater versus Effluent Application

Heat recovery from raw wastewater is possible. However, it poses significantly more challenges than heat recovery from effluent. Since raw wastewater contains solids and other constituents in concentrations much higher than those for effluent, there are significant concerns for fouling and clogging of heat exchangers. Therefore, raw wastewater should undergo some form of pre-treatment, such as screening or settling, prior to use for heat recovery applications. There are currently examples of raw wastewater applications in Canada (Southeast False Creek, Vancouver Olympic and Paralympic Athlete's Village – Vancouver, British Columbia) and elsewhere (Basel – Switzerland, Wärmeversorgung Binningen AG; and Oslo, Norway – Skøyen Heat Pump Plant)

Heat recovery from effluent is advantageous in that the effluent quality is better (i.e. less solids) than for raw wastewater. As a result, potential fouling and clogging of heat exchangers, which are associated with the use of raw effluent for heat recovery, are reduced. However, a significant limitation of effluent applications is that wastewater treatment plants are not often located near the potential users of the heat. There are currently examples of effluent heat recovery applications in Canada (Whistler Olympic and Paralympic Athlete's Village – Whistler, British Columbia), and elsewhere (Göteborg, Sweden – Göteborg Rya AB Wastewater Treatment Plant and Rya Heat Pump Works, Göteborg Energi; and Stockholm, Sweden – Henriksdal Reningsverk and Hammerby Heat Pump Facility, Fortum Energi)

3.3 Other Considerations

Besides the thermodynamic limitations in the amount of heat that can practically be recovered from wastewater or effluent, some other issues must be considered. Low wastewater temperatures can impact collection system operations and treatment facility performance. As a result the amount of heat extracted from wastewater should be limited to maintain the optimum temperatures.

Since the City has a very high infiltration and inflow (I&I) rate, the source wastewater temperatures are expected to be lower than average. This can also limit the amount of heat extracted from the wastewater.

The other issue that requires consideration is effluent discharged to the aquatic receiving environment. Colder effluent is less buoyant which results in slower dilution and dispersion rate. Further, changes in ambient water temperatures may pose potential thermal impacts on aquatic life within the vicinity of the outfall. This is of less importance in marine discharges such as Prince Rupert Harbour since the effects of density variation are much higher than the temperature variation.

The total amount of heat energy that could potentially be recovered from wastewater/effluent generated within the City, in the context of the LWMP, is a function of the transfer efficiency of the heat exchanger technology, wastewater/effluent flow rates, initial temperature of the wastewater/effluent, minimum temperature requirements for the wastewater/effluent, and efficiency of the heat pumps. Feasibility of the heat recovery should be further considered in later stages of implementation (i.e. preliminary design). Heat recovery options will not affect the key decisions and outcomes of the Stage 2 LWMP.

4 Biosolids Energy Recovery and Re-use Technology

Wastewater treatment facilities create primary and secondary sludges. These sludges contain organics and, as such, contain potential energy that can be extracted, at least to some degree, through a variety of processes. These processes include aerobic and anaerobic digestion, composting, and thermal destruction of various kinds. Source-separated organics, such as those from fish processing centres, kitchen and restaurant waste solid waste diversion program, can also be treated in the same manner as wastewater sludges to create energy and/or a soil amendment. These processes can occur separately for both the wastewater sludges and the source-separated organics or they can be done together, i.e. wastewater treatment sludges and source-separated organics, commingled and treated together, depending on the situation.

4.1 Anaerobic Digestion and Biogas Use

Anaerobic digestion is a three-stage bacterial process that takes place in liquid slurry, in a closed vessel, in the absence of oxygen at temperatures of either 37°C or 55°C. Under theses conditions anaerobic digestion creates biogas. This biogas is typically in the range of 60% to 65% methane and 35% to 40% carbon dioxide with various amounts of hydrogen sulphide, siloxane (a silica-based compound), ammonia and other gases. Anaerobic digestion also results in a stabilized organic residue. If the digestion was at 55°C for long enough, the pathogen content of the biosolids will be greatly reduced. After some treatment, the biogas can be used in a number of ways, including cogeneration (cogen) to create heat and electricity and/or in case of large facilities, use as a fuel for vehicles.

Residuals from anaerobic digestion can be used as a soil amendment, based on the organic content of the biosolids. Depending on the pathogenic bacteria concentrations, this land application is either somewhat restricted (Class B) or unrestricted (Class A). They can also be dried to a certain level and be used as bio-fuel.

There are several examples of mid-sized treatment facilities that use anaerobic digestion and some form of energy recovery in western Canada. These facilities represent the current “low-end” in terms of size: the City of Red Deer, the City of Lethbridge, the Regional District of Nanaimo, BC, Greater Nanaimo Pollution Control Centre and the City of Chilliwack, BC. All of these facilities recover energy from mesophilically (~ 38°C) produced digester gas by using a portion of the gas to fuel boilers. The heat generated is used to heat the sludges undergoing anaerobic digestion, in addition to providing heat for treatment facility buildings.

In the subject of anaerobic digestion, it is important to consider the issue of practical scale. Historically, the decision to implement anaerobic solids digestion at wastewater treatment facilities, with some form of energy recovery, was made on a relatively simple economic basis. The costs were such that only larger treatment facilities had the economy-of-scale necessary to justify the investment of anaerobic digestion and energy recovery.

All of the above mentioned communities have populations in the order of 60,000 to 90,000 people. In the City's case with the current approximate population of 12,000, and final design (build-out) population of 25,000, the loading of solids may not be high enough to make the anaerobic digestion economical. There may be a potential to add the fish processing waste to the wastewater sludge. Depending on the amount of waste extracted from fish processing facilities, anaerobic digestion may prove to be a feasible option. This should be determined at the preliminary design stage for the preferred wastewater treatment approach.

4.2 Aerobic Digestion

Aerobic digestion is a bacterial process occurring in the presence of oxygen. Under aerobic conditions, bacteria rapidly consume organic matter and convert it into carbon dioxide. Once there is a lack of organic matter, bacteria die and are used as food by other bacteria. This stage of the process is known as *endogenous respiration*. Solids reduction occurs in this phase.

Because the aerobic digestion occurs much faster than anaerobic digestion, the capital costs of aerobic digestion are lower. However, the operating costs are characteristically much greater for aerobic digestion because of energy costs for aeration systems needed to provide oxygen for the process. Aerobic digestion, however, does not provide the biogas that can be collected and reused for energy production purposes. Aerobically digested sludge can be composted as described in the next section.

4.3 Composting

Composting is an aerobic process by which dewatered raw sludge or dewatered digested biosolids and/or source-separated solid waste organics are mixed with a woody amendment, such a wood chips, and then aerated for a period up to 21 days, achieving temperatures in the 55°C to 65°C range. This primary composting phase is followed by a lower temperature, actively aerobic, curing phase and then by a longer term (several weeks) less aerobic final curing phase. After screening out the wood chips that have not been broken down, the resulting compost is very much like a natural organic-rich top soil, both in sight and odour. Providing the temperatures were held high enough for long enough, e.g. at least three days at 55°C or higher, the resulting product will also have a very low pathogen content, in addition to being well stabilized to prevent vector (fly and rat) attraction.

Composting of raw wastewater sludges is practiced successfully in the Comox Valley Regional District and in the Vernon area for the City of Kelowna / City of Vernon using biological nutrient removal mixed raw primary and secondary sludges. Comox Valley markets their product for landscaping and gardening use as “Skyrocket”. Kelowna markets their product for similar markets as “Ogogrow™” **(Figure 4-1)**. In both cases, the demand is generally greater than the supply

It should be noted that source-separated organics can be composted in a similar manner.

Figure 4-1
Kelowna/Vernon Composting Facility
(Source: Engineered Compost Systems, 2007)

With any composting operation, odour generation is a concern. Facilities need to be enclosed with the foul air collected and treated. Also the facilities should be located far from any neighbours that could be impacted by the odours.

5 Summary

The City has significant opportunity to manage wastewater flow and its conveyance in a manner that minimizes energy consumption. Siting the distributed wastewater treatment / resource recovery facilities at low elevations and implementing operational and policy strategies can contribute to notably reduced energy requirements.

Although a relatively new technology application, the recovery of pressure energy from flowing wastewater / effluent can potentially be technically feasible within the City’s planned wastewater infrastructure. With currently available technology, and at existing household electricity consumption rates, the relative amount of recoverable pressure energy is minimal. However, as technology and associated recovery efficiency improves, and in combination with a decreasing trend in household electricity consumption, some gains in the relative significance of recovered energy may be achieved.

Technology currently exists to recover heat from both raw wastewater and treated effluent, with implemented examples found in Canada and elsewhere in the world. While there are more challenges in the operation and maintenance of raw wastewater heat recovery systems, relative to effluent applications, continued technology development will likely mitigate these challenges to some extent in the future. The potential heat energy available in wastewater/effluent should be considered as the City develops the LWMP.

Biosolids probably provide the most significant potential for resource recovery for the City. Biosolids can offer a resource for energy and/or soil amendments for the City. Depending on the treatment facility option, the following options will be available for the City to take advantage of the wastewater biosolids:

- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion at the largest site.
- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion off site (e.g. at the City's landfill).
- Composting the dewatered aerobically digested or raw biosolids and possible combining with other organic waste offsite at a location away from the City centre.

During preliminary design stage the feasibility of all the presented potentials for taking advantage of the resource recovery should be investigated. For the purpose of Stage 2 LWMP, and to provide conservative numbers for land requirements and capital cost estimates, we have assumed that aerobic digestion will be carried out at one of the treatment facilities. For cost estimate purposes, capital costs for a typical composting facility will be provided as well.

In considering all of the presented possible opportunities, the key is to evaluate the issue of practical scale. This should be considered at the preliminary design stage of the preferred treatment approach. Except for the biosolids treatment, other options presented in this DP will not be included in the cost estimate at this stage.

G Appendix G - DP2-7 - Cost Estimates

DISCUSSION PAPER

City of Prince Rupert
Stage 2 Liquid Waste Management Plan

Discussion Paper 2-7– Cost Estimates

Prepared by:	Manjit Herar, M.S., P.Eng., LEED® AP
Issued:	March 10, 2010
Previous Issue:	None

1 Introduction

The City of Prince Rupert (City) has developed several Discussion Papers as part of the Stage 2 Liquid Waste Management Plan (LWMP) work. Three different wastewater management options have been investigated, along with wastewater conveyance and disposal. This Discussion Paper will provide brief overviews of the treatment options being considered by the City, along with Class D, planning level, capital and operation and maintenance (O&M) cost estimates for these options

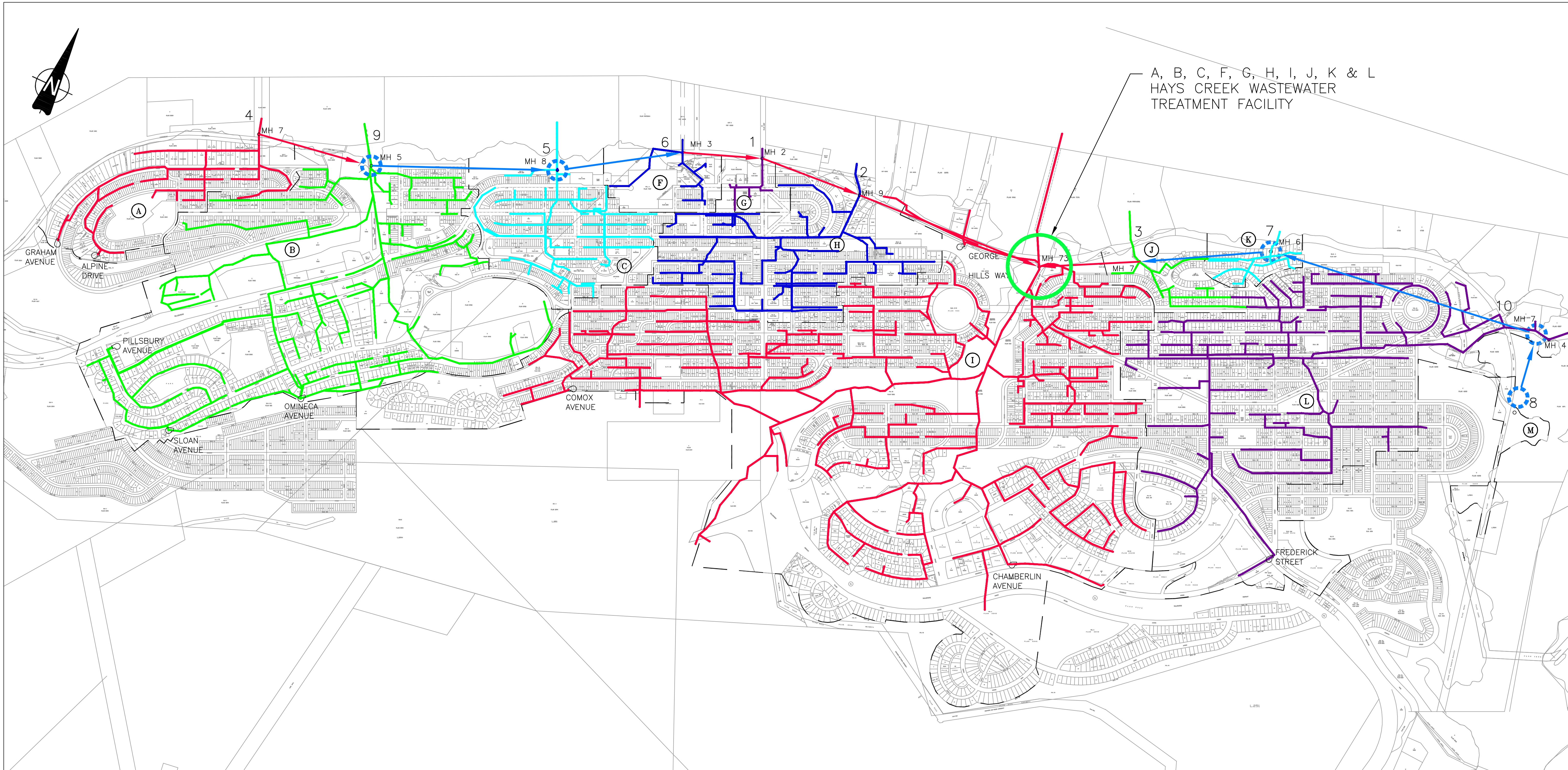
2 Option Descriptions

2.1 Option 1A - Single Wastewater Treatment Facility (Centralized Treatment) at Hays Creek

Option 1A (refer to Figure 2-1) involves having one central treatment facility in the Hays Creek area. The Hays Creek area alone makes up approximately 40 percent of the City's sewered area. Due to the extremely high wet weather peaking factors for the City, only four times the Average Dry Weather Flow (ADWF) from each catchment (A, B, C, F, G, H, I, J, K, and L) would be conveyed to the Hays Creek Wastewater Treatment Facility via newly installed gravity trunk sewers and pump stations and force mains along the City's waterfront. The wastewater in Catchment M is currently treated using on-site septic tank and disposal field technology. In the future, should the City decide to connect Catchment M residents to the City's sewer system, the wastewater would also be conveyed to the Hays Creek Wastewater Treatment Facility.

Two times the ADWF for Design Years 2030 (15,700 m^3/day) and 2050 (21,200 m^3/day) would undergo secondary treatment. Four times the ADWF for Design Years 2030 (31,400 m^3/day) and 2050 (42,400 m^3/day) would undergo primary treatment.

Diversion chambers with flow controls will need to be installed near the waterfront, upstream of the existing outfalls to divert only four times the ADWF to the treatment facility. As an interim wet weather flow strategy and considering extremely high peaking factors, the diversion chambers will direct the remaining flows, i.e. those greater than four times the ADWF to the existing outfalls which will act as CSOs.



LEGEND

POTENTIAL PUMP STATION

FORCE MAIN

GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
OPTION 1A

FIGURE 2-1

N.T.S.

Associated Engineering

P:\20062891\02_PLRP_LWMP_S2\Working_Dwgs\100_Civil\Figure 2-7.dwg
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Option 1A, will require flows from the various catchment areas to be consolidated by constructing a major sewer interceptor system, which will consist of gravity sewers and pump stations with force mains along the City's waterfront that would direct the wastewater from all ten existing catchment areas to the centralized treatment facility. Wastewater needs to be intercepted at manholes upstream of the existing outfalls and conveyed to the treatment facility by means of trunk sewers and pump stations. The gravity trunk sewers and force mains will be sized to convey four times the Year 2050 ADWFs.

This option will require four pump stations to convey flows to the wastewater treatment facility. The remaining catchments will use gravity flow. The pump stations will be sited and built strategically along the City's waterfront. The pump stations will be designed for four times the Year 2030 ADWF. The stations can be upgraded in the future to meet four times the Year 2050 ADWF. For cost estimate purposes, the pump station costs are for the Year 2050 design flows.

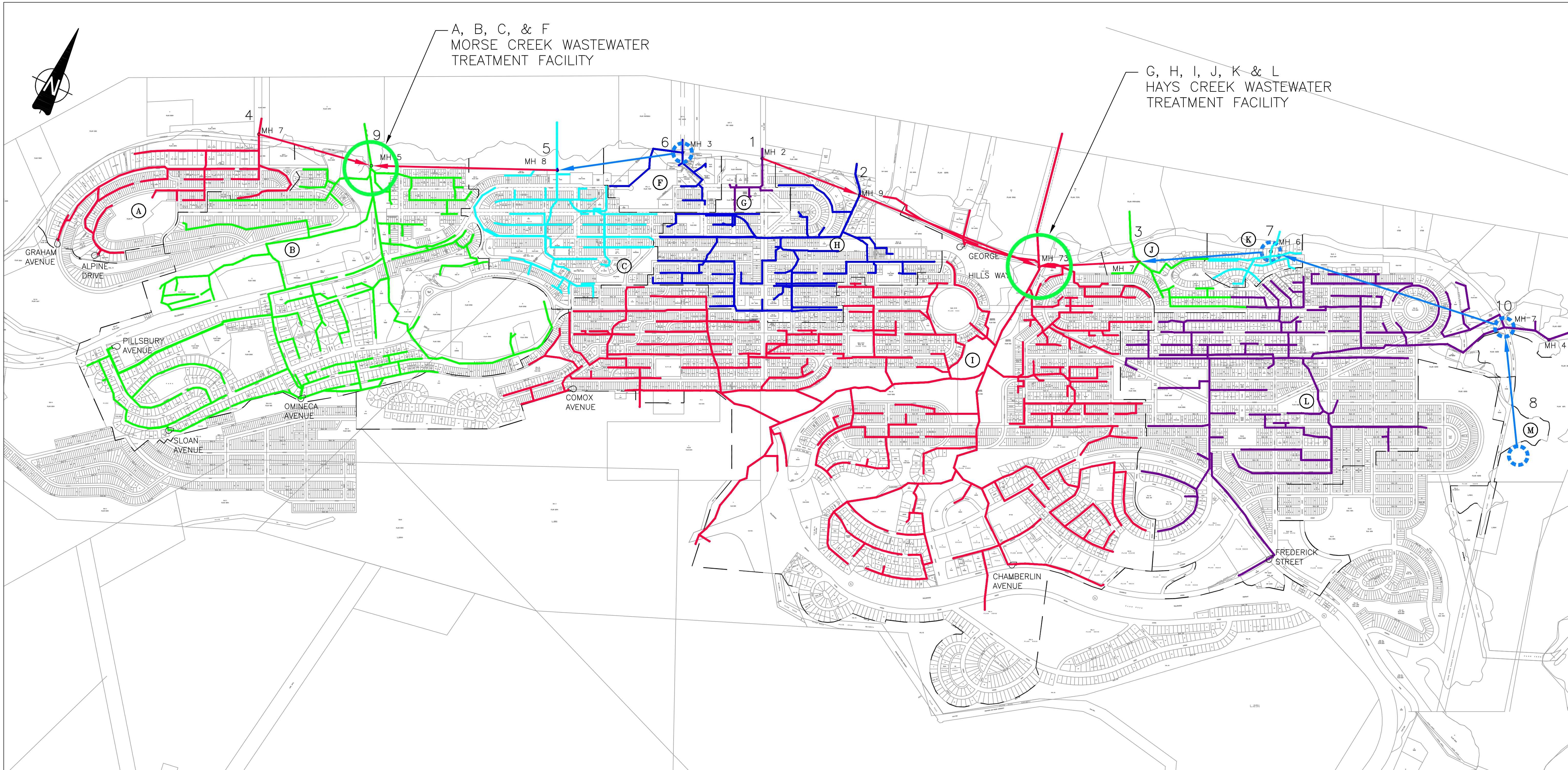
Currently, the City's wastewater is discharged to the ocean via a designated outfall from each of the ten catchments. The outfall corresponding to the Hays Creek Wastewater Treatment Facility is Outfall I. Outfall I would be a potential discharge point for the consolidated treated flows, and also the flows captured in Catchment I that are diverted away from the treatment facility because they are greater than four times the ADWF. The remaining outfalls would remain in service to handle the flows greater than four times the ADWF.

Initial evaluation of Outfall I suggests sufficient capacity to discharge the required Year 2050 design flow (4 times the treated ADWF). If the Year 2050 design flow (4 times the treated ADWF and the wet weather component) are to be discharged through this outfall, approximately another 1.5 m of static head is required to overcome the dynamic losses (minor and friction). This can be achieved by increasing the water level at the treatment facility by another 1.5 m via pumping, thus increasing the available static head. Alternatively, the wet weather flow portion can be diverted to the overflow weir in Catchment I.

2.2 Option 2 - Two Wastewater Treatment Facilities (Decentralized Treatment) at Hays Creek and Morse Creek

Option 2A (refer to Figure 2-2) consists of decentralized treatment using two wastewater treatment facilities located near the harbour front, in the vicinity of Hays Creek and Morse Creek. Up to four times the ADWF from areas A, B, C, and F would be treated at the Morse Creek Wastewater Treatment Facility. Up to four times the ADWF from areas G, H, I, J, K, L, and potentially M would be treated at the Hays Creek Wastewater Treatment Facility. These potential treatment facility locations have been selected because they correspond with the areas generating the largest sanitary flows.

Only four times the Average Dry Weather Flow (ADWF) will be conveyed to the treatment facility(ies) via newly installed gravity trunk sewers and pump stations and force mains along the City's waterfront.



CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
OPTION 2A

FIGURE 2-2

N.T.S.

Associated Engineering

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For the Hays Creek Wastewater Treatment Facility - two times the ADWF for Design Years 2030 (11,100 m^3/day) and 2050 (15,000 m^3/day) would undergo secondary treatment and four times the ADWF for Design Years 2030 (22,200 m^3/day) and 2050 (29,900 m^3/day) would undergo primary treatment. .

For the Morse Creek Wastewater Treatment Facility - two times the ADWF for Design Years 2030 (4,700 m^3/day) and 2050 (6,300 m^3/day) would undergo secondary treatment and four times the ADWF for Design Years 2030 (9,300 m^3/day) and 2050 (12,600 m^3/day) would undergo primary treatment.

Diversion chambers with flow controls will need to be installed near the waterfront, upstream of the existing outfalls to divert only four times the ADWF to the treatment facility. As an interim wet weather flow strategy and considering extremely high peaking factors, the diversion chambers will direct the remaining flows, i.e. those greater than four times the ADWF to the existing outfalls which will act as CSOs.

The gravity trunk sewers will be sized to convey four times the Year 2050 ADWF. In catchments where gravity conveyance is not feasible, pump stations will need to be sited and built strategically along the City's waterfront. The pump stations will be designed for four times the Year 2030 ADWF. The stations can be upgraded in the future to meet four times the Year 2050 ADWF. For cost estimation purposes, the pump station costs are for the Year 2050 design flows. The force mains have been sized to convey four times the Year 2050 ADWF.

Conveyance requirements for the Hays Creek Wastewater Treatment Facility include two pump stations and gravity conveyance from the remaining feeder catchments. Conveyance requirements for the Morse Creek Wastewater Treatment Facility include one pump station and gravity conveyance from the remaining feeder catchments.

The proposed methods of disposal from the Hays Creek the Morse Creek Wastewater Treatment Facilities would be using Outfalls I and B respectively. Both Outfalls I and B have sufficient capacity to discharge the required Year 2050 design flow (4 times the treated ADWF only). For both outfalls, if the wet weather portion is to be included, an additional 1 m of static head is required. This can be achieved by increasing the water level at the treatment facility by another 1 m via pumping, thus increasing the available static head. Alternatively, for Outfall I, the wet weather flow portion can be diverted to the overflow weir in Catchment I. The existing outfall in Catchment B is short and discharges into water that is too shallow to promote sufficient mixing. As such, cost estimates for Option 2A will include a new, longer Outfall B discharging into deeper water. The existing Outfall I will not be changed in any way. If required, the wet weather flow in Catchment I can be diverted to the overflow weir in Catchment I.

2.3 Option 3 - Three Wastewater Treatment Facilities (Decentralized Treatment) at Hays Creek, Ritchie Point, and Morse Creek

Option 3 (refer to Figure 2-3) involves having three wastewater treatment facilities. These facilities would be located near the harbour front, in the vicinity of Morse Creek, Hays Creek, and Ritchie Point. Wastewater from Areas A, B, C, and F would be conveyed to a Morse Creek Wastewater Treatment Facility. Wastewater from Areas G, H, I, and J would be conveyed to a Hays Creek Wastewater Treatment Facility. Wastewater from Areas K, L, and potentially M would be conveyed to a Ritchie Point Wastewater Treatment Facility.

Only four times the Average Dry Weather Flow (ADWF) will be conveyed to the treatment facility(ies) via newly installed gravity trunk sewers and pump stations and force mains along the City's waterfront.

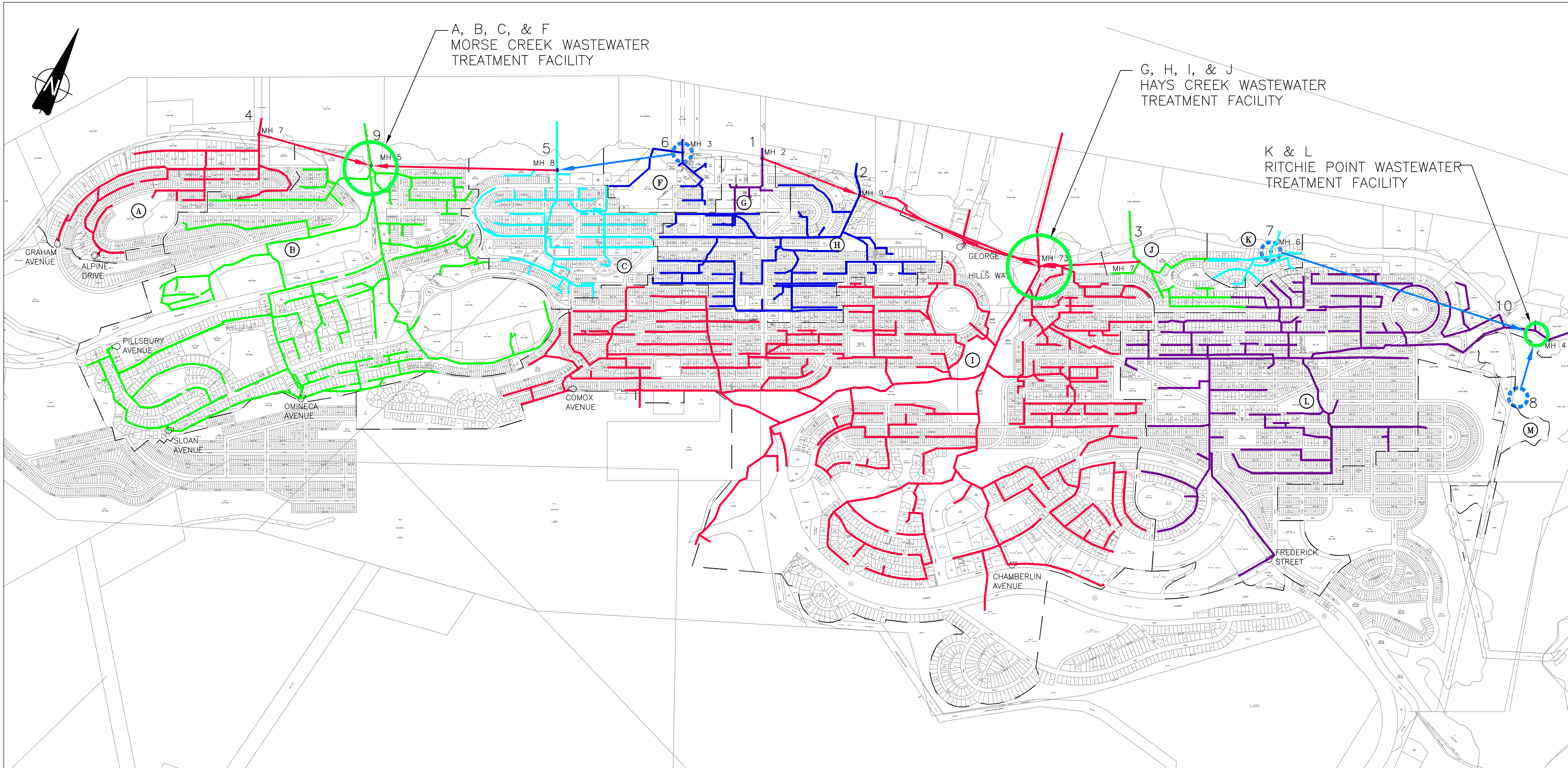
For the Hays Creek Wastewater Treatment Facility - two times the ADWF for Design Years 2030 (8,000 m^3/day) and 2050 (10,800 m^3/day) would undergo secondary treatment and four times the ADWF for Design Years 2030 (15,900 m^3/day) and 2050 (21,500 m^3/day) would undergo primary treatment. All flows greater than this amount would be discharged as Combined Sewer Overflow (CSO) events.

For the Morse Creek Wastewater Treatment Facility - two times the ADWF for Design Years 2030 (4,700 m^3/day) and 2050 (6,300 m^3/day) would undergo secondary treatment and four times the ADWF for Design Years 2030 (9,300 m^3/day) and 2050 (12,600 m^3/day) would undergo primary treatment. All flows greater than this amount would be discharged as Combined Sewer Overflow (CSO) events.

For the Ritchie Point Wastewater Treatment Facility - two times the ADWF for Design Years 2030 (3,200 m^3/day) and 2050 (4,300 m^3/day) would undergo secondary treatment and four times the ADWF for Design Years 2030 (6,300 m^3/day) and 2050 (8,500 m^3/day) would undergo primary treatment. All flows greater than this amount would be discharged as Combined Sewer Overflow (CSO) events.

Diversion chambers with flow controls will need to be installed near the waterfront, upstream of the existing outfalls to divert only four times the ADWF to the treatment facility. As an interim wet weather flow strategy and considering extremely high peaking factors, the diversion chambers will direct the remaining flows to the existing outfalls, which will act as CSOs.

The gravity trunk sewers will be sized to convey four times the Year 2050 ADWF. In catchments where gravity conveyance is not feasible, pump stations and force mains will be used. Conveyance to the Hays Creek Wastewater Treatment Facility will be via gravity trunk sewers. Conveyance to the Morse Creek Wastewater Treatment Facility will require one pump station, with the remaining catchments using gravity conveyance. The Ritchie Point Wastewater Treatment Facility will also require one pump station.



LEGEND

POTENTIAL PUMP STATION

FORCE MAIN

GRAVITY SEWER

CITY OF PRINCE RUPERT
STAGE 2 LIQUID WASTE MANAGEMENT PLAN
OPTION 3

FIGURE 2-3

N.T.S.

Associated Engineering

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The pump stations will need to be sited and built strategically along the City's waterfront. The pump stations will be designed for four times the Year 2050 ADWF. The stations can be upgraded in the future to meet four times the Year 2050 ADWF. For cost estimate purposes, the pump station costs are for the Year 2050 design flows. The force mains will be sized to convey four times the Year 2050 ADWF.

The outfalls corresponding to the Hays Creek, Morse Creek, and Ritchie Point Wastewater Treatment Facilities are Outfalls I, B, and L, respectively. Outfalls I and B have sufficient capacity to discharge the required Year 2050 design flow (4 times the treated ADWF only). Outfall L has sufficient capacity to discharge both the required Year 2050 treated and wet weather flows. For Outfalls I and B, if the wet weather portion is to be included, an additional 1 m of static head is required. This can be achieved by increasing the water level at the treatment facility by another 1 m via pumping, thus increasing the available static head. Alternatively, for Outfall I, the wet weather flow portion can be diverted to the overflow weir in Catchment I. The existing outfalls in Catchment B and L are short and discharge into too shallow water to promote sufficient mixing. Outfall L would have to be realigned to discharge out to Prince Rupert Harbour and not into the confines of Seal Cove, as it currently does. As such, cost estimates for Option 3 include new, longer Outfalls B and L.

3 Solids Treatment and Other Resource Recovery Options

The most significant potential resource recovery options for the City involve biosolids. Biosolids offer a significant source of energy and/or soil amendments for the City. The following resource recovery options have been identified in Discussion Paper 2-6:

- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion at the largest site.
- Combining the wastewater sludge with the fish processing waste, and if feasible, provide anaerobic digestion off site (e.g. at the City's landfill).
- Composting the dewatered aerobically digested or raw sludges and possible combining with other organic waste offsite at a location away from the City centre.

The aforementioned resource recovery options may be explored during the preliminary design stage to determine the prospective benefit of implementation to the wastewater treatment facility option selected by the City, Option 1A, 2A, or 3. For the purpose of the Stage 2 Liquid Waste Management Plan and to provide conservative numbers for land requirements and capital cost estimates, we have assumed that wastewater solids will be treated using aerobic digestion at the largest of the wastewater treatment facilities. For cost estimate purposes, capital costs for a typical composting facility have been provided as well.

4 Capital Costs

The capital costs provided in this section are Class D level estimates. A Class D cost estimate is strictly an indication (rough order of magnitude) of the final project cost, and should be sufficient to provide an indication of cost and allow for ranking all the options being considered. The capital cost estimate for each option includes the following items:

- Wastewater treatment facilities
- Pump stations
- Force mains
- Gravity trunk sewers
- Diversion chambers
- Outfalls
- Off-site composting facility (provided separately)

The cost estimates are in 2010 dollars and include contingency and engineering allowances of 35 and 15 percent respectively. The capital costs provided are for the maximum design, Year 2050 design criteria, and represent the amount of capital that the City could potentially spend, should the City grow to the maximum design population of 25,000. The actual implementation of the required capital work would be phased so that the selected wastewater treatment facility option (Option 1A, 2A, or 3) conveyance requirements (gravity sewers, pump stations, force mains, and diversion chambers) are put in place prior to the construction of the wastewater treatment facility(ies) and outfall(s). The City's implementation plan will attempt to build capital works of sufficient capacity to meet the City's near future requirements, but still be robust enough to provide room for potential growth.

Tables 4-1, 4-2, and 4-3 provide capital costs of Options 1A, 2A, and 3 respectively. Table 4-4 provides the capital cost for an off-site composting facility that could potentially be applied to all treatment facility options. The capital costs do not include the costs for local sewer systems, sewer system separation (mitigation measures for wet weather flow), and off-site infrastructure costs associated with resource recovery. Land acquisition costs are not included in the capital cost estimates or the net present value analysis; however, they are provided in Appendix A.

Table 4-1
Capital Cost Estimate for Option 1A – Hays Creek Wastewater Treatment Facility

ITEM	COST ($ Millions)
Wastewater Treatment Facility	$66.8
Pump Stations	$6.6
Force Mains	$6.1
Gravity Sewers	$4.7
Diversion Chambers	$1.6
Total Capital Cost	**$85.8**

Table 4-2
Capital Cost Estimate for Option 2A – Hays Creek and Morse Creek Wastewater Treatment Facilities

ITEM	COST ($ Millions)
Wastewater Treatment Facility	$71.5
Pump Stations	$3.7
Force Mains	$3.8
Gravity Sewers	$5.5
Diversion Chambers	$1.6
Outfall	$3.5
Total Capital Cost	**$89.6**

Table 4-3
Capital Cost Estimate for Option 3 – Hays Creek, Morse Creek, and Ritchie Point Wastewater Treatment Facilities

ITEM	COST ($ Millions)
Wastewater Treatment Facility	$74.8
Pump Stations	$0.6
Force Mains	$1.4
Gravity Sewers	$5.5
Diversion Chambers	$1.6
Outfall	$6.3
Total Capital Cost	**$90.2**

Table 4-4
Capital Cost Estimate for Off-site Composting Facility

ITEM	COST ($ Millions)
Composting Facility (Year 2030 Design Criteria)	$1.8
Composting Facility (Year 2050 Design Criteria)	$2.5

5 Net Present Value Analysis

Net present value (NPV) analysis of the capital and O&M cost estimates for each of the options was conducted using an interest rate of 3.5 percent. The O&M costs for the treatment facilities are based on 3 percent of capital costs. The O&M costs for the pump stations, force mains, gravity trunk sewers, and diversion chambers are based on 1 percent of the capital costs. The O&M costs for the outfalls are based on 2 percent of the capital costs.

The electrical costs for the wastewater treatment facilities and pump stations were calculated using the ADWF for the specific year and multiplying it first by the total unit power requirement (0.705

kW-hr/day per m3/day of ADWF treated) and then by 365 days/year. To determine the annual cost of electricity, the annual power requirement was multiplied by the cost of electricity ($0.07/kWh).

NPV analysis results are summarized in Table 5-2 and detailed analysis results are provided in Appendix B.

Table 5-2
Net Present Value Analysis Summary

OPTION	TOTAL NPV ($ Millions)
1A – Hays Creek Wastewater Treatment Facility	$117.6
2A – Hays Creek and Morse Creek Wastewater Treatment Facilities	$122.1
3 - Hays Creek, Morse Creek, and Ritchie Point Wastewater Treatment Facilities	$124.3

Appendix A - Land Acquisition Cost Estimates

City of Prince Rupert - Liquid Waste Management Plan - Stage 2
Discussion Paper 2-7 - Appendix B

Prepared by: Manjit Herar **Date:** **26-Jan-10** **Date of Last Revision:** **8-Mar-10**
Reviewed by: **Date:**

Background:

As part of the City of Prince Rupert's Stage 2 Liquid Waste Management Plan (LWMP) work, potential wastewater treatment plants (WWTP) are to be sized.

For conceptual planning purposes, the estimated size of one to three treatment facilities will be based the Porteau Cove, Village of Pemberton, and Capital Regional District's Saanich and West Shore treatment facilities.

Notes:

1. Concord Pacific Group Inc., Porteau Cove Development Wastewater Treatment Facility Preliminary Design Report, Associated Engineering, March 2007.
2. Village of Pemberton, Wastewater Treatment Plant Operation & Maintenance Manual, Vol. 1, Section 2, Maple Reinders, March 2005.
3. Use adjustment factor to modify the required calculated treatment plant area. The factor adjusts required land area based on the premise that the m2/m3 does not increase to the same extent as flow increases. The operational areas of the plant (office
3. Capital Regional District, Core Area Wastewater Management Plan, Conceptual Plan for a new treatment facility at West Shore C. Associated Engineering project number 20062935.
4. Capital Regional District, Core Area Wastewater Management Plan, Conceptual Plan for a new treatment facility at Saanich East - Option 3. Associated Engineering project number 20062935.

5. Used the reference facilities ADWF (m3) and the reference facilities treatment area required per ADWF treated (m2/m3) to generate an ADWF versus treatment area required per ADWF curve. From the curve, the equation of the line was generated by Excel a
6. Fifty percent additional area was added to the Liquid Stream area to provide sufficient area for full sludge processing. For decentratlized treatment facilities, sludge will be processed at the largest treatment facility.
7. To determine the overall site area required, including area for access roads and buffering, a factor of 2.5 was used for the large treatment facilities and a factor of 4 was used for the small treatment facilities.

Reference Treatment Facilities and Primary and Preliminary Treatment Technologies	**Porteau Cove[1.]**		**Pemberton[2.]**		**CRD West Shore C[3.]**		**CRD Saanich East Option 3[4.]**	
		m^2/m^3 of ADWF		m^2/m^3 of ADWF		m^2/m^3 of ADWF		m^2/m^3 of ADWF
Average Dry Weather Flow (m3/day):	1,359		1,530		15,658		22,721	
Average Dry Weather Flow (L/s):	15.73		17.71		181.23		262.97	
Treatment Technology Used:	Batch Decant Reactor		Sequencing Batch Reactor		Membranes		Membranes	
Approx. total tankage/building area (m2)	959	0.71	828	0.54	3,272	0.21	4,321	0.19
Appox. area solids thickening (m2)	19	0.01	29	0.02	4,470	0.29	5,472	0.24
Appox. area UV disinfection (m2)	48	0.03	18	0.01	381	0.02	496	0.02
Total approximate area (m2):	1,026	0.75	874	0.57	8,123	0.52	10,289	0.45

Potential Wastewater Treatment Facility Approximate Land Requirements	**Design Year**	**Facility Location**	**Wastewater Treatment Facility** ADWF (m3/day)	m^2/m^3 of ADWF[5.]	Area Required for Liquid Stream (m^2)	Area for Sludge Processing (m^2)[6.]	Total Building and Tankage Area (m^2)	**Multiplier for Access Roads, Landscaping, Buffer**	**Total Appoximate Area Required (m^2)[7.]**	**Total Appoximate Area Required (ha)[7.]**	**Approx. Land Value ($/ha)**	**Approximate Land Cost ($)**
Option 1A - 1 facility	**2030**	**Hays Creek**	**7,843**	**0.640**	**5,017**	**2,509**	**7,526**	**2.5**	**18,815**	**1.88**	**$ 1,500,000**	**$ 2,823,000**
	2050	Hays Creek	10,599	0.629	6,664	3,332	9,996	2.5	24,989	2.50	$ 1,500,000	$ 3,749,000
Option 2A - 2 facilities	**2030**	**Hays Creek**	**5,528**	**0.649**	**3,588**	**1,794**	**5,381**	**2.5**	**13,453**	**1.35**	**$ 1,500,000**	**$ 2,018,000**
	2050	Hays Creek	7,465	0.641	4,787	2,394	7,181	2.5	17,952	1.80	$ 1,500,000	$ 2,693,000
	2030	**Morse Creek**	**2,315**	**0.662**	**1,532**		**1,532**	**4**	**6,129**	**0.61**	**$ 1,500,000**	**$ 920,000**
	2050	Morse Creek	3,134	0.659	2,064		2,064	4	8,255	0.83	$ 1,500,000	$ 1,239,000
Option 3 - 3 facilities	**2030**	**Hays Creek**	**3,967**	**0.655**	**2,599**	**1,300**	**3,899**	**2.5**	**9,747**	**0.97**	**$ 1,500,000**	**$ 1,462,000**
	2050	Hays Creek	5,356	0.650	3,479	1,740	5,219	2.5	13,048	1.30	$ 1,500,000	$ 1,958,000
	2030	**Morse Creek**	**2,315**	**0.662**	**1,532**		**1,532**	**4**	**6,129**	**0.61**	**$ 1,500,000**	**$ 920,000**
	2050	Morse Creek	3,134	0.659	2,064		2,064	4	8,255	0.83	$ 1,500,000	$ 1,239,000
	2030	**Ritchie Point**	**1,561**	**0.665**	**1,038**		**1,038**	**4**	**4,152**	**0.42**	**$ 1,500,000**	**$ 623,000**
	2050	Ritchie Point	2,110	0.663	1,398		1,398	4	5,592	0.56	$ 1,500,000	$ 839,000

Appendix B - Net Present Value Analysis of Options 1A, 2A, and 3

City of Prince Rupert Stage 2 Liquid Waste Management Plan																								
Stage 2 Liquid Waste Management Plan																								
Option 1A - Hays Creek Wastewater Treatment Facility																								
Net Present Value Analysis																								
Prepared by:		Manjit Herar	Date:	8-Mar-10																				
Reviewed by:			Date:																					
	Interest Rate =	3.5%																						
	Costs in 2010 Dollars																							
	Hays Creek WWTF			Pump Station B			Pump Station C			Pump Station L			Pump Station K			Force Mains		Gravity Sewers		Outfalls		Diversion Chambers		
Year	Capital Cost	Electricity	O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	
2010																								
2011																								
2012																								
2013																								
2014																								
2015	$ 50,095,362			$ 1,115,159			$ 1,336,941			$ 1,230,851			$ 1,247,053			$ 6,074,933		$ 4,630,797		$ -		$ 1,552,500		
2016		$ 99,614	$ 1,502,861		$ 894	$ 15,215		$ 3,379	$ 19,812		$ 3,200	17,175		$ 1,206	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2017		$ 101,991	$ 1,502,861		$ 915	$ 15,215		$ 3,457	$ 19,812		$ 3,277	17,175		$ 1,235	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2018		$ 104,367	$ 1,502,861		$ 936	$ 15,215		$ 3,536	$ 19,812		$ 3,355	17,175		$ 1,264	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2019		$ 106,744	$ 1,502,861		$ 957	$ 15,215		$ 3,614	$ 19,812		$ 3,432	17,175		$ 1,294	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2020		$ 109,120	$ 1,502,861		$ 978	$ 15,215		$ 3,693	$ 19,812		$ 3,510	17,175		$ 1,323	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2021		$ 111,497	$ 1,502,861		$ 999	$ 15,215		$ 3,772	$ 19,812		$ 3,588	17,175		$ 1,353	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2022		$ 113,874	$ 1,502,861		$ 1,021	$ 15,215		$ 3,851	$ 19,812		$ 3,666	17,175		$ 1,382	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2023		$ 116,250	$ 1,502,861		$ 1,042	$ 15,215		$ 3,930	$ 19,812		$ 3,745	17,175		$ 1,412	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2024		$ 118,627	$ 1,502,861		$ 1,063	$ 15,215		$ 4,009	$ 19,812		$ 3,823	17,175		$ 1,442	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2025		$ 121,003	$ 1,502,861		$ 1,085	$ 15,215		$ 4,088	$ 19,812		$ 3,902	17,175		$ 1,472	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2026		$ 123,380	$ 1,502,861		$ 1,106	$ 15,215		$ 4,167	$ 19,812		$ 3,981	17,175		$ 1,502	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2027		$ 125,756	$ 1,502,861		$ 1,128	$ 15,215		$ 4,247	$ 19,812		$ 4,060	17,175		$ 1,532	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2028		$ 128,133	$ 1,502,861		$ 1,149	$ 15,215		$ 4,326	$ 19,812		$ 4,140	17,175		$ 1,562	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2029		$ 130,509	$ 1,502,861		$ 1,171	$ 15,215		$ 4,406	$ 19,812		$ 4,219	17,175		$ 1,593	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2030		$ 132,886	$ 1,502,861		$ 1,193	$ 15,215		$ 4,486	$ 19,812		$ 4,299	17,175		$ 1,623	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2031		$ 135,262	$ 1,502,861		$ 1,214	$ 15,215		$ 4,566	$ 19,812		$ 4,379	17,175		$ 1,654	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2032		$ 137,639	$ 1,502,861		$ 1,236	$ 15,215		$ 4,646	$ 19,812		$ 4,459	17,175		$ 1,684	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2033		$ 140,015	$ 1,502,861		$ 1,258	$ 15,215		$ 4,726	$ 19,812		$ 4,540	17,175		$ 1,715	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2034		$ 142,392	$ 1,502,861		$ 1,280	$ 15,215		$ 4,807	$ 19,812		$ 4,621	17,175		$ 1,746	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2035	$ 16,698,454	$ 144,768	$ 1,502,861	$ 371,720	$ 1,302	$ 15,215	$ 445,647	$ 4,887	$ 19,812	$ 410,284	$ 4,702	17,175	$ 415,684	$ 1,777	17,512		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2036		$ 147,145	$ 2,003,814		$ 1,324	$ 17,471		$ 4,968	$ 20,945		$ 4,783	19,283		$ 1,808	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2037		$ 149,522	$ 2,003,814		$ 1,346	$ 17,471		$ 5,049	$ 20,945		$ 4,864	19,283		$ 1,839	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2038		$ 151,898	$ 2,003,814		$ 1,369	$ 17,471		$ 5,130	$ 20,945		$ 4,946	19,283		$ 1,871	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2039		$ 154,275	$ 2,003,814		$ 1,391	$ 17,471		$ 5,211	$ 20,945		$ 5,028	19,283		$ 1,902	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2040		$ 156,651	$ 2,003,814		$ 1,413	$ 17,471		$ 5,292	$ 20,945		$ 5,110	19,283		$ 1,934	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2041		$ 159,028	$ 2,003,814		$ 1,436	$ 17,471		$ 5,374	$ 20,945		$ 5,193	19,283		$ 1,965	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2042		$ 161,404	$ 2,003,814		$ 1,458	$ 17,471		$ 5,455	$ 20,945		$ 5,276	19,283		$ 1,997	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2043		$ 163,781	$ 2,003,814		$ 1,481	$ 17,471		$ 5,537	$ 20,945		$ 5,359	19,283		$ 2,029	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2044		$ 166,157	$ 2,003,814		$ 1,504	$ 17,471		$ 5,619	$ 20,945		$ 5,442	19,283		$ 2,061	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2045		$ 168,534	$ 2,003,814		$ 1,527	$ 17,471		$ 5,701	$ 20,945		$ 5,525	19,283		$ 2,094	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2046		$ 170,910	$ 2,003,814		$ 1,549	$ 17,471		$ 5,783	$ 20,945		$ 5,609	19,283		$ 2,126	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2047		$ 173,287	$ 2,003,814		$ 1,572	$ 17,471		$ 5,866	$ 20,945		$ 5,693	19,283		$ 2,158	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2048		$ 175,663	$ 2,003,814		$ 1,595	$ 17,471		$ 5,948	$ 20,945		$ 5,778	19,283		$ 2,191	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2049		$ 178,040	$ 2,003,814		$ 1,618	$ 17,471		$ 6,031	$ 20,945		$ 5,862	19,283		$ 2,224	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
2050		$ 180,416	$ 2,003,814		$ 1,642	$ 17,471		$ 6,114	$ 20,945		$ 5,947	19,283		$ 2,257	19,537		$ 60,749		$ 46,308		$ 67,534		$ 15,525	
NPV	$58,487,436	$2,637,512	$32,957,860	$1,301,972	$23,728	$317,362	$1,560,908	$89,168	$402,808	$1,437,046	$85,515	$355,710	$1,455,961	$32,305	$361,972	$6,074,933	$1,215,027	$4,630,797	$926,190	$0	$1,350,720	$1,552,500	$310,510	**Total NPV: $117,600,000**

City of Prince Rupert Stage 2 Liquid Waste Management Plan
Stage 2 Liquid Waste Management Plan
Option 2A - Hays Creek and Morse Creek Wastewater Treatment Facilities
Net Present Value Analysis
Prepared by: Manjit Herar Date: 8-Mar-10
Reviewed by: Date:

Interest Rate = 3.5%
Costs in 2010 Dollars

	Hays Creek WWTF			Morse Creek WWTF			Pump Station F			Pump Station L			Pump Station K			Force Mains		Gravity Sewers		Outfalls		Diversion Chambers		
Year	Capital Cost	Electricity	O&M	Capital Cost	Electricity	O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	
2010																								
2011																								
2012																								
2013																								
2014																								
2015	$ 41,776,976			$ 11,825,790			$ 248,325			$ 1,230,851			$ 1,247,053			$ 3,743,854		$ 5,477,220		$ 3,407,738		$ 1,552,500		
2016		$ 73,397	$ 1,253,309		$ 25,614	$ 354,774		$ 150	$ 2,980		$ 3,201	$ 17,175		$ 1,206	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2017		$ 75,142	$ 1,253,309		$ 26,231	$ 354,774		$ 154	$ 2,980		$ 3,278	$ 17,175		$ 1,235	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2018		$ 76,887	$ 1,253,309		$ 26,848	$ 354,774		$ 158	$ 2,980		$ 3,355	$ 17,175		$ 1,264	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2019		$ 78,631	$ 1,253,309		$ 27,465	$ 354,774		$ 162	$ 2,980		$ 3,433	$ 17,175		$ 1,294	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2020		$ 80,376	$ 1,253,309		$ 28,082	$ 354,774		$ 167	$ 2,980		$ 3,511	$ 17,175		$ 1,323	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2021		$ 82,120	$ 1,253,309		$ 28,699	$ 354,774		$ 171	$ 2,980		$ 3,589	$ 17,175		$ 1,353	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2022		$ 83,865	$ 1,253,309		$ 29,316	$ 354,774		$ 175	$ 2,980		$ 3,667	$ 17,175		$ 1,382	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2023		$ 85,609	$ 1,253,309		$ 29,932	$ 354,774		$ 179	$ 2,980		$ 3,746	$ 17,175		$ 1,412	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2024		$ 87,354	$ 1,253,309		$ 30,549	$ 354,774		$ 184	$ 2,980		$ 3,824	$ 17,175		$ 1,442	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2025		$ 89,098	$ 1,253,309		$ 31,166	$ 354,774		$ 188	$ 2,980		$ 3,903	$ 17,175		$ 1,472	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2026		$ 90,843	$ 1,253,309		$ 31,783	$ 354,774		$ 192	$ 2,980		$ 3,982	$ 17,175		$ 1,502	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2027		$ 92,587	$ 1,253,309		$ 32,400	$ 354,774		$ 196	$ 2,980		$ 4,061	$ 17,175		$ 1,532	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2028		$ 94,332	$ 1,253,309		$ 33,017	$ 354,774		$ 201	$ 2,980		$ 4,141	$ 17,175		$ 1,562	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2029		$ 96,076	$ 1,253,309		$ 33,634	$ 354,774		$ 205	$ 2,980		$ 4,220	$ 17,175		$ 1,593	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2030		$ 97,821	$ 1,253,309		$ 34,251	$ 354,774		$ 209	$ 2,980		$ 4,300	$ 17,175		$ 1,623	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2031		$ 99,565	$ 1,253,309		$ 34,868	$ 354,774		$ 213	$ 2,980		$ 4,380	$ 17,175		$ 1,654	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2032		$ 101,310	$ 1,253,309		$ 35,485	$ 354,774		$ 218	$ 2,980		$ 4,461	$ 17,175		$ 1,684	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2033		$ 103,055	$ 1,253,309		$ 36,102	$ 354,774		$ 222	$ 2,980		$ 4,541	$ 17,175		$ 1,715	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2034		$ 104,799	$ 1,253,309		$ 36,718	$ 354,774		$ 226	$ 2,980		$ 4,622	$ 17,175		$ 1,746	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2035	$ 13,925,659	$ 106,544	$ 1,253,309	$ 3,941,930	$ 37,335	$ 354,774	$ 82,775	$ 231	$ 2,980	$ 410,284	$ 4,703	$ 17,175	$ 415,684	$ 1,777	17,512		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2036		$ 108,288	$ 1,671,079		$ 37,952	$ 473,032		$ 235	$ 3,890		$ 4,784	$ 19,283		$ 1,808	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2037		$ 110,033	$ 1,671,079		$ 38,569	$ 473,032		$ 239	$ 3,890		$ 4,866	$ 19,283		$ 1,839	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2038		$ 111,777	$ 1,671,079		$ 39,186	$ 473,032		$ 244	$ 3,890		$ 4,948	$ 19,283		$ 1,871	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2039		$ 113,522	$ 1,671,079		$ 39,803	$ 473,032		$ 248	$ 3,890		$ 5,030	$ 19,283		$ 1,902	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2040		$ 115,266	$ 1,671,079		$ 40,420	$ 473,032		$ 252	$ 3,890		$ 5,112	$ 19,283		$ 1,934	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2041		$ 117,011	$ 1,671,079		$ 41,037	$ 473,032		$ 257	$ 3,890		$ 5,195	$ 19,283		$ 1,965	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2042		$ 118,755	$ 1,671,079		$ 41,654	$ 473,032		$ 261	$ 3,890		$ 5,277	$ 19,283		$ 1,997	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2043		$ 120,500	$ 1,671,079		$ 42,271	$ 473,032		$ 265	$ 3,890		$ 5,360	$ 19,283		$ 2,029	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2044		$ 122,244	$ 1,671,079		$ 42,888	$ 473,032		$ 270	$ 3,890		$ 5,444	$ 19,283		$ 2,061	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2045		$ 123,989	$ 1,671,079		$ 43,504	$ 473,032		$ 274	$ 3,890		$ 5,527	$ 19,283		$ 2,094	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2046		$ 125,733	$ 1,671,079		$ 44,121	$ 473,032		$ 278	$ 3,890		$ 5,611	$ 19,283		$ 2,126	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2047		$ 127,478	$ 1,671,079		$ 44,738	$ 473,032		$ 283	$ 3,890		$ 5,695	$ 19,283		$ 2,158	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2048		$ 129,223	$ 1,671,079		$ 45,355	$ 473,032		$ 287	$ 3,890		$ 5,780	$ 19,283		$ 2,191	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2049		$ 130,967	$ 1,671,079		$ 45,972	$ 473,032		$ 292	$ 3,890		$ 5,864	$ 19,283		$ 2,224	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
2050		$ 132,712	$ 1,671,079		$ 46,589	$ 473,032		$ 296	$ 3,890		$ 5,949	$ 19,283		$ 2,257	19,537		$ 37,439		$ 46,308		$ 68,155		$ 15,525	
																								Total NPV:
NPV	$48,775,537	$1,941,587	$27,485,173	$13,806,870	$679,772	$7,780,216	$289,925	$4,153	$64,866	$1,437,046	$85,541	$355,710	$1,455,961	$32,305	$361,972	$3,743,854	$748,796	$5,477,220	$926,190	$3,407,738	$1,363,140	$1,552,500	$310,510	**$122,100,000**

City of Prince Rupert Stage 2 Liquid Waste Management Plan
Stage 2 Liquid Waste Management Plan
Option 3 - Hays Creek, Morse Creek, Ritchie Point Wastewater Treatment Facility
Net Present Value Analysis

Prepared by: Manjit Herar Date: 8-Mar-10
Reviewed by: Date:

Interest Rate = 3.5%
Costs in 2010 Dollars

	Hays Creek WWTF			Morse Creek WWTF			Ritchie Point WWTF			Pump Station F			Pump Station K			Force Mains		Gravity Sewers		Outfalls		Diversion Chambers		
Year	Capital Cost	Electricity	O&M	Capital Cost	Electricity	O&M	Capital Cost	Electricity	O&M	Capital Cost	Electricity	Other O&M	Capital Cost	Electricity	Other O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M	
2010																								
2011																								
2012																								
2013																								
2014																								
2015	$ 35,923,816			$ 11,825,790			$ 8,280,312			$ 248,325			$ 164,989			$ 1,377,456		$ 5,477,220		$ 6,216,210		$ 1,552,500		
2016		$ 52,683	$ 1,077,714		$ 25,614	$ 354,774		$ 19,812	$ 248,409		$ 150	$ 2,980		$ 193	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2017		$ 53,934	$ 1,077,714		$ 26,231	$ 354,774		$ 20,285	$ 248,409		$ 154	$ 2,980		$ 197	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2018		$ 55,185	$ 1,077,714		$ 26,848	$ 354,774		$ 20,758	$ 248,409		$ 158	$ 2,980		$ 200	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2019		$ 56,436	$ 1,077,714		$ 27,465	$ 354,774		$ 21,232	$ 248,409		$ 162	$ 2,980		$ 204	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2020		$ 57,687	$ 1,077,714		$ 28,082	$ 354,774		$ 21,705	$ 248,409		$ 167	$ 2,980		$ 207	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2021		$ 58,938	$ 1,077,714		$ 28,699	$ 354,774		$ 22,179	$ 248,409		$ 171	$ 2,980		$ 211	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2022		$ 60,189	$ 1,077,714		$ 29,316	$ 354,774		$ 22,652	$ 248,409		$ 175	$ 2,980		$ 214	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2023		$ 61,440	$ 1,077,714		$ 29,932	$ 354,774		$ 23,125	$ 248,409		$ 179	$ 2,980		$ 218	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2024		$ 62,691	$ 1,077,714		$ 30,549	$ 354,774		$ 23,599	$ 248,409		$ 184	$ 2,980		$ 221	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2025		$ 63,942	$ 1,077,714		$ 31,166	$ 354,774		$ 24,072	$ 248,409		$ 188	$ 2,980		$ 225	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2026		$ 65,193	$ 1,077,714		$ 31,783	$ 354,774		$ 24,546	$ 248,409		$ 192	$ 2,980		$ 228	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2027		$ 66,444	$ 1,077,714		$ 32,400	$ 354,774		$ 25,019	$ 248,409		$ 196	$ 2,980		$ 232	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2028		$ 67,695	$ 1,077,714		$ 33,017	$ 354,774		$ 25,493	$ 248,409		$ 201	$ 2,980		$ 235	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2029		$ 68,946	$ 1,077,714		$ 33,634	$ 354,774		$ 25,966	$ 248,409		$ 205	$ 2,980		$ 239	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2030		$ 70,197	$ 1,077,714		$ 34,251	$ 354,774		$ 26,439	$ 248,409		$ 209	$ 2,980		$ 242	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2031		$ 71,448	$ 1,077,714		$ 34,868	$ 354,774		$ 26,913	$ 248,409		$ 213	$ 2,980		$ 246	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2032		$ 72,699	$ 1,077,714		$ 35,485	$ 354,774		$ 27,386	$ 248,409		$ 218	$ 2,980		$ 250	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2033		$ 73,950	$ 1,077,714		$ 36,102	$ 354,774		$ 27,860	$ 248,409		$ 222	$ 2,980		$ 253	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2034		$ 75,201	$ 1,077,714		$ 36,718	$ 354,774		$ 28,333	$ 248,409		$ 226	$ 2,980		$ 257	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2035	$ 11,974,605	$ 76,452	$ 1,077,714	$ 3,941,930	$ 37,335	$ 354,774	$ 2,760,104	$ 28,806	$ 248,409	$ 82,775	$ 231	$ 2,980	$ 54,996	$ 260	2,168		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2036		$ 77,703	$ 1,436,953		$ 37,952	$ 473,032		$ 29,280	$ 331,212		$ 235	$ 3,890		$ 264	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2037		$ 78,953	$ 1,436,953		$ 38,569	$ 473,032		$ 29,753	$ 331,212		$ 239	$ 3,890		$ 267	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2038		$ 80,204	$ 1,436,953		$ 39,186	$ 473,032		$ 30,227	$ 331,212		$ 244	$ 3,890		$ 271	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2039		$ 81,455	$ 1,436,953		$ 39,803	$ 473,032		$ 30,700	$ 331,212		$ 248	$ 3,890		$ 274	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2040		$ 82,706	$ 1,436,953		$ 40,420	$ 473,032		$ 31,173	$ 331,212		$ 252	$ 3,890		$ 278	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2041		$ 83,957	$ 1,436,953		$ 41,037	$ 473,032		$ 31,647	$ 331,212		$ 257	$ 3,890		$ 282	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2042		$ 85,208	$ 1,436,953		$ 41,654	$ 473,032		$ 32,120	$ 331,212		$ 261	$ 3,890		$ 285	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2043		$ 86,459	$ 1,436,953		$ 42,271	$ 473,032		$ 32,594	$ 331,212		$ 265	$ 3,890		$ 289	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2044		$ 87,710	$ 1,436,953		$ 42,888	$ 473,032		$ 33,067	$ 331,212		$ 270	$ 3,890		$ 292	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2045		$ 88,961	$ 1,436,953		$ 43,504	$ 473,032		$ 33,541	$ 331,212		$ 274	$ 3,890		$ 296	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2046		$ 90,212	$ 1,436,953		$ 44,121	$ 473,032		$ 34,014	$ 331,212		$ 278	$ 3,890		$ 299	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2047		$ 91,463	$ 1,436,953		$ 44,738	$ 473,032		$ 34,487	$ 331,212		$ 283	$ 3,890		$ 303	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2048		$ 92,714	$ 1,436,953		$ 45,355	$ 473,032		$ 34,961	$ 331,212		$ 287	$ 3,890		$ 306	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2049		$ 93,965	$ 1,436,953		$ 45,972	$ 473,032		$ 35,434	$ 331,212		$ 292	$ 3,890		$ 310	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
2050		$ 95,216	$ 1,436,953		$ 46,589	$ 473,032		$ 35,908	$ 331,212		$ 296	$ 3,890		$ 314	2,585		$ 13,775		$ 54,772		$ 124,324		$ 15,525	
																								Total NPV:
NPV	$41,941,844	$1,393,296	$23,634,365	$13,806,870	$679,772	$7,780,216	$9,667,446	$524,762	$5,447,637	$289,925	$4,153	$64,866	$192,629	$4,821	$45,768	$1,377,456	$275,500	$5,477,220	$1,095,480	$6,216,210	$2,486,566	$1,552,500	$310,510	**$124,300,000**

H Appendix H - Minutes of TAC and LAC Meetings

Technical Advisory Committee	Mailing Address	Phone #	Fax #	Email	Contact
Department of Fisheries & Oceans - North Coast	417 2nd Avenue West Prince Rupert, B.C. V8J 1G6	250-627-3447	250-627-3427	Renny.talbot@dfo-mpo.gc.ca	Renny Talbot-Ellis
Environment Canada - Pacific & Yukon Region	401 Burrard Street Vancouver, B.C. V6C 3S5	604-666-5419	604-713-9517	snehal.lakhani@ec.gc.ca	Snehal Lakhani
Ministry of Environment - Skeena Regional Office	Box 5000 Smithers, B.C. V0J 2N0	250-847-7454	250-847-7591	Gillian.bakker@gov.bc.ca	Gillian Bakker, M.A.Sc., Environmental Protection Officer
Ministry of Health Services - Northwest Division	3412 Kalum Street Terrace, B.C. V8G 4T2	250 631-4222	250 638-2209	Russell.Seltenrich@northernhealth.ca	Russell Seltenrich, Env. Health Officer
Integrated Management Bureau formerly - Min. of Sustainable Resource Management	Box 5000 Smithers, B.C. V0J 2N0	250 847-7862	847-7536		Kelly Wozniak
Skeena Queen Charlotte Regional District	100 1st Avenue East Prince Rupert, B.C. V8J 1A6	250 624-2455 #3		recycle@citytel.net	Tim DesChamp
Ministry of Community & Rural Development formerly Ministry of Community Services	PO Box 9838, Stn Prov Gov't Victoria, B.C. V8W 9T1	250 387-4072		tara.tompkins@gov.bc.ca	Tara Tompkins, Infrastructure Res. Officer

Local Advisory Committee	Mailing Address	Phone #	Fax #	Email	Contact
Metlakatla Band Council	PO Box 459 Prince Rupert, B.C. V8J 3R2	628- 3234	628- 9205	aweir@metlakatla.ca	Alex Weir
Prince Rupert Port Authority	200 - 215 Cow Bay Road Prince Rupert, B.C. V8J 1A2	627- 2505	627- 8980	acook@rupertport.com	Andy Cook, Manager, Planning & Design
Prince Rupert & District Chamber of Commerce	200 - 215 Cow Bay Road Prince Rupert, B.C. V8J 1A2	627- 2521	624- 6105	mangus@rupertport.com	Maynard Angus, 1st VP
Tourism Prince Rupert	260 - 110 1st Avenue West Prince Rupert, B.C. V8J 1A8	624- 8687	627- 5105	wishart@citytel.net	Bruce Wishart, Executive Director
Prince Rupert Environmental Society	1603 2nd Avenue West Prince Rupert, B.C. V8J 1J5	624- 5197		lgolden@citytel.net	Larry Golden
Canadian Fishing Company	PO Box 550 Prince Rupert, B.C. V8J 3R5	624- 6726	624- 4793	Tom.Coleman@goldseal.ca	Tom Coleman, Plant Manager
CN Rail	PO Box 8100 Montreal, Quebec H3C 3N4	514 399- 7400		normand.pellerin@cn.ca	Normand Pellerin, Assistant VP Environment
Northwest Comm. College	353 5th Street Prince Rupert, B.C. V8J 1J5	624- 6054	624- 4920	dstava@nwcc.bc.ca	Deb Stava, Principal of Prince Rupert Campus
Lax Kw'Alaams Band Council	206 Shashaak Port Simpson, B.C. V0V 1G0	625- 3293 or 604 317- 8928	625- 3246 or 604 608- 3144	wayne_drury@brinkman.ca	Wayne Drury, Corp. Dev. CEO
Ocean Ecology	1662 Parmenter Avenue Prince Rupert, B.C. V8J 4R3	622- 2501		blueseas@oceanecology.ca	Dr. Barb Faggetter
World Wildlife Fund	#3-437 3rd Avenue West Prince Rupert, B.C. V8J 1L7	624- 3705	624- 3725	mambach@wwfcanada.org	Mike Ambach

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Date:	November 25, 2009	**File:**	20062891.02.A.04.00
Time:	11:30 a.m.	**Page:**	1 of 6
Project:	Liquid Waste Management Plan		
Subject:	Stage 2 LWMP LAC/TAC Presentation		
Client:	City of Prince Rupert		
Location:	City of Prince Rupert City Hall		
Present:	Keith Cameron (KC) – City of Prince Rupert (CoPR) Garin Gardiner (GG) – CoPR Bill Horne (BH) – CoPR Zeno Krekic (ZK) – CoPR Richard Pucci (RP) – CoPR Bob Thompson (BT) – CoPR Renny Talbot-Ellis (RT) – Fisheries & Oceans (DFO) Darrell Belanger (DB) – Northern Health Jeannette Lough (JL) – Ministry of Environment (MOE) Alex Weir (AW) – Metlakatla Governing Council (MGC) Maynard Angus (MA) – Prince Rupert Port Authority Andy Cook (AC) – Prince Rupert Port Authority Tom Coleman (TC) – Canadian Fishing Co. (CFC) David Sutherland (DS) – CN Rail Barb Faggetter (BF) – Ocean Ecology (OE) Kennard Hall (KH) – OE Larry Golden (LG) – PR Environmental Society (PRES) Jeff Chen (JC) – Associated Engineering (AE) Arash Masbough (AM) - AE		
Distribution:	Those Present Tara Tompkins – Ministry of Community & Rural Development Rick Corbett – AE Dave Forgie – AE Manjit Herar – AE		

RECORD OF MEETING

These minutes are considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise these minutes will be considered to be an accurate record of the discussions.

Action By:	**Discussion:**
	1 BACKGROUND AND INTRODUCTION
Info	• Attendees introduced themselves (contact list and a copy of the slide show are attached). • LWMP's final deliverable is for a long range, sustainable wastewater management strategy developed by the community after consideration of social, economic, and environmental impacts, i.e., the triple bottom line approach.

Action By:	Discussion:
	• The LWMP will encompass the entire City boundary and is intended to be a living document.
	2 STAGE 1 LWMP
Info	• In Stage 1, we covered the following: • Wastewater management issues • Existing, projected community development • Source control, enforcement and education • CSO and wet weather (stormwater) flow management • Regulatory requirements for the City • Development of wastewater management options
	Currently tide circulation in the harbour is not well known, but such a study can be included in the LWMP as a recommendation for future work. However, the outcome of the study will likely not impact the treatment option(s).
	3 STAGE 2 LWMP
Info	• The base flow was calculated based on the build-out population according to the official community plan and does not include installation of any new combined sewers in the future. Flow generation was based on the worst case scenario. The approach for flow generation has been to assign different, conservative peaking factors for the separated and combined flows. • Studies have shown that climate change affects the maximum day flow (MDF), which relates to intensity. Obviously the peaking factor for combined sewer flow is greater than for the separated sewer areas. • The City will continue to work on the reduction of infiltration and inflow (I&I) and replacement of combined sewer, as the funding becomes available. • Current flow estimates are to be refined further prior to the preliminary design stage, but they should be adequate for the purpose of high-level decision making. • The current proposed primary treatment capacity of 4 times average dry weather flow (ADWF) is very close to the MDFs, which means even the MDF will receive primary treatment most of the time. • Sludge produced from wastewater treatment can be utilized as a potential resource. Treatment of sludge produced would be more efficient and economically feasible if situated in one location.

Action By:	Discussion:
	4 TREATMENT FACILITY LOCATION OPTIONS
	4.1 OPTION 1A, HAYS CREEK FACILITY
Info	• The major advantage of this location is that it already collects about 40% of the City's flow by gravity; therefore, conveyance cost of wastewater is potentially reduced. The existing outfall may be reused, but that depends on further evaluation.
AE	• Evaluation of the treatment facility location should also be looked at from the receiving water perspective. The treatment facility should be designed such that it can be expanded/upgraded to meet future discharge requirements. The amount of land required for future use should also be determined.
	4.2 OPTION 1B, PORT EDWARD FACILITY
Info	• This option will require significant pumping for all wastewater, which is potentially associated with large capital, and operation and maintenance costs. • Although there are existing tanks at Port Edward, the tank size and configuration will limit type of treatment and will also require refurbishment and/or upgrades.
AE	• The amount of energy required to pump the wastewater to Port Edward will also be significant. All agreed Port Edward might not be a very good option due to the amount of pumping to and from the treatment facility.
Info	• Wainwright Basin has had issues with effluent in the past. BF indicated that it is a more sensitive area for discharge compared to the harbour.
	4.3 OPTION 1C, INDUSTRIAL PARK FACILITY
Info	• Wastewater conveyance costs will also be higher than Option 1A. There will be requirements for pumping the treated effluent back to the harbour. RT indicated that discharging into Fern Passage can be a sensitive issue due to known recreational use.
	4.4 OPTION 2A, HAYS CREEK AND MORSE CREEK FACILITY
Info	• Conveyance costs would be lower than the previous two options, and resource and heat recovery are potentially viable. The treatment system is most cost effective near source of flow generation.

Action By:	Discussion:
	• As land availability can be an issue for both potential sites, it is crucial to estimate the approximate footprint of the treatment facility. This will be included in the subsequent tasks of the Stage 2 LWMP. Floating treatment facilities have been built on water in other places, but they can have significant cost implications.
Info	• Energy recovery from biosolids produced is usually utilized by the treatment facility itself. Heat recovery will depend on the net present value evaluation, to see if it is feasible, at later stages and closer to implementation. Heat recovered can be used for treatment process or building heating.
	4.5 OPTION 2B, HAYS CREEK AND RICHIE POINT
Info	• Richie Point is close to a location designated for future development.
	• Hays Creek would treat 80%, while Richie Point about 20% with solids hauled to Hays Creek for treatment. Effluent discharge is to deep sea for Hays Creek, but may be shallower for Richie Point. However, a longer outfall can be a possibility.
	4.6 OPTION 3, HAYS CREEK, RICHIE POINT, AND MORSE CREEK
Info	• The three proposed facilities in this option are situated at location of highest flow. Three facilities is the maximum number that should be considered, but from an operational point of view, two facilities are more feasible to reduce the unit flow treatment cost.
Info	• The land size will ultimately depend on the treatment technology selected. Cost of capital of each site will likely far exceed the cost of land acquisition.
	4.7 FEASIBLE OPTIONS
AE/CoPR	• Options 1A, 2A, and 3 are selected for further review in terms of land size requirement and cost.
	• If the option for Richie Point does not compete well with Hays Creek or Morse Creek, the team will pursuit Richie Point as a backup alternative. City will need to secure property at proposed location(s) in future.
Info	• Design considerations will have to take into account the implications of future sea level rise, treatment level increase (i.e. moving to tertiary treatment), and treatment capacity increase.

Action By:	**Discussion:**
	5 DISINFECTION
Info	• Currently, there is no regulatory requirement for disinfection, but it is recommended on the basis of potential future shellfish harvest, as well as from a recreation and perception point of view. Cost for disinfection will be presented in the LWMP, but is not anticipated to be a large portion of the treatment cost. Grant applications will likely not reject disinfection if this option is selected.
Info	• The process of disinfection is independent of the level of treatment. All levels of treatment can have disinfection, but disinfection does not alter the treatment level. Annacis Island Wastewater Treatment Facility is under the same (MSR) regulation, but does disinfect due to discharge into the river and size of population serviced.
	• BF indicated that, even with disinfection, the harbour may not become open to shellfishing due to other issues that cause fecal coliform count rise, from both human and non-human sources. However, it is agreed that disinfection is still preferred.
AE	• The team will include federal regulation requirements on discharge limits in addition to those outlined from the MSR. Federal guidelines are average values, while those from the MSR are "never-to-exceed" values *(presentation modified).*
	6 TECHNOLOGY SELECTION
Info	• As indicated in the previous LWMP stage: • Preliminary treatment (screening) needs to handle flows over 4 times average dry weather flow. • Primary treatment needs to handle flows up to 4 times average dry weather flow. • Secondary treatment needs to handle flows up to 2 times average dry weather flow. • The option is still available to utilize overflow storage tanks and in-line storage for peak flows for later treatment or to size the system to treat peak flows. (Discussed in Stage 1).
	• The recommended technologies are selected with ease of operation and maintenance in mind.
	• Even though viable at this time, the recommended technologies are used for planning purposes only, for sizing and cost estimates. Detailed evaluations will need to be conducted in later stages of project implementation.

Action By:	Discussion:
	• Aesthetics will be a key issue, with architectural input from the planning stages.
	• Urban stormwater runoff may require evaluation in the future.
	• If more than one treatment facility is chosen, all facilities will not be manned 24/7, but would incorporate Supervisory Control and Data Acquisition and be monitored from one central location. Different facilities may utilize same technology for ease of operation and maintenance.

7 NEXT STEPS

Action By	
AE	• Comments from this meeting to be incorporated into the current discussion papers. The team will proceed with the next discussion papers.
CoPR	• The City will provide information to First Nations and will continue to include them in future discussions.
AE	• Next stage: • Land requirement and availability, system sizing, wastewater conveyance methods and pump station locations. • Resource recovery potentials. • Evaluation of outfall locations and existing capacity. • Timing and location of options. • Comparison of cost for each option. • Public involvement and final report.
	• Target date for the public meeting and final report presentation is the end of winter 2010, followed shortly by a final TAC/LAC meeting.

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Project Manager

JC/AM/lp

City of Prince Rupert
LWMP Stage 2
TAC/LAC Meeting No. 1
November 25, 2009
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Associated Engineering

GLOBAL PERSPECTIVE. LOCAL FOCUS.

City of Prince Rupert Liquid Waste Management Plan Stage 2

Technical Advisory / Local Advisory Committees Meeting

November 25, 2009

Meeting Agenda

- Introduction/Background
- Summary of Stage 1
- Stage 2 LWMP
- Work to Date
- Group Discussion
- Potential Directions and Next Steps

The Liquid Waste Management Plan

- A long range planning tool
- Part of integrated sustainable community planning
- Three stages - setting the stage; evaluating strategies; implementation planning
- Key players - Steering Committee, Technical Advisory Committee, Local Advisory Committee; the Public

LWMP - The Deliverable

A long range, sustainable wastewater management strategy developed by the community after consideration of environmental, social and economic elements.

Background

- Largest City in the Skeena Queen Charlotte Regional District
- Land, water and air hub for BC's north coast
- Covering a land area of approximately 55 square kilometres

Historic Setting

- Trading area for centuries
- Contemporary history influenced by extending rail services
- Traditionally resource-focused economy (fishing and forestry)
- Shifting patterns of world trade (Asia), a large contributing factor to City's economy
- Population growth pattern

Sewerage Areas

Existing Wastewater Management Where Have We Started From?

- 10 major sewerage areas
- Mix of combined and separated sewers
- Preliminary treatment on only one area
- No treatment on the other 9 areas
- Some sewers are over 80 years old

Existing Wastewater Management - Regulatory Background

- Little regulation prior to 1960s
- Pollution Control Act introduced in 1967
- Master Sewer Plan developed in mid-1970s
- Regulatory Permits put in place in 1980 - work not completed
- Permits rewritten in 2000 to provide compliance
- One of the conditions - a comprehensive monitoring program

Existing Wastewater Management - The State of the Harbour

The Harbour has been impacted by both a century of industrial activities and by the discharge of raw wastewater and stormwater into the harbour. Future liquid waste management planning needs to consider the harbour in a holistic manner, looking at both the existing situation, the objectives of the community and the ability to implement any environmental improvement program in an affordable manner.

Sewage System Upgrading Plan, May 2004

Long Term Land Use

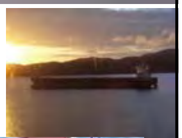
Stage 1 LWMP

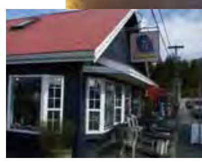
- **Discussion Papers Prepared**
  - Wastewater Management Issues
  - Existing/Projected Community Development
  - Source Control
  - CSO and Wet Weather Flow Management
  - Develop Wastewater Management Options
- **Three LAC/TAC meetings**
- **Public Presentation and Open House**
- **Summary Report**

Work to Date: Community Development

Major Industries:

- Deep sea port and terminals,
- Commercial fishing and fish processing,
- Logging and lumber processing,
- Cargo transport and storage, and
- Tourism





Work To Date: Source Control - What is It?

Source control is the control and reduction of potential pollutants at the source.

Source Control - Enforcement and Public Education

- **Enforcement**
  - Predefined
  - Fair, transparent process
- **Education**
  - Source reduction (water conservation)
  - Recycling
  - Economic, environmental, and health issues
  - May include product and/or process changes (for ICUs)

Work To Date: Wet Weather Flows

- Wet weather flow management is a significant issue
- Currently not "critical" due to lack of wastewater treatment
- Significant impact in the future
- Solution will encompass a combination of options presented

Regulatory Requirements

- Based on Municipal Sewage Regulation:
  - "Effluent Class C" Requirements
  - Secondary treatment required

Parameter	*Compliance Criteria*
Biochemical Oxygen Demand	45 mg/L maximum
Total Suspended Solids	45 mg/L maximum
Fecal Coliforms	Not applicable
Turbidity	Not applicable
Nitrogen	Not applicable

Stage 2 LWMP Tasks and DPs

1. **Waste Volumes and Facility Sizing Criteria**
2. **Wastewater Treatment Facility Options**
3. **Treatment Technology Options**
4. **Land Requirements and Availability**
5. **Wastewater Conveyance and Disposal Methods**
6. **Sustainability and Integrated Resource Recovery Options**
7. **Cost Estimate for Short Listed Options**
8. **Public Involvement** and **Final Report for Stage 2**

LWMP - Stage 2

Discussion Paper 2-1

Waste Volumes and Facility Sizing Criteria

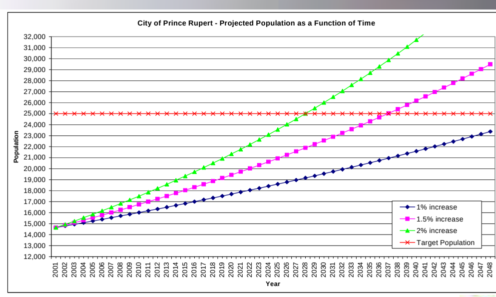
Objectives of Discussion Paper 2-1

- Confirm population projection developed in Stage 1
- Estimate wastewater volumes
- Wastewater treatment requirements
- Estimate the amount of non-biodegradable solids
- Estimate the amount of sludge

Historical Population Values

Year	Population
1961	11,987
1966	14,677
1971	15,947
1976	14,754
1982	17,444
1991	16,620
1996	16,714
2001	14,643
2006	12,815

Future Population



Projected Populations for 2030 and 2050

Growth %	Population – 2030	Population - 2050
1	16,272	19,855
1.5	18,319	25,673
2	20,612	30,629

Average Dry Weather Flow

- The average flow occurring over a 24-hour period under dry weather conditions (late May through June and July to the beginning of August)
- Made up of both the average sanitary flow and the average dry weather inflow/infiltration.
- City does not have complete flow records.
- Est. total ADWF for 2030 is 195 L/s (17 MLD)
- Est. total ADWF for 2050 is 263 L/s (23 MLD)

Maximum Daily Flow

- Maximum flow occurring over a 24-hour period under wet weather conditions.
- ADWF of 195 L/s for 2030: the est. max. daily flowrate is 800 L/s (67 MLD)
- ADWF of 263 L/s for 2050: the est. max. daily flowrate is 1080 L/s (91 MLD)

Wastewater Treatment Requirements

- City will develop a wastewater treatment regime to meet the following treatment requirements:
  - Up to two times the ADWF - secondary treatment
  - Up to four times the ADWF - primary treatment
  - All flows greater than four times the ADWF - preliminary treatment

Wastewater Volume Reduction

- Achieved by water conservation (source control) and reduction of infiltration and inflow
- Rehabilitation or complete replacement of the aging collection systems

Non-biodegradeable Solids (Grit)

- Materials such as plastic, sand, gravel, eggshells, etc.
- Based on an ADWF of 195 L/s (16,848 m^3/day) for 2030, the amount of grit generated is est. to be **0.25 m^3/day.**
- Based on an ADWF of 263 L/s (22,723 m^3/day) for 2050, the amount of grit generated is est. to be **0.34 m^3/day.**

Biodegradable Solids (Sludge)

- Est. sludge for 2030 is 33 m^3/day at 4% (thickened) sludge and 5.3 m^3/day at 25% (dewatered) sludge.
- Est. sludge for 2050 is 45 m^3/day at 4% (thickened) sludge and 7.2 m^3/day at 25% (dewatered) sludge.

Discussion Paper 2-1 Conclusions

- Design population based on 1.5 percent growth
- ADWF is estimated for 2030 and 2050
- Maximum daily flow is estimated for 2030 and 2050
- Solids production estimated
- Treatment requirements defined

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-2

Wastewater Treatment Facility Options

Objectives of Discussion Paper 2-2

- Present options for number and location(s) of wastewater treatment facilities
- Advantages and disadvantages of each option

Treatment Facility Options

- **Why not a wastewater treatment facility for each of the ten sewer catchments?**
- **Develop a cost effective approach to consolidate the wastewater collection system.**
- **Several potential options**

Option 1

Single treatment facility (centralized treatment), e.g. Hays Creek, Port Edward, or the Industrial Park

Option 1A – Hays Creek

Option 1A – Hays Creek

- Vicinity of Hays Creek area
- Approximately 40 percent of the City's total wastewater
- Requires installation of new pump stations and gravity sewers

Option 1A – Hays Creek

Advantages:

- 40 percent of the City's total wastewater
- May be able to use existing outfall
- Solids would likely be treated on site
- Resource recovery, such as energy recovery from organic solids is potentially viable.

Disadvantages:

- Requires new pump stations and sewers.
- May require new, larger capacity outfall.
- Located in the City core area.
- Land may be difficult and more expensive to acquire.

Option 1B - Port Edward

Option 1B - Port Edward

- Former pulp mill at Port Edward, located about 15 km outside the City
- Existing tankage at the former pulp mill industrial wastewater treatment facility
- Convey wastewater to central location, then pump to the Port Edward facility

Option 1B – Port Edward

Advantages:

- Existing tankage.
- Away from highly populated area.
- Land acquisition
- Solids would likely be treated on site and not require hauling off site.

Disadvantages:

- Requires conveyance of wastewater to centralized site and then to Port Edward.
- Higher conveyance costs than Option 1A and 1C.
- Existing tankage may limit the treatment process selection.
- Tanks will likely require refurbishment.

Option 1C - Industrial Park

Option 1C - Industrial Park

- Would require wastewater conveyed initially to central location and pumped to the Industrial Park facility.
- Would likely require an effluent pump station and force main back to the Harbour outfall.

Option 1C – Industrial Park

Advantages:

- Away from highly populated area.
- Land may be cheaper and easier to acquire than Option 1A.
- Solids would likely be treated on site

Disadvantages:

- Requires conveyance of wastewater to centralized site and then to Industrial Park.
- Higher conveyance costs than Option 1A.
- Will likely require an effluent pump station and force main to the Harbour outfall.

Option 2

- Two treatment facilities (decentralized treatment), e.g. Hays Creek and Ritchie Point, or Hays Creek and Morse Creek.

2A – Hays Creek and Morse Creek

2A – Hays Creek and Morse Creek

- Hays Creek - handle 70 percent of the sewered area
- Morse Creek - handle 30 percent of the sewered area
- Effluent would be discharged to the harbour through long, deep outfalls.
- Pump stations to convey flows

Option 2A – Hays Creek and Morse Creek

Advantages:

- 40 percent of the City's total wastewater is already discharged through Outfall I (Hays Creek area).
- Lower conveyance costs than Options 1A, 1B, 1C, 2B and 3.
- Resource recovery, such as heat recovery is potentially viable.

Disadvantages:

- The Hays Creek Treatment Facility in the City's core area.
- Land may be difficult and more expensive to acquire.
- Solids would likely be treated at a central facility (hauling off site).

Option 2B – Hays Creek and Ritchie Point

Option 2B – Hays Creek and Ritchie Point

- Hays Creek - handle 80 percent of the sewered area
- Ritchie Point - handle 20 percent of the sewered area
- Effluent would be discharged to the harbour through long, deep outfalls

Option 2B – Hays Creek and Ritchie Point

Advantages:

- 40 percent of the City's total wastewater is discharged through Outfall I.
- Lower conveyance costs than Options 1A, 1B, and 1C.
- Resource recovery, such as heat recovery is potentially viable.

Disadvantages:

- The Hays and Morse Creek Facilities are location in the City's core area.
- Land may be difficult and expensive to acquire.
- Solids would likely be treated at a central facility (require hauling off site).

Option 3

- Three separate wastewater treatment facilities (decentralized treatment)
- Example, one each at Hays Creek, Ritchie Point, and Morse Creek area

Option 3 - Three Facilities - Hays Creek, Ritchie Point, and Morse Creek

Option 3 - Three Facilities - Hays Creek, Ritchie Point, and Morse Creek

- Hays Creek, Morse Creek, and Ritchie Point would handle approximately 50, 30, and 20 percent of the sewered areas, respectively.
- Treated effluent would be discharged to the harbour through long, deep outfalls.

Option 3 – Hays Creek, Ritchie Point, and Morse Creek

Advantages:

- 40 percent of the total wastewater discharged through Outfall I.
- Treatment facilities are located in areas with largest wastewater flows.
- Lower conveyance costs than Options 1B, and 1C.
- Resource recovery, such as heat recovery is potentially viable.

Disadvantages:

- Located in the City core area.
- Land may be difficult and more expensive to acquire.
- Solids would likely be treated at a central facility and will require hauling off site.

Discussion Paper 2-2 Summary

- Potential options for managing the City's wastewater
- Options 1A - single treatment facility at Hays Creek, and Option 2A - treatment facilities at Hays Creek and Morse Creek, should be considered further. Ritchie Point facility (Options 2B and 3) will also remain as a viable alternative if required.

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-3

Treatment Technology Options

Objectives of Discussion Paper 2-3

Feasible treatment options short-listed down to two to three for more extensive investigation, costing, and reviews

Treatment Requirements

- Up to **two times the ADWF** will be treated to secondary treatment standards.
- Up to **four times the ADWF** will be treated to primary treatment standards.
- All flows **greater than four times the ADWF** will be treated to preliminary treatment level.

Regulatory Effluent Quality Requirements for Primary and Secondary Treatment

Parameter	Compliance Criteria Primary Treatment	Compliance Criteria Secondary Treatment	CCME National Performance
Biochemical Oxygen Demand (BOD_5)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Total Suspended Solids (TSS)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Fecal Coliforms	Not applicable	Not applicable	Not applicable
Turbidity	Not applicable (at this time)	Not applicable (at this time)	Not applicable
Nitrogen	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone	Not applicable

Redundancy Requirements

- Increase the reliability of the treatment system, usually in the case of failure or regular maintenance requirements
- Schedule 7 – Design Standards for Sewage Facilities of the British Columbia MSR

What are the levels of Treatment?

- Preliminary (screening only)
- Primary (grit removal and sedimentation)
- Secondary (with or without Primary)
- Advanced or Tertiary

Preliminary Treatment Technologies

- Preliminary treatment - first level of treatment
- Technologies
  - Screening (3 different types)
  - Vortex separators.

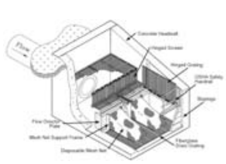
Mechanical Screening

- Typically uses a mesh
- Retains solids and the liquid passes through
- Perforated panels convey screened material
- Discharge solids on the downstream side of the screen.
- Screened material is removed from the panels by a high-speed rotating brush and water spray.

Fine Screens

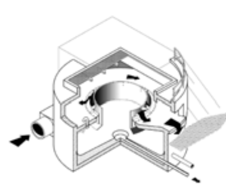
- Normally effective at removing floatables and solids greater than 4 mm.
- Screenings are typically bagged and disposed of in a landfill.
- Potentially high operation and maintenance costs

Solid Collection Systems (e.g., Netting TrashTrap®)



- Prefabricated trash and floatables collection system
- No external power - energy of the flow is used
- End of pipe system
- Full nets would require disposal at a licensed landfill

Vortex Separators



Picture FluidSep™ courtesy of John Meunier, Inc.

- Swirling action to move particles to a centre drain and the liquid to the outside effluent channel
- Removes gritty materials, heavy particulates, and floatables
- Relatively small foot print requirement
- Relatively low capital and operational costs

Primary Treatment Technologies

- Unit processes that can effectively remove floating, and settleable solids
- Leaves a portion of the non-soluble organics and most of the soluble organics
- Up to four times the City's ADWF will be treated to primary treatment standards

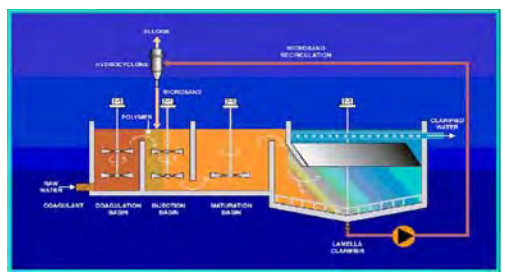
Primary Clarification

- Rectangular or circular tank
- Capable of removing 50 to 70% of the suspended solids and 25 to 40% of the BOD.
- Large footprint
- Quite expensive to build and operate
- Requires infrastructure for sludge thickening, digestion and dewatering

Chemically Enhanced Primary Treatment

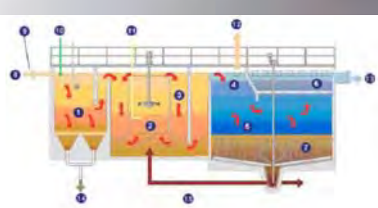
- Treatment improved via addition of coagulant chemicals
- Requires infrastructure to deal with the settled solids (sludge)
- CEPT systems that use fine sand and/or polymers (sticky long-chain chemicals)
- Less space than conventional primary treatment systems

Actiflo™



The Actiflo™ process (courtesy of John Meunier, Inc).

Densadeg™



Legend
1-Grit removal/coagulation
2-Flocculation, first stage
3-Flocculation, second stage
4-Grease and scum removal
5-6-Pre-settling and lamellar settling
7-Sludge densification and thickening
8-Raw wastewater
9-Coagulating agent
10-Air
11-Flocculating agent
12-Grease and scum draw-off
13-Treated water
14-Grit draw-off
15-Sludge recirculation

Microscreens

- Use mesh filter with openings ranging from 1 to 350 µm
- TSS and BOD removal - soluble BOD is not removed
- Solids are either captured on screen or indirectly captured on "mat" or thin film of solids that have been previously caught on the mesh surface.

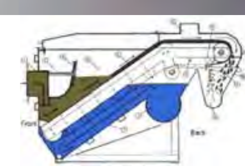


Figure courtesy of Salsnes Filter® North America

Secondary Treatment Technologies

- Removes soluble and insoluble organic matter
- Prevents oxygen depletion - loss of fish
- Helps remove EDCs and PPCPs
- Helps manage the creation of nitrous oxide from proteins and ammonia
- All flows up to two times ADWF would receive secondary treatment
- Secondary treatment technologies

Activated Sludge

- Type of suspended growth process
- Activated mass of microorganisms capable of stabilizing wastewater in an aerobic environment (oxygen is added)
- Good nitrification (oxidation of ammonium)
- Handle peak loads
- Require aeration: high operational costs
- Requires a settling tank: large overall footprint

Sequencing Batch Reactor

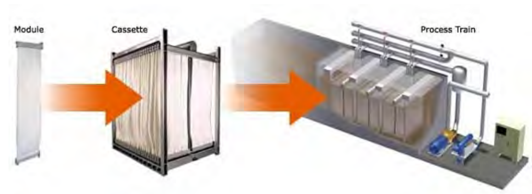
- Suspended growth treatment process
- High quality effluent – possibility of biological nutrient (nitrogen and phosphorus) removal.
- Treatment processes occur in one tank
- Some capacity to reduce EDCs and PPCPs, longer sludge ages
- Often used to treat smaller flows
- Small footprint and provide good settling, flexible operation, and automation
- Construction of tanks can be staged

Sequencing Batch Reactor

Membrane Bioreactor

- Use a single-tank system
- Compact footprint
- High quality effluent
- Long sludge ages - most likely to reduce EDCs and PPCPs
- Require additional equipment and energy
- High capital costs and operational costs

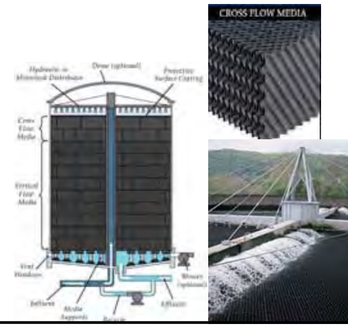
Membrane Bioreactor



Trickling Filter / Solids Contact

- Treatment occurs when the wastewater comes in contact with the rock or plastic media
- A robust form of secondary treatment
- Can be used for biological nutrient removal
- Likely reduces EDC and PPCP concentrations more than a straight trickling filter system

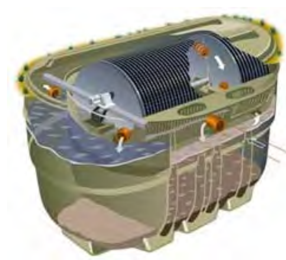
Trickling Filter / Solids Contact



Rotating Biological Contactors

- Fixed-film secondary treatment process – similar to trickling filter.
- Series of closely spaced circular disks, submerged in wastewater and rotated slowly through it
- Robust form of secondary treatment
- Potentially capable of being incorporated into some form of biological nutrient removal scheme
- Easy to maintain
- Suitable for small treatment systems

Rotating Biological Contactors



Integrated Fixed Film Activated Sludge / Moving Bed Biofilm Reactor

- IFAS is a variation of the conventional activated sludge process
- Synthetic materials are used within the activated sludge tank
- Generally provides better EDC and PPCP removal capabilities
- Clarifier follows the aeration tank to settle out biological solids

Integrated Fixed Film Activated Sludge / Moving Bed Biofilm Reactor

Images courtesy of Veolia - Kaldnes

Disinfection

- Process used to kill most disease-causing organisms
- Disinfection efficiency measured using "indicator organisms" - fecal coliforms
- Most widely used disinfection technologies:
  - Chlorination/dechlorination
  - Ultraviolet (UV) irradiation (becoming industry standard)
- Disinfection of the City's wastewater effluent may not be "required"

Chlorination / Dechlorination

- Most widely used method of disinfection
- Effective against a wide spectrum of microorganisms, even in low concentrations
- Offers flexible dosing which enables greater control over disinfection
- Safety concerns with chlorine gas

Chlorination / Dechlorination

- Disinfection by-products
- Dechlorination - achieved with the addition of another chemical
- Chlorine residual - toxic to aquatic life
- All forms of chlorine are highly corrosive and toxic
- High operation and maintenance costs.

Ultraviolet (UV) Irradiation

- Common alternative to chlorination
- Physical disinfection process - uses electromagnetic radiation
- Function of TSS concentration and light transmittance, as well as contact time and UV intensity
- Physical treatment should precede the disinfection process
- Installed in an open or closed channel

Ultraviolet (UV) Irradiation

Picture Courtesy of Trojan Technologies

Comparison of the Reviewed Treatment Processes

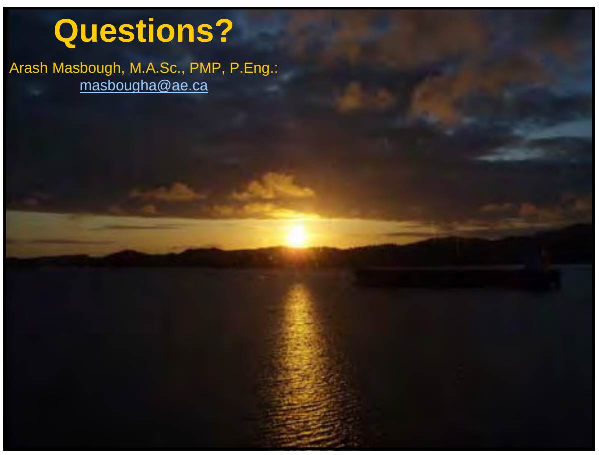
- Technologies were compared based on capital cost, operational cost, footprint, BOD removal, TSS removal, and EDC/PPCP removal
- Ratings of low, medium, and high were used to rank each technology

Comparison of the Reviewed Treatment Processes Contd.

- Short-listed options are:
  - **Preliminary treatment - vortex separator**
  - **Primary treatment - microscreen**
  - **Secondary treatment - activated sludge or sequencing batch reactor**
  - **Disinfection - UV irradiation**
- Short-listing technologies is for planning purposes only
- More in-depth evaluation during pre-design stage
- Land availability and conditions - important in final technology selection

Next Steps

- Finalize the existing DPs
- Prepare the next DPs:
  - **Land Requirements and Availability**
  - **Wastewater Conveyance and Disposal Methods**
  - **Sustainability & Integrated Resource Recovery Options**
  - **Cost Estimate for the Short Listed Options**
- Next TAC/LAC meeting
- Public Involvement & Final Report for Stage 2



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Date:	March 12, 2010
File:	20062891.02.PM.04.00
Time:	12 pm – 3 pm
Page:	1 of 3
Project:	LWMP Stage 2
Subject:	TAC/LAC Meeting
Client:	City of Prince Rupert
Location:	City of Prince Rupert - Council Chambers
Present:	Bob Thompson (BT) – City of Prince Rupert (CPR) Keith Cameron (KC) – CPR Bill Horne (BH) – CPR Richard Pucci (RP) – CPR Zeno Krekic (ZK) – CPR Larry Golden (LG) – Prince Rupert Environmental Society Jeannette Lough (JL) – Ministry of Environment Tom Coleman (TC) – Canadian Fishing Co. Renny Talbot-Ellis (RTE) – Department of Fisheries & Oceans Mike Graham (MG) – Prince Rupert Port Authority Reto Riesen (RR) – Northwest Community College Arash Masbough (AM) – Associated Engineering (AE) Manjit Herar (MH) - AE
Distribution:	Those Present

RECORD OF MEETING

These minutes are considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise these minutes will be considered to be an accurate record of the discussions.

Action By: | **Discussion:**

Info — **1 INTRODUCTIONS**

AM welcomed the local and technical advisory committees. Meeting attendees introduced themselves.

Info — **2 OVERVIEW OF PUBLIC OPEN HOUSE**

AM provided an overview of the Public Open House. The Public Open House presentation provided an overview of the Stage 2 LWMP goals and objectives and work completed to date. A copy of the open house minutes is attached.

3 REVIEW OF PREVIOUS AND RECENT STAGE II WORK

Info — AM provided an overview of previously presented Discussion Papers (A copy of the presentation slides is attached to this document):

- Waste volume and facility sizing

Action By:	Discussion:

- Treatment facility options
- Treatment technology options

The recent tasks were discussed in more detail:

- Land requirement and availability
- Wastewater conveyance and disposal methods
- Sustainability and resource recovery options
- Cost Estimates

4 LAND REQUIREMENTS AND AVAILABILITY

The approximate area required for each treatment facility option was presented along with proposed general area to site the treatment facility.

Question was asked regarding how will the city handle densification in certain catchments. Each treatment facility will include a plan in place for expansion.

AE — Land availability at the proposed locations should be invested in more detail in later stages. ZK recommends plotting the size of footprint on actual property lots.

5 WASTEWATER CONVEYANCE AND DISPOSAL METHODS

Info — Wastewater conveyance to the treatment facilities using a combination of gravity sewers and pump stations and force mains was presented. Treated wastewater effluent disposal methods were also presented.

Question was asked regarding what the difference is between the flows experienced by the City of Prince Rupert and similar size communities with dryer climates. The City will treat up to four times ADWF. This is not required by the Municipal Sewage Regulations, but will be done to address the wet climate.

6 SUSTAINABILITY AND RESOURCE RECOVERY OPTIONS

Integrated resource recovery and added value sustainability options within the wastewater collection, treatment, and disposal systems, as well as, solid waste collection and disposal processes were presented.

A question was asked regarding anaerobic digestion and why the minimum population required is 60,000? Smaller anaerobic digestion systems have been implemented.

Action By:	Discussion:
	However, based on today's available technology, it may not be economically feasible to install an anaerobic system that is not large enough (due to the sludge inputs), and therefore, can not generate enough gas for heating all or parts of the treatment facility.
	The biosolids may potentially be composted. Fish waste could be potentially mixed with sludge and composted. The supply of fish waste in the City is variable. Supplies can not be stored for very long. Suggestion was made to look at locally available muskeg to add to the compost mix. Other municipalities have land applied sludge as a method of sludge disposal.
Info	The various classifications of biosolids were discussed. Composting is regulated by the Ministry of Environment's Organic Matter Recycling Regulation (OMRR). The Kelowna-Vernon Composting Facility produces a Class A product which adheres to the strictest requirements of OMRR.
	A question was asked if Kelowna has any problems meeting the requirements of heavy metals. The facility in Kelowna has been designed to meet the Class A product requirements which provides certain limitations for the maximum concentration of the heavy metals.
	7 COST ESTIMATES
	Class D, planning level, order of magnitude, cost estimates were presented for each of the three options. Net Present Value (NPV) of each option was presented. The NPV cost estimates use an interest rate of 3%. Operational and Maintenance Costs for WWTF are 3 percent of capital. Operational and Maintenance Costs for Pump stations, force mains, gravity sewers and diversion chambers are 1 percent of capital. Operational and Maintenance Costs for outfalls are 2 percent of capital.
	BT mentioned that when the time comes for implementation, the governments will have to look at where is the best place to spend the funding. Per capita cost may become more and more important.
	The implementation plan will be completed in Stage 3 of the LWMP. The phasing of the capital works would likely occur in the next decade or so.
AE	Suggestion was made to have the architecture of the treatment facility take the presence of First Nation communities into consideration.

Action By: **Discussion:**

8 MOVING FORWARD

The treatment facilities; and therefore, the outfalls will be dispersed throughout and can be phased. Phasing of the treatment facilities would also enable the City to more effectively mitigate the environmental issues and social implications.

Advisory Committees recommended moving forward with Option 3 – Treatment facilities at Hays Creek, Morse Creek, and Ritchie Point. For this option, one treatment facility at Hays Creek will be built. If needed, one or two additional treatment facilities can be built in the Morse Creek and Ritchie Point areas. Or the City can decide to expand the Hays Creek Treatment Facility to accommodate all of the City's wastewater volume. This option provides the City with the most flexibility.

Next steps are to finalize the Discussion Papers, prepare a Stage 2 Final Draft Report, incorporate comments received from the City and Advisory Committees, and submit the Final Stage 2 Report to the Ministry for approval.

Post Meeting Note: The Stage 3 LWMP will be undertaken in the next fiscal year (2011).

Prepared by:

Manjit Herar, M.S., P.Eng., LEED® AP
Environmental Engineer

Reviewed by:

Arash Masbough, M.A.Sc., PMP, P.Eng.
Project Manager

MH/AM/lp

Enclosures:
- Open House Minutes
- Attendees List
- Slides

City of Prince Rupert
LWMP Stage 2
TAC/LAC Meeting No. 2
March 12, 2010
Sign in Sheet

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GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Associated Engineering

City of Prince Rupert Liquid Waste Management Plan Stage 2

Technical Advisory / Local Advisory Committees Meeting

March 12, 2010

Meeting Agenda

- Introduction/Background
- Summary of Stage 1
- Stage 2 LWMP
- Group Discussion
  - Options Evaluation and Preferred Selection
- Potential Directions and Next Steps

The Liquid Waste Management Plan

- A long range **planning** tool
- Part of integrated sustainable community planning
- Three stages - setting the stage; evaluating strategies; implementation planning
- Key players - Steering Committee, Technical Advisory Committee, Local Advisory Committee; the Public

LWMP - The Deliverable

A long range, sustainable wastewater management strategy developed by the community after consideration of environmental, social and economic elements.

Sewerage Areas

Existing Wastewater Management Where Have We Started From?

- 10 major sewerage areas
- Mix of combined and separated sewers
- Partial preliminary treatment on only one area
- No treatment on the other 9 areas
- Some sewers are over 80 years old

Existing Wastewater Management - The State of the Harbour

The Harbour has been impacted by both a century of industrial activities and by the discharge of raw wastewater and stormwater into the harbour. Future liquid waste management planning needs to consider the harbour in a holistic manner, looking at both the existing situation, the objectives of the community and the ability to implement any environmental improvement program in an affordable manner.

Sewage System Upgrading Plan, May 2004

Stage 1 LWMP

- **Discussion Papers Prepared**
  - Wastewater Management Issues
  - Existing/Projected Community Development
  - Source Control
  - CSO and Wet Weather Flow Management
  - Develop Wastewater Management Options
- **Three LAC/TAC meetings**
- **Public Presentation and Open House**
- **Summary Report**

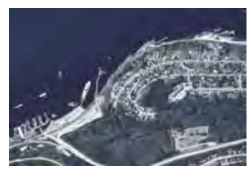
Stage 2 LWMP Tasks and DPs

1. **Waste Volumes and Facility Sizing Criteria**
2. **Wastewater Treatment Facility Options**
3. **Treatment Technology Options**
4. **Land Requirements and Availability**
5. **Wastewater Conveyance and Disposal Methods**
6. **Sustainability and Integrated Resource Recovery Options**
7. **Cost Estimate for Short Listed Options**
8. **Public Involvement** and **Final Report for Stage 2**

LWMP - Stage 2

Discussion Paper 2-1

Waste Volumes and Facility Sizing Criteria



Objectives of Discussion Paper 2-1

- Confirm population projection developed in Stage 1
- Estimate wastewater volumes
- Wastewater treatment requirements
- Estimate the amount of non-biodegradable solids
- Estimate the amount of sludge

Projected Populations for 2030 and 2050

Growth %	Population – 2030	Population - 2050
1	16,272	19,855
1.5	18,319	25,673
2	20,612	30,629

Wastewater Treatment Requirements

- City will develop a wastewater treatment regime to meet the following treatment requirements:
  - Up to two times the ADWF - secondary treatment
  - Up to four times the ADWF - primary treatment
  - All flows greater than four times the ADWF - treated as Combined Sewer Overflow (CSO) as discussed in Stage 1

Discussion Paper 2-1 Conclusions

- Design population based on 1.5 percent growth
- ADWF is estimated for 2030 and 2050
- Maximum daily flow is estimated for 2030 and 2050
- Solids production estimated
- Treatment requirements defined

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-2

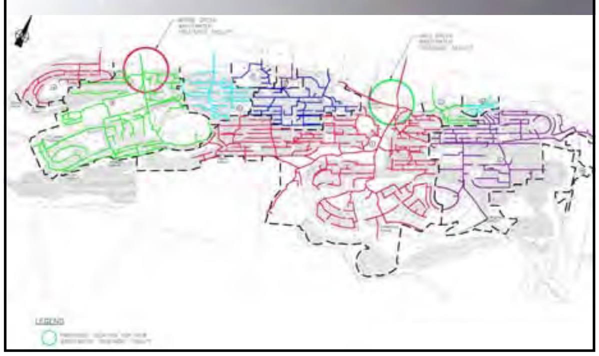
Wastewater Treatment Facility Options

Objectives of Discussion Paper 2-2

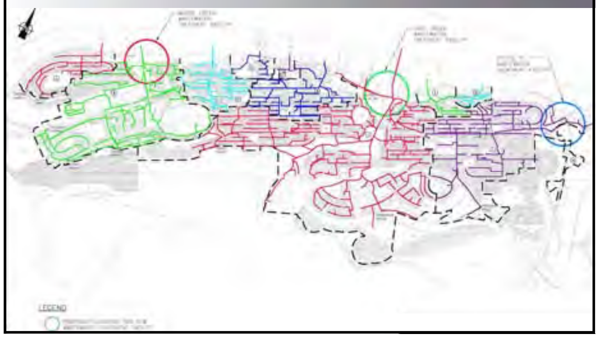
- Present options for number and location(s) of wastewater treatment facilities
- Advantages and disadvantages of each option
- After consideration at TAC/LAC meeting, three options shortlisted

Option 1A – Hays Creek

2A – Hays Creek and Morse Creek



Option 3 - Three Facilities - Hays Creek, Ritchie Point, and Morse Creek



Discussion Paper 2-2 Summary

- Potential options for managing the City's wastewater
- Options 1A - single treatment facility at Hays Creek, and Option 2A - treatment facilities at Hays Creek and Morse Creek, should be considered further. Ritchie Point facility (Option 3) will also remain as a viable alternative if required.

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-3

Treatment Technology Options

Objectives of Discussion Paper 2-3

Feasible treatment options short-listed down to two to three for more extensive investigation, costing, and reviews

Treatment Requirements

- Up to **two times the ADWF** will be treated to secondary treatment standards.
- Up to **four times the ADWF** will be treated to primary treatment standards.
- All flows **greater than four times the ADWF** will be treated as CSO

Regulatory Effluent Quality Requirements for Primary and Secondary Treatment

Parameter	Compliance Criteria Primary Treatment	Compliance Criteria Secondary Treatment	CCME National Performance
Biochemical Oxygen Demand (BOD_5)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Total Suspended Solids (TSS)	130 mg/L Maximum	45 mg/L Maximum	25 mg/L Average
Fecal Coliforms	Not applicable	Not applicable	Not applicable
Turbidity	Not applicable (at this time)	Not applicable (at this time)	Not applicable
Nitrogen	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone	Not applicable

Comparison of the Reviewed Treatment Processes Contd.

- Short-listed options are:
  - **Preliminary treatment - vortex separator**
  - **Primary treatment - microscreen**
  - **Secondary treatment - activated sludge or sequencing batch reactor**
  - **Disinfection - UV irradiation**
- Short-listing technologies is for planning purposes only
- More in-depth evaluation during pre-design stage
- Land availability and conditions - important in final technology selection

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-4

Land Requirements and Availability

Options Considered

- **Option 1A** – Single Wastewater Treatment Facility at Hays Creek;
- **Option 2A** – Two Wastewater Treatment Facilities at Hays Creek and Morse Creek;
- **Option 3** – Three Wastewater Treatment Facilities at Hays Creek, Ritchie Point, and Morse Creek.

Methodology

- approximate “liquid treatment” footprints for the currently operating or designed treatment facilities
- a treatment area per volume of ADWF treated ratio (m^2/m^3)

Estimated Footprint Requirements (Year 2030 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	7,600	19,000
2A – Two facilities	Hays Creek	5,400	13,500
	Morse Creek	1,600	6,400
3 – Three facilities	Hays Creek	3,900	9,800
	Morse Creek	1,600	6,400
	Ritchie Point	1,100	4,400

Estimated Footprint Requirements (Year 2050 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	10,000	25,000
2A – Two facilities	Hays Creek	7,200	18,000
	Morse Creek	2,100	8,400
3 – Three facilities	Hays Creek	5,300	13,300
	Morse Creek	2,100	8,400
	Ritchie Point	1,400	5,600

Land Availability

- The City needs to select and acquire properties to site one or more treatment facilities in near future
- Wastewater treatment facilities are preferred to be located away from or screened from residential areas
- Future “optimization” opportunities

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-5

Wastewater Conveyance and Disposal Methods

Conveyance and Disposal Methods

- Wastewater conveyance and disposal methods for the proposed treatment options
- Pumping vs. gravity sewers
- Capacity of the existing outfalls

Option 1A: Hays Creek Facility (4 pump stations + 5 gravity trunks)

One Facility: Hays Creek

Advantages

- Gravity flow to consolidate flows from five catchments.
- 40 percent of the City’s total wastewater already discharged through Outfall I.
- Able to use the existing Outfall I

Disadvantages

- Requires four pump stations.
- Pumping out of Outfall I may be required.
- Located in the City core area.
- Land may be difficult and expensive to acquire.

Option 2A: Hays Creek and Morse Creek Facilities(3 pump stations + 5 gravity trunks)

Two Facilities: Hays Creek and Morse Creek

Advantages
- Gravity flow can be used for flows from five catchments.
- Number of pump stations required less than Option 1A.
- 40 percent of the City's total wastewater discharged through Outfall I
- Sufficient capacity in Outfall I.
- May be able to use the existing Outfall B

Disadvantages
- Requires three pump stations.
- Land may be difficult and expensive to acquire.
- Cost of pumping out of Outfall B.
- Longer, larger diameter Outfall B is required

Option 3: Hays Creek , Morse Creek & Ritchie Point (2 pump stations + 5 gravity trunks)

Three Facilities: Hays Creek, Morse Creek, & Ritchie Point

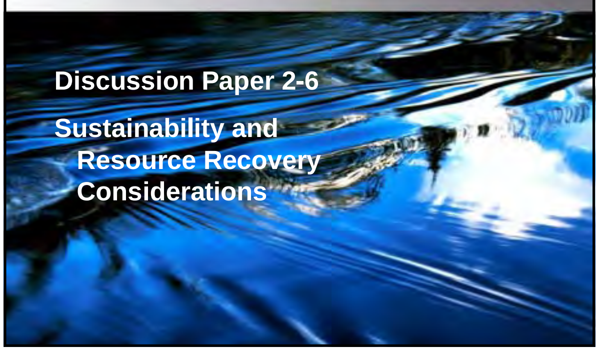
Advantages
- Gravity flow for flows from five catchments.
- Number of pump stations less than Options 1A and 2A.
- 40 percent of the City's total wastewater discharged through Outfall I
- Treatment facilities are located in areas with largest wastewater flows.
- Sufficient capacity in Outfalls I and L.

Disadvantages
- Requires two pump stations.
- Located in the City core area.
- Land may be difficult and expensive to acquire.
- Longer, larger diameter Outfall B is required
- Outfall L requires a new alignment to discharge to Prince Rupert Harbour. Realignment will require pumping.

Conveyance & Discharge Summary

- Different options for each of the three different wastewater treatment options
- Combination of gravity sewers and pumping stations
- Should be reviewed in conjunction with overall wastewater management direction

Liquid Waste Management Plan - Stage 2



Sustainability & resource recovery considerations

- Flow Energy Management
  - Wastewater flow management
  - Pressure energy recovery
- Wastewater Heat Recovery
- Biosolids energy recovery and reuse
- Water reclamation not being discussed at the moment

Flow Energy Management

- Wastewater Flow Management
  - Flow energy management: focuses on conveying wastewater to practically minimize external energy inputs (i.e. pumping)
  - Example design strategies:
    - siting wastewater treatment facilities at lower elevations
    - maintain high water levels in pump and lift station wet-wells during low wastewater flow periods

Pressure Energy Recovery

- A turbine or other mechanical device captures the energy in water flow:
- In-pipe turbines
- Pumps as turbines

Source: New Energy Foundation

Source: Associated Engineering

Heat Recovery Technology

- The low-grade heat extracted from wastewater used for space heating and water heating
- Heat pump technology: a reverse refrigeration cycle to increase low temperatures up to useable heating levels

Heat Recovery Technology

- Pumped Heat Systems
  - Plate and Frame
  - Shell and Tube

Source: Associated Engineering

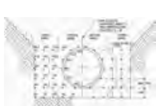
Source: Friotherm

Heat Recovery Technology

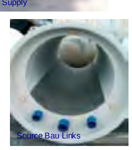
- **In-tank heat exchangers**

Source AWEB Supply

- **In-Pipe or In-Trench Heat Exchangers**



Source Cobalt Engineering



Source Bau Links

Biosolids Energy Recovery & Re-use Technology

- How to deal with biosolids?
- "Resource" vs. "Waste"
  - Anaerobic Digestion
  - Aerobic Digestion
  - Composting

Anaerobic Digestion & Bio Gas Use

- Bacterial process in a closed vessel in the absence of oxygen
- Biogas: 60-65% methane and 35-40% CO_2
- Cogeneration or Fuel
- Practical Scale: ~ 60,000 population
- “Mixed” biosolids (fish waste etc.)

Composting

- Aerobic process
- Dewatered raw sludge or dewatered digested biosolids and/or source-separated solid waste organics mixed with a woody amendment
- Aerated for a period up to 21 days, with temperatures in the 55 to 65°C

Composting

- Odour generation an issue
- Enclosed facilities
- Foul air collection and treatment
- Away from residences and core area

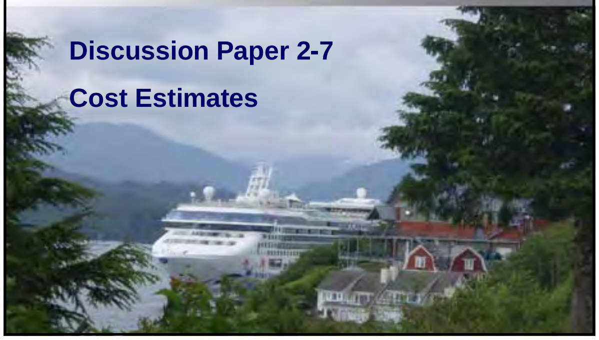
Sustainability & Resource Recovery Considerations: Summary

- Good opportunity for the City to manage wastewater flows and conveyance
- Pressure energy recovery and heat recovery can be considered at later stages
- A number of options to deal with biosolids

Bio-Solids

- Combining wastewater sludge with fish processing waste, and if feasible, anaerobic digestion at the “largest” site
- Combining wastewater sludge with fish processing waste, and if feasible, anaerobic digestion off site (e.g. at the City’s landfill)
- Composting the dewatered aerobically digested or raw sludge (possible combining with other organic waste) offsite (away from the City centre)

Liquid Waste Management Plan - Stage 2



COST ESTIMATES

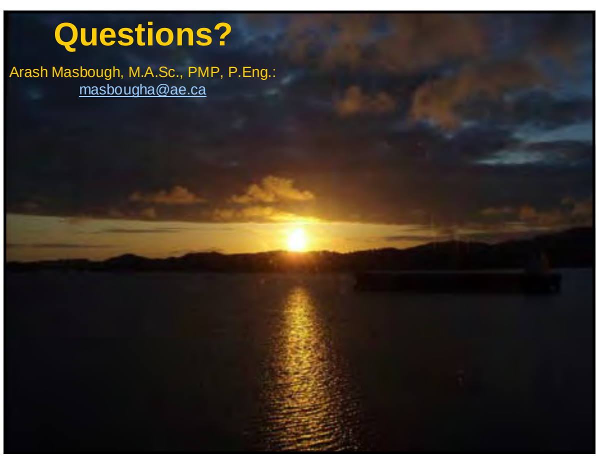
- "High Level" cost estimates for comparison/planning purposes
- Order of magnitude $$
- 2010 Dollars
- 35% contingency
- 15% engineering and management

Cost Estimates

- The capital cost estimate for each option includes the following items:
  - Wastewater treatment facilities
  - Pump stations and Force mains
  - Gravity trunk sewers
  - Diversion chambers
  - Outfalls
  - Off-site composting facility (separate)
  - No Land Acquisition Costs
  - $$ to be spent over a number of years

Next Steps

- Finalize the DPs
- Prepare the Final Draft Report
- Incorporate Comments
- Submit to the Ministry
- Stage 3 Startup (2011)



Appendix I - Public Open House Presentation Materials

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Date:	March 11, 2010	**File:**	20062891.02.P.04.00
Time:	4:30 pm to 7:30 pm	**Page:**	
Project:	LWMP Stage 2		
Subject:	Public Open House		
Client:	City of Prince Rupert		
Location:	City of Prince Rupert, Council Chambers		
Present:	Bob Thompson (BT) – City of Prince Rupert (CPR) Keith Cameron (KC) – CPR Richard Pucci (RP) – CPR Zeno Krekic (ZK) – CPR Larry Golden (LG) – Prince Rupert Environmental Society Tom Coleman (TC) – Canadian Fishing Co. Reto Riesen (RR) – Northwest Community College Laura Walker (LW) David Walker (DW) Joy Thorkelson (JT) Ken Lippett (KL) Anna Lamb-Yorski (ALY) Monica Lamb-Yorski (MLY) – Prince Rupert Daily News Arash Masbough (AM) – Associated Engineering (AE) Manjit Herar (MH) - AE		
Distribution:	File and TAC/LAC Members		

RECORD OF MEETING

These minutes are considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise these minutes will be considered to be an accurate record of the discussions.

Action By: | **Discussion:**

1 INTRODUCTION

A Public Open House was held between 4:30 p.m. and 7:30 p.m. in the City of Prince Rupert (City) Council Chambers to inform the citizens residing in the City about the Stage 2 Liquid Waste Management Plan (LWMP) and to hear comments on the LWMP process. Invitations to the Public Open House had been placed in the Daily News, the City's local newspaper on March 5, 2010 and March 10, 2010. A newspaper article regarding the Stage 2 LWMP and inviting the public to attend the Open House was published in the Daily News on March 9, 2010. The Local and Technical Advisory Committees (TAC/LAC) had had been sent invitations to attend the Public Open House.

The initial part of the meeting was an open house format with posters to allow one-on-one discussion with City staff and the consultant team. The second part of the meeting was a formal presentation by the consultant team. The presentation was formatted to allow questions and dialog with the members of the public. The third part of the meeting was a question and answer period. A public open house was held The Stage 2 LWMP work was formally presented by AM and MH.

Action By: **Discussion:**

2 QUESTION AND ANSWER PERIOD

Following the presentation, there was a question and answer period. The following questions were asked:

Q: Can bark material be used in compost? Bark is plentiful due to the logging industry.

A: Yes, that is a potential source. Would need to put it through a chipper to maximize the available surface area for composting.

Q: Some of the sewer lines are 80 years old. How do we know which lines are operating properly and which ones have operational issues?

A: The City is constantly monitoring the status of the sewer lines. They are upgraded and repaired as necessary. The City is currently working on the Hays Creek sewer replacement. Eventually other major sewers will also be replaced, as required, and when the funding is available.

Q: Has the City considered abandoning the existing sewer system and just building a new sanitary sewer and using the existing sewer as storm sewers?

A: Yes. Sewer separation has been considered and is being implemented. Some of the existing sewers are too old to be used for storm. Better to replace the existing sewers with a new storm and new sanitary sewer.

Q: Is the sewer system in Catchment I separated?

A: Yes, but rainwater still enters the sanitary sewer line through holes and cracks in the pipes and manholes.

Q: So we are moving ahead with primary and secondary treatment. Is disinfection also included?

A: Yes. Disinfection has been included to provide a safer environment for recreational use and possibly, in the future, opening up the harbour to shellfish harvesting.

Q: If water reclamation is to be done, is disinfection required?

A: Depending on the type of usage, disinfection may or may not be required.

Action By: **Discussion:**

Q: The term "Average Dry Weather Flow" (ADWF) was asked to be explained. How many days in Rupert would be considered ADWF?

A: ADWF is the amount of flow that would require treatment during an extended period of dryer weather. It is normally from mid to late May to the end of July.

Q: The stormwater contains lots of pollutants. Shouldn't we be treating that?

A: The City currently uses stormceptors in some locations. The stormceptors remove particulates and oil and grease. The future treatment facility(ies) will take the "first flush", which is the worst because it is more contaminated.

Q: What is the maximum build out?

A: The maximum build out of the City is 25,000 people based on the City's Official Community Plan.

Q: Have we talked about regulations for the vessels? Has that waste been taken into consideration?

A: Wastewater from cruise ships can be accepted off-hours. The City can build this capacity into the system.

Q: How long will the LWMP process take to implement?

A: The City could be expected to have treatment ten years from now.

Q: Can the tanks at the mill be used for composting?

A: They may be too large, but can still be considered.

Q: Can the tanks be used as digesters?

A: No. The City will not produce adequate sludge to make use of the tanks capacity..

Q: What would the standard footprint be for a composting facility for the City?

A: Prince Rupert would require a compost facility one-third the size of City of Kelowna/Vernon Composting Facility.

Action By: **Discussion:**

3 CLOSURE

AM thanked members of the public for their attendance and input.

The next steps the City will take regarding Stage 2 of the LWMP are to finalize the discussion papers, prepare the Final Draft Report to the City for approval, incorporate comments from the City, prepare the Final Report, submit the Final Report to the Ministry for approval. On approval of the Stage 2 LWMP, the City can begin Stage 3,

Prepared by:

Manjit Herar, M.S., P.Eng., LEED® AP
Environmental Engineer

Reviewed by:

Arash Masbough, M.A.Sc., PMP, P.Eng.
Project Manager

MH/AM/lp

CITY OF PRINCE RUPERT
STAGE 2 - LIQUID WASTE MANAGEMENT PLAN
PUBLIC OPEN HOUSE
MARCH 11, 2010

MEETING REPORT

MEETING FORMAT

The Public Open House was held between 4:30 pm and 7:30 pm in the City Of Prince Rupert Council Chambers. Advertisements of the Public Open House had been placed in the Daily News, the City's local newspaper on March 5th, 2010 and March 10th, 2010. A newspaper article regarding the Stage 2 LWMP and inviting the public to attend the Open House was published in the Daily News on March 9th, 2010. The Local and Technical Advisory Committees had had been sent invitations to attend the Public Open House.

The initial part of the meeting was an open house format with posters to allow one-on-one discussion with City staff and the consultant team. The second part of the meeting was a formal presentation by the consultant team. The presentation was formatted to allow questions and dialog with the members of the public. The third part of the meeting was a question and answer period.

ATTENDANCE

Fourteen members of the public attended the meeting, including a staff member from the Daily News. A newspaper article on the progress of the Stage 2 LWMP is expected.

DISCUSSION

A copy of the slide presentation is appended, along with the handout and questionnaire. The discussion with the public covered a wide range of issues in the presentation. Although the return of completed questionnaire was limited, there was a sense that the participants came away with a good understanding of what the Stage 2 LWMP process is all about. There was also general support for the direction of the LWMP into Stage 3.

FEEDBACK FOR INCORPORATION INTO STAGE 2 REPORT

The public was supportive of the LWMP process and the implementation of wastewater treatment. There was also interest in the potential for resource recovery, such as composting or biogas generation from the wastewater, as well as the potential for co-management with other waste sources (solid waste and fish processing waste).

SUMMARY

The public information meeting was considered successful. This coupled, with the posting of Stage 2 LWMP material on the City's web page, has led to a reasonable degree of communication with the public in Stage 2.

Attachments

Meeting Minutes
Copy of Slide Show
Handout
Questionnaire

Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

City of Prince Rupert Liquid Waste Management Plan Stage 2

PUBLIC OPEN HOUSE
March 11, 2010

Outline

- Introduction/Background
- Summary of Stage 1
- Stage 2 LWMP
- Potential Directions and Next Steps

The Liquid Waste Management Plan

- A long range **planning** tool
- Part of integrated sustainable community planning
- Three stages - setting the stage; evaluating strategies; implementation planning
- Key players - Steering Committee, Technical Advisory Committee, Local Advisory Committee; the Public

LWMP - The Deliverable

A long range, sustainable wastewater management strategy developed by the community after consideration of environmental, social and economic elements.

Sewerage Areas

Existing Wastewater Management
Where Have We Started From?

- 10 major sewerage areas
- Mix of combined and separated sewers
- Partial preliminary treatment on only one area
- No treatment on the other 9 areas
- Some sewers are over 80 years old

Existing Wastewater Management - The State of the Harbour

The Harbour has been impacted by both a century of industrial activities and by the discharge of raw wastewater and stormwater into the harbour. Future liquid waste management planning needs to consider the harbour in a holistic manner, looking at both the existing situation, the objectives of the community and the ability to implement any environmental improvement program in an affordable manner.

Sewage System Upgrading Plan, May 2004

Stage 1 LWMP

- **Discussion Papers Prepared**
  - Wastewater Management Issues
  - Existing/Projected Community Development
  - Source Control
  - CSO and Wet Weather Flow Management
  - Develop Wastewater Management Options
- **Three LAC/TAC meetings**
- **Public Presentation and Open House**
- **Summary Report**

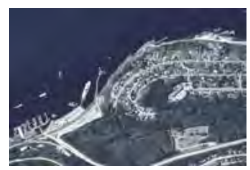
Stage 2 LWMP Tasks and DPs

1. **Waste Volumes and Facility Sizing Criteria**
2. **Wastewater Treatment Facility Options**
3. **Treatment Technology Options**
4. **Land Requirements and Availability**
5. **Wastewater Conveyance and Disposal Methods**
6. **Sustainability and Integrated Resource Recovery Options**
7. **Cost Estimate for Short Listed Options**
8. **Public Involvement** and **Final Report for Stage 2**

LWMP - Stage 2

Discussion Paper 2-1

Waste Volumes and Facility Sizing Criteria



Objectives of Discussion Paper 2-1

- Confirm population projection developed in Stage 1
- Estimate wastewater volumes
- Wastewater treatment requirements
- Estimate the amount of non-biodegradable solids
- Estimate the amount of sludge

Discussion Paper 2-1 Conclusions

- Design population based on 1.5 percent growth
- ADWF is estimated for 2030 and 2050
- Maximum daily flow is estimated for 2030 and 2050
- Solids production estimated
- Treatment requirements defined

Liquid Waste Management Plan - Stage 2

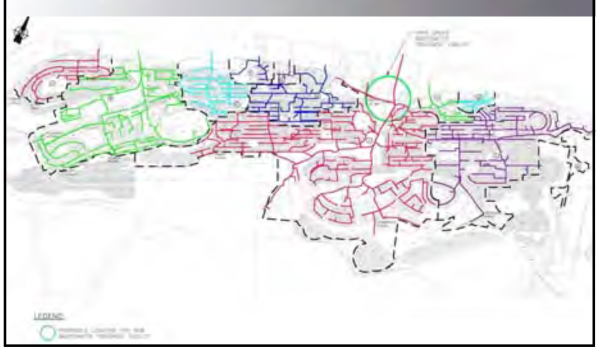
Discussion Paper 2-2

Wastewater Treatment Facility Options

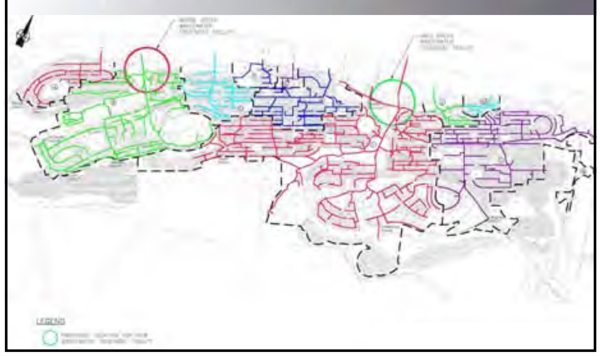
Objectives of Discussion Paper 2-2

- Present options for number and location(s) of wastewater treatment facilities
- Advantages and disadvantages of each option
- After consideration at TAC/LAC meeting, three options shortlisted

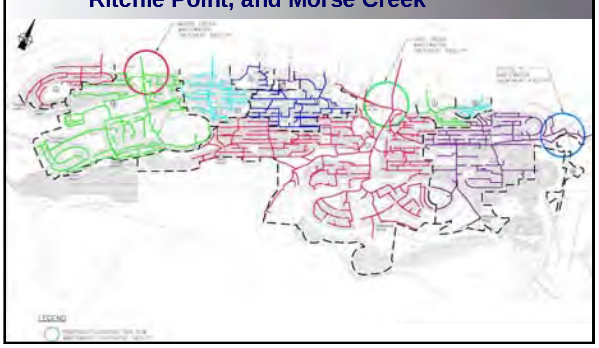
Option 1A – Hays Creek



2A – Hays Creek and Morse Creek



Option 3 - Three Facilities - Hays Creek, Ritchie Point, and Morse Creek



Discussion Paper 2-2 Summary

- Potential options for managing the City's wastewater
- Options 1A - single treatment facility at Hays Creek, and Option 2A - treatment facilities at Hays Creek and Morse Creek, should be considered further. Ritchie Point facility (Option 3) will also remain as a viable alternative if required.

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-3

Treatment Technology Options

Objectives of Discussion Paper 2-3

Feasible treatment options short-listed down to two to three for more extensive investigation, costing, and reviews

Treatment Requirements

- Up to **two times the ADWF** will be treated to secondary treatment standards.
- Up to **four times the ADWF** will be treated to primary treatment standards.
- All flows **greater than four times the ADWF** will be treated as CSO

Comparison of the Reviewed Treatment Processes Contd.

- Short-listed options are:
  - **Preliminary treatment - vortex separator**
  - **Primary treatment - microscreen**
  - **Secondary treatment - activated sludge or sequencing batch reactor**
  - **Disinfection - UV irradiation**
- Short-listing technologies is for planning purposes only
- More in-depth evaluation during pre-design stage
- Land availability and conditions - important in final technology selection

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-4

Land Requirements and Availability

Options Considered

- **Option 1A** – Single Wastewater Treatment Facility at Hays Creek;
- **Option 2A** – Two Wastewater Treatment Facilities at Hays Creek and Morse Creek;
- **Option 3** – Three Wastewater Treatment Facilities at Hays Creek, Ritchie Point, and Morse Creek.

Estimated Footprint Requirements (Year 2030 Design Flows)

Option	Facility Location	Estimated Building and Tankage Footprint Requirements (m^2)	Total Estimated Footprint, Including Access Road and Buffer Area (m^2)
1A – One facility	Hays Creek	7,600	19,000
2A – Two facilities	Hays Creek	5,400	13,500
	Morse Creek	1,600	6,400
3 – Three facilities	Hays Creek	3,900	9,800
	Morse Creek	1,600	6,400
	Ritchie Point	1,100	4,400

Land Availability

- The City needs to select and acquire properties to site one or more treatment facilities in near future
- Wastewater treatment facilities are preferred to be located away from or screened from residential areas
- Future "optimization" opportunities

Liquid Waste Management Plan - Stage 2

Discussion Paper 2-5

Wastewater Conveyance and Disposal Methods

Conveyance and Disposal Methods

- Wastewater conveyance and disposal methods for the proposed treatment options
- Pumping vs. gravity sewers
- Capacity of the existing outfalls

Option 1A: Hays Creek Facility (4 pump stations + 5 gravity trunks)

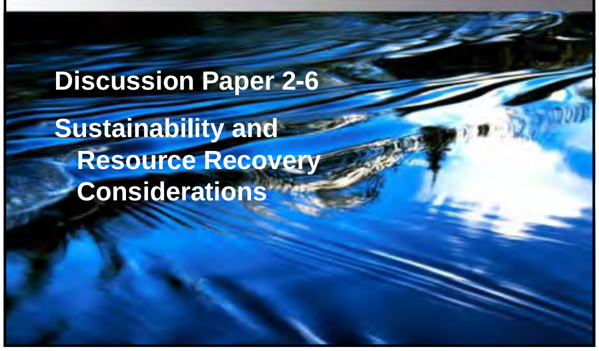
Option 2A: Hays Creek and Morse Creek Facilities(3 pump stations + 5 gravity trunks)

Option 3: Hays Creek , Morse Creek & Ritchie Point (2 pump stations + 5 gravity trunks)

Conveyance & Discharge Summary

- Different options for each of the three different wastewater treatment options
- Combination of gravity sewers and pumping stations
- Should be reviewed in conjunction with overall wastewater management direction

Liquid Waste Management Plan - Stage 2



Sustainability & resource recovery considerations

- Flow Energy Management
  - Wastewater flow management
  - Pressure energy recovery
- Wastewater Heat Recovery
- Biosolids energy recovery and reuse
- Water reclamation not being discussed at the moment (ruled out for the time being)

Biosolids Energy Recovery & Re-use Technology

- How to deal with biosolids?
- "Resource" vs. "Waste"
  - Anaerobic Digestion
  - Aerobic Digestion
  - Composting

Anaerobic Digestion & Bio Gas Use

- Bacterial process in a closed vessel in the absence of oxygen
- Biogas: 60-65% methane and 35-40% CO_2
- Cogeneration or Fuel
- Practical Scale: ~ 60,000 population
- "Mixed" biosolids (fish waste etc.)

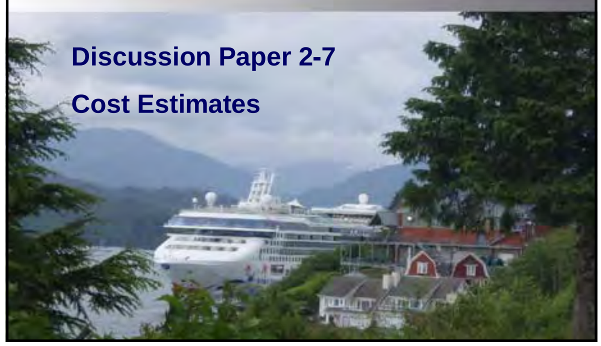
Sustainability & resource recovery considerations: Summary

- Good opportunity for the City to manage wastewater flows and conveyance
- Pressure energy recovery and heat recovery can be considered at later stages
- A number of options to deal with biosolids

Bio-Solids

- Combining wastewater sludge with fish processing waste, and if feasible, anaerobic digestion at the “largest” site or off- site
- Composting the dewatered aerobically digested or raw sludge (possible combining with other organic waste) offsite (away from the City centre)

Liquid Waste Management Plan - Stage 2



COST ESTIMATES

- “High Level” cost estimates for comparison/planning purposes
- Order of magnitude $$
- 2010 Dollars
- 35% contingency
- 15% engineering and management

Cost Estimates

- The capital cost estimate for each option includes the following items:
  - Wastewater treatment facilities
  - Pump stations and Force mains
  - Gravity trunk sewers
  - Diversion chambers
  - Outfalls
  - Off-site composting facility (separate)
  - No Land Acquisition Costs
  - $$ to be spent over a number of years

Summary of Cost Estimate

- Between 2-4 pumping Stations
- Between 1-3 treatment facilities
- A number of gravity sewers and forcemains
- Total Capital Cost estimate for different options: $80 - $90 M
- To be spent over 10-30+ years

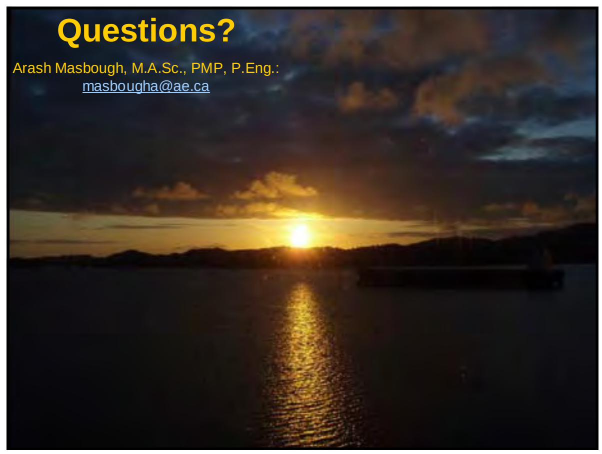
Moving Forward

OPTION	NPV	Environ.	Social	Econ.	Total
Hays					
Hays & Morse					
Hays, Morse, & Ritchie					

1high (i.e. bad), 2 medium, (i.e. OK), 3 high (i.e. good)

Next Steps

- Finalize the DPs
- Prepare the Final Draft Report
- Incorporate Comments
- Submit to the Ministry
- Stage 3 Startup



CITY OF PRINCE RUPERT
LIQUID WASTE MANAGEMENT PLAN
STAGE 2
PUBLIC OPEN HOUSE – MARCH 11, 2010
HANDOUT

LIQUID WASTE MANAGEMENT PLAN – WHAT IS IT?

A Liquid Waste Management Plan (LWMP) is a long range sustainable wastewater management strategy developed by the community, which considers environmental, social, and economic elements.

LIQUID WASTE MANAGEMENT PLAN – WHAT IS THE PROCESS?

A LWMP has three stages: setting the stage; evaluating strategies; implementation planning. The Plan is currently in the second stage. Stage one was finalized and approved in 2009. The third stage will be finalized in 2010/11. Implementation of the plan could take from ten to twenty years.

WHAT IS THE EXISTING SITUATION?

The City is discharging untreated wastewater from ten sewerage areas to the Harbour. The sewerage areas have a combination of separate and combined sewers.

WHAT IS THE CONDITION OF THE HARBOUR?

A comprehensive evaluation of the impact of the wastewater discharges and the state of the Harbour was conducted in 2001 to 2003. The conclusion was that the Harbour has been impacted by both a century of industrial activities and by the discharge of raw wastewater and stormwater into the Harbour. The major impacts were identified as pathogenic organisms in the near shore water and elevated levels of metals and trace organics in the sediments near the outfalls.

WASTEWATER MANAGEMENT – WHAT ARE THE CRITICAL ISSUES?

Stage 2 has identified land requirements and availability, conveyance and disposal options, resource recovery, and overall costs as critical issues.

WASTEWATER MANAGEMENT – WHAT IS DONE AND WHAT IS THE MOST LIKELY DIRECTION?

The work to date has identified that directing the wastewater flow to between one and three wastewater treatment facilities, located along the Harbour shoreline, is the most likely direction. A number of options are short listed and high level cost estimates are provided. Land requirements for each option are calculated. Most likely a preferred option will be selected and an implementation plan for staging and timelines will be prepared.

CITY OF PRINCE RUPERT
LIQUID WASTE MANGEMENT PLAN
STAGE 2
PUBLIC INFORMATION MEETING – March 11, 2010

QUESTIONNAIRE

1 EXISTING SITUATION

Was the existing wastewater management situation clearly explained? ____________________

If not, what areas do you think require more explanation? ______________________________

____

____

2 CRITICAL ISSUES

The critical issues identified were treatment facility locations, land requirements and high level cost estimates.

Did the presentation help you understand these issues? _______________________________

Would you like more information on some of the issues? _______________________________

Do you feel there are critical issues that were not discussed? __________________________

____

____

3 FUTURE STEPS

The LWMP is currently at the second stage of three stages. The possible directions in Stage 3 were discussed.

Do you feel the planning work is going in the right direction? __________________________

If not, can you suggest directions that should be considered? __________________________

____

____

Thank you for your attendance. Please provide any further input or questions to City Hall (www.princerupert.ca) or to the engineering team at masbougha@ae.ca.

MARCH 5/10

3323

CITY OF PRINCE RUPERT

INVITATION – PUBLIC OPEN HOUSE
MARCH 11, 2010
STAGE II LIQUID WASTE MANAGEMENT PLAN

The City of Prince Rupert is developing a Liquid Waste Management Plan (LWMP) to act as a guide over the next few decades as the City moves towards implementation of secondary wastewater treatment. At present, the City has minimal formal wastewater treatment and 11 wastewater outfall pipes into Prince Rupert Harbour. Based on the final result of the three stage LWMP, the City will commit to the implementation of secondary wastewater treatment, in compliance with the goals of the Canadian Council of Ministers of the Environment (CCME) and the Province of BC's Municipal Sewage Regulation (MSR).

At this point, the City, with its wastewater consultant, Associated Engineering, is in the process of completing Stage II of the three stage LWMP process. Stage II has developed the background wastewater flows and has identified the wastewater treatment issues and the likely long list of potential solutions. As a result, it is appropriate to bring this information to the general public for their comments.

We are pleased to invite you to a public information meeting for a presentation of the Stage II Draft Summary Report and to hear your comments on the LWMP process. Refreshments will be provided.

Date: **Thursday, March 11th, 2010**
Location: **City Hall, Council Chambers**
Time: **4:30 pm to 5:30 pm Open House**
5:30 pm to 6:30 pm Formal Presentation
6:30 pm to 7:30 pm Question & Answer Period

heart rate, swelling in her hands and arms, and spasms of post-surgical pain unlike anything she had felt before.

Kehoe weighed 267 pounds going into surgery. In 2002, when she was at her heaviest, she weighed 310 pounds. But even at 240 pounds, she could ski down a mountain or walk 10 kilometres. She admits there were times she was fitter than others, times when the sheer size of her body and the ache in her joints made exercise painful. But there were times, too, when she would exercise regularly, hitting the gym three to four times a week for months at a time. But the numbers on the scale never budged.

Kehoe is an extreme example of an overweight nation, a nation that has been taught exercise is a surefire path to weight loss. But controversy is growing over whether working out to lose weight can be an exercise in futility. At issue is whether the amount of exercise needed to make a meaningful impact on the prevalence of obesity is unrealistic and whether gluttony, and not sluggishness, is where we should be focusing our efforts.

According to the latest estimates from Statistics Canada, 37 per cent of the adult population aged 20 to 69 - 7.9 million people - are overweight, meaning they have a body mass index between 25 and 30. Another 24 per cent - 5.3 million - are obese, with a BMI of 30 or more.

Eric Ravussin, who is recognized internationally for his work in obesity and diabetes, says the amount of exercise needed to cause significant weight loss is more than most free-living individuals are capable of undertaking. In general, he says, that holds for anyone

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MONICA LAMB-YORSKI PHOTO

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laid out in 1908, and by 1912 there were hydro electric buildings erected there. The town grew, due to the fishing industry, but Prince Rupert has never "spilled over" into Port Edward.

During World War II, Port Edward became a military base. Nearby Watson Island was busy with ships and trains arriving at all hours of the night and day and Port Edward was incorporated in 1966.

Today the population is around 577. The district encompasses two provincial parks, an ecological reserve and a major historical site at North Pacific Cannery.

"Outdoor recreation opportunities are abundant, and include fresh-water and salt-water sport fishing, hunting, hiking, camping, and boating. Because of its time-honoured presence, west coast native culture is a prominent feature of the area," states the District's website.

mayor also

s in the city

March 10/10
D.N.

CITY OF PRINCE RUPERT

INVITATION – PUBLIC OPEN HOUSE
MARCH 11, 2010
STAGE II LIQUID WASTE MANAGEMENT PLAN

The City of Prince Rupert is developing a Liquid Waste Management Plan (LWMP) to act as a guide over the next few decades as the City moves towards implementation of secondary wastewater treatment. At present, the City has minimal formal wastewater treatment and 11 wastewater outfall pipes into Prince Rupert Harbour. Based on the final result of the three stage LWMP, the City will commit to the implementation of secondary wastewater treatment, in compliance with the goals of the Canadian Council of Ministers of the Environment (CCME) and the Province of BC's Municipal Sewage Regulation (MSR).

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250-627-5687

TUESDAY • MARCH 9, 2010

Community invited to comment on waste management plans

$1.00 INCLUDING GST

801 SECOND AVENUE WEST, PRINCE RUPERT, BRITISH COLUMBIA, V8J 1H6
SECOND CLASS MAIL - REGISTRATION NO. 0221

BY MONICA LAMB-YORSKI
The Daily News

It may be a dirty word, but wastewater is being discussed in a good way.

Prince Rupert's harbour has been the recipient of raw sewage for over a century. Some of the city's sewer system was constructed prior to WWI and some prior to WWII.

Major infrastructure work was done in 1959 and 1960 to replace and extend many trunk and lateral sewers.

According to the City's website, "In the late 1970s, the Prince Rupert sewage system consisted of twelve individual sub-catchment areas, all discharging directly into Prince Rupert Harbour without treatment.

At the present time only the core urban area sewage system receives preliminary wastewater treatment through the use of comminutors, which are units that grind up sewage solids prior to discharge directly to Prince Rupert Harbour without treatment."

To address sewage concerns, the City is developing a Liquid Waste Management Plan to act as a guide over the next few decades as the City moves towards implementation of secondary wastewater treatment.

On March 11, the day after the City's one hundredth birthday, the community will have the opportunity to see a presentation of the plan's Stage II Draft Summary Report and give feedback.

An Open House will occur between 4:30 and 5:30 p.m., there will be a formal presentation from 5:30 to 6:30 p.m. and a question and answer period between 6:30 and 7:30 p.m.

The Daily News has had a sneak preview of the report.

Within the document are various options surrounding single, double or triple facilities for centralized treatment. Possible locations include Hays and Morse Creeks, Ritchie Point, the Industrial Park and Watson Island.

Under the single facility options, Hays Creek would require the installation of new pump stations and gravity sewers to accommodate approximately 40 percent of the City's total wastewater.

In its analysis, the steering committee has listed advantages and disadvantages of the Hays Creek site.

While solids would be treated onsite, the overall treatment would be taking place in the City's core.

"Resource recovery, such as energy recovery from organic solids, is potentially viable," states the report while, "land may be difficult and more expensive to acquire."

With the Port Edward option, the former pulp mill, located 15 km outside the City, could be used.

Existing tankage at the former pulp mill industrial wastewater treatment facility could be utilized and from there wastewater would be pumped to the Port Edward facility.

Again advantages outlined in the report include existing tankage, treatment taking place away from a highly populated area, and the fact that solids would be likely to be treated onsite and not require hauling elsewhere.

Under its list of disadvantages, the report lists the cost of conveying wastewater from the City to Watson Island, that existing tankage may limit the treatment process selection, and the tanks would be likely to require refurbishment.

WASTEWATER cont'd on page 5

MONICA LAMB-YORSKI PHOTO

WHO HAS MORE FUN THAN KIDS? this youngster is definitely enjoying her ride as she bounces around the activities of this year's Children's Festival held last Saturday. For a photo display of more great pics, see page 10.

Fish treaty talks will

Flip-flop in Beaufort Sea dispute

nwest News Service

ys after the Conservative gov-s throne speech pledged to everal outstanding Arctic terri-sputes, polar experts have an unexpected twist in the nning disagreement over the -U.S. border in the southern t Sea.

lecades, the two countries have eadlocked over where to draw aritime boundary off the coasts ska and the Yukon - a conflict as flared occasionally when it to fisheries management and oil-gas exploration.

e dispute has created a wedge-ed, Lake Ontario-sized section of Arctic Ocean that both countries n is theirs. Canada's position is ed on a 19th-century treaty that ends the Yukon-Alaska land bound-out to sea, and the U.S. position is ived from an "equidistance" princi-based on the shape of the adjacent erican and Canadian coastlines.

But at a weekend conference in nchorage, Alaska, where U.S. and anadian experts in Arctic sovereignty and international law met to discuss the long-simmering dispute, they emerged with a fresh understanding of the boundary battle that turns the whole business upside down.

They concluded that as the two countries pursue new seabed claims under a UN treaty beyond the disputed area - in the central and northern parts of the Beaufort Sea - the U.S. would actually benefit from Canada's interpretation of the offshore boundary, and Canada would gain a greater share of undersea territory using the American approach.

The reason, says University of British Columbia professor Michael Byers, is that the farther north the disputed boundary runs, the more Canada's Banks Island comes into play under the U.S. formula for drawing the demarcation line.

Until recently, the focus of the dispute was on potential oil and gas resources in the southern wedge of overlapping ocean, which covers about 21,500 square kilometres.

According to the U.S. position, Alaska's northward-sloping coastline means the sea's southern maritime boundary veers slightly eastward of the Yukon-Alaska land boundary, giving the U.S. a greater amount of marine jurisdiction.

But the overlap in the northerly expanse of the Beaufort would be much larger - and reversed, with the boundary under the U.S. formula swinging far to the west because of Banks Island, giving Canada a greater share of the potentially oil-rich seabed.

"The curiosity of this is that, in terms of sheer amount of seabed, the U.S. position ends up being better for Canada, and the Canadian position ends up being better for the United States," says Byers, who helped organize the weekend workshop with leading scholars on Arctic issues and maritime law.

"All of a sudden, we have this almost perfect opportunity for a win-win, negotiated solution," he adds. "Regardless of which method you use (to determine the boundary), each country is going to get a substantial amount of what is the new disputed sector - the perfect recipe for a negotiated compromise."

Byers points out that the nears part of the Beaufort may still be sidered more valuable becaus example, undersea oil deposits be more readily exploited close coast.

But recent seabed surveys central and northern Beaufort - have yielded evidence of thick sediments far from the outlet Mackenzie River - have generat mism among both Canadian a officials that significant u petroleum resources exist in th

The unusual boundary situ arisen now because both Ca the U.S. are gathering underv logical data for planned seab beyond the countries' 370-kilometre (200-mile) off nomic zones.

WASTEWATER cont'd from page 1

The third location, the Industrial Park, has the advantage of being located away from the City. The land would be cheaper to acquire than the Hays Creek option, and solids could be treated onsite.

Again, there are the costs involved with conveying the wastewater to a centralized site and then to the Industrial Park. "It will likely require an effluent pump station and force main to Harbour outfall," cites the report.

Under the two-treatment facilities option, the first one, Hays Creek and Morse Creek, recognizes the fact that 40 percent of the City's total wastewater is already discharged through Hays Creek at Outfall I.

There would be lower costs for conveyance than having a single facility at Hays Creek, Watson Island or the Industrial Park.

An additional advantage would be, "resource recovery, such as heat recovery is potentially viable," states the report.

In its notes on disadvantages, the report points to the location of Hays Creek within City limits, the cost of the land and the reality that "solids would like likely be treated at a central facility and requiring hauling offsite."

For the Hays Creek & Ritchie Point option, Hays Creek would handle 80 percent of the sewer and Ritchie Point 20 percent. Effluent would be discharged to the harbour through long, deep outfalls.

The third option outlined is for three separate wastewater treatment facilities located at Hays Creek, Ritchie Point and Morse Creek.

Again, there are advantages and disadvantages. Treatment facilities are located in areas with the largest wastewater flows and resource recovery is possible, states the report, but similar to other options, the location is in the city core, land is expensive and solids would have to be transferred.

The presentation will also cover various treatment technologies. All community members are encouraged to attend.